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ABSTRACT

This collection presents papers pertaining to the wide area of educational multimedia/hypermedia and telecommunications. The conference serves as a forum for the dissemination of information on the research, development, and applications in all areas of multimedia/hypermedia and telecommunications in education across all disciplines and levels. The papers cover a range of topics, including: instructional design; distance education; authoring; media in education; interactive learning environments; pedagogical issues; hypermedia systems; hypermedia applications; small dedicated applications; networked environments; courseware; educational media design; and computer supported cooperative work. This collection is a guide to what is happening in educational multimedia and hypermedia, now and in the future. This proceedings contains 485 short and full papers, reports of 6 panels, 23 tutorials and workshops, and 130 posters and demos. (DLS)

ED-MEDIA & ED-TELECOM 98

10th WORLD CONFERENCE ON EDUCATIONAL MULTIMEDIA AND HYPERMEDIA & WORLD CONFERENCE ON EDUCATIONAL TELECOMMUNICATIONS

Edited by
Thomas Ottmann
Ivan Tomek

Proceedings of ED-MEDIA/ED-TELECOM 98

WORLD CONFERENCE ON EDUCATIONAL MULTIMEDIA AND HYPERMEDIA
& WORLD CONFERENCE ON EDUCATIONAL TELECOMMUNICATIONS

Freiburg, Germany; June 20-25, 1998

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Preface

Welcome to ED-MEDIA/ED-TELECOM 98 in historic Freiburg, Germany. After two years in North America (Boston and Calgary), the conference is returning for its regular third year in Europe. The conference, a successor of the International Conference on Computers and Learning (ICCAL) which started in 1987, is already in its eleventh year. Over the last decade, ED-MEDIA/ED-TELECOM has become one of the top events of its kind in the world, thanks largely to the efforts of many volunteers.

Organized by the Association for the Advancement of Computing in Education (AACE), ED-MEDIA/ED-TELECOM retains many valued aspects of the earlier conferences, most importantly the truly international nature of its participants and its wide scope of coverage. Over the years, the conference has grown in sophistication, scope and number of participants, as has the technology that it presents, and this year's version will live up to this established trend. The following paragraph summarizing this year's statistics attests to this claim.

This year's conference received proposals for papers, panels, posters and demonstrations, and tutorials and workshops from 46 countries. After a careful review by the conference Program Committee (PC) whose members are listed on the following page, a total of 485 short and full papers, six panels, 23 tutorials and workshops, and 130 posters and demos were accepted. Although submissions arrived from all around the world, the following ten countries were the source of most submissions: USA, Germany, Australia, Canada, Japan, United Kingdom, Spain, Austria, The Netherlands, and France.

Based on preliminary inquiries and early registration, AACE expects around 1,000 attendees, a 35% increase over 1995 when the conference was last held in Europe (Graz, Austria). Both the number of submissions and the interest of potential participants confirm the growing importance of computer technology in education, and the popularity of ED-MEDIA/ED-TELECOM.

As co-chairs of the conference, we have done our best to ensure high quality of papers, tutorials, workshops, posters, demonstrations, panels, showcases and other events at this year's conference. This would not have been possible without the hard work of PC members from nearly twenty countries who reviewed more proposals than ever before. Separately, demos and posters were reviewed by Nick Scherbakov, panels by Peter Brusilovsky, and tutorials and workshops by Maria Teresa Molfino. Members of the PC and of the Steering Committee members also suggested and selected the keynote and invited speakers. The hard work of logistics was performed by the AACE team under the leadership of its Executive Director Gary Marks.

We acknowledge the hard work of the Local Executive Committee in Germany including Dieter Fellner (Technical University Braunschweig), Günter Müller, Eduard Bock, Frank Dal-Ri, Volker Krieger, Rainer Müller, Elisabeth Patschke. and most particularly Michael Sethe.

Finally, special thanks are extended to the conference local host, Albert-Ludwigs-Universität Freiburg, and to the local sponsors: University of Freiburg, State of Baden-Württemberg, Medien- und Filmgesellschaft Baden-Württemberg, Medienforum Freiburg, City of Freiburg, ASKnet GmbH Karlsruhe, and Eurographics Association.

A conference could not occur without presentations, and we are grateful to the hundreds of authors who submitted their thoughts, experiences, and hard work for presentation. Thank you one and all.

More than a year of preparation will soon be over and ED-MEDIA/ED-TELECOM 98 will be a memory. It is our hope that this memory will be refreshed each time you open this volume, seeking information and inspiration for your future work. We look forward to meeting you in Freiburg, and seeing you again next year at ED-MEDIA/ED-TELECOM 99 in Seattle, USA.

Thomas Ottmann, University of Freiburg, Germany
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KEYNOTE PAPERS

AEIOU - The Development and Presentation of a Multimedia National Project

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Abstract: The 5 letters AEIOU are found over the entrance of Austria's most famous gothic cathedral, St.Stephan's in Vienna. Nobody really knows what they stood for. Some say they stood for "Austria Erit In Orbe Ultima" (Latin) meaning something like "Austria will be the ultimate country in the world" or (German) "Allen Ernstes Ist Oesterreich Unersetzlich" meaning something like "All of the world belongs to Austria", and there are also some more modest interpretations! Be it as it be, Austria celebrated its millennium in 1996 and for this occasion the hypermedia group at Graz University of Technology was awarded a contract to prepare a multimedia presentation of Austria, again using AEIOU as acronym: this time the 5 letters stand for "Annotatable Electronic Interactive Austrian (in German Austria is called Oesterreich) Universal encyclopedia".

By end of 1996 a 4 G Byte presentation of Austria including a complete encyclopedia, hundreds of pieces of music, hundreds of historic movie-clips, thousands of historic, geographic and arts pictures, and much more was available on the Web (see http://www.aeiou.at). To be able to strucure and adminstrate such a huge amount of information new techniques involving the WWW based knowledge-management system Hyperwave (see http://www.hyperwave.com) were necessary.

In this presentation, those techniques are presented. It is explained how AEIOU can be used as a treasure-cove for teaching and learning purposes. Continuing work and why it is necessary will also be discussed. AEIOU will be compared with some other similar undertakings. A good part of the demonstration will, however, be dedicated to a guided tour through some of the highlights of AEIOU, and this tour should be a feast for both eyes and ears.

Virtual Education Manifesto:
Where Are We Going Technologically and Market-wise?

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Abstract: How can we integrate educational technology into the workflow? We will consider three activities: courseware and learning, virtual classroom and teaching, and virtual school and administering. Our own efforts to integrate into the workflow of users will be illustrated for each of these activities. Then the market will be broadly analyzed from the perspective of three types of providers: corporate educators, state educators, and brokers. A growing market is predicted for corporate education to employees and clients. One challenge is to implement the model of student learning that fits into the life style of the student and that allows the computer to monitor for quality.

1 Introduction

Virtual education realizes a new synergy among people and their information technology tools. Virtual education *transcends boundaries* – space, time, and organizational boundaries [Rada 1997]. What tools are being developed for this education and what audiences are best positioned to benefit from these tools? What organizations will take responsibility for what education? Some people predict the end of traditional, place-bound education [Noam 1995]. The more compelling argument is that new markets exist, and that a continual adjustment is needed so that certain, new technologies fit into the educational needs of certain students.

The next section of this document views the educational enterprise as divided into Learning and Courseware, Teaching and Classrooms, and Administering and Schools. From each of these three views, what is the model of the educational process and what tools are relevant? Our work in implementing models is used to illustrate the directions that we believe are most profitable. Next, the deliverers of virtual education are related to new market niches. Finally, the challenge to virtual education is posed as a *dialectic* that needs to be repeatedly resolved through the mapping of people, tools, and problems.

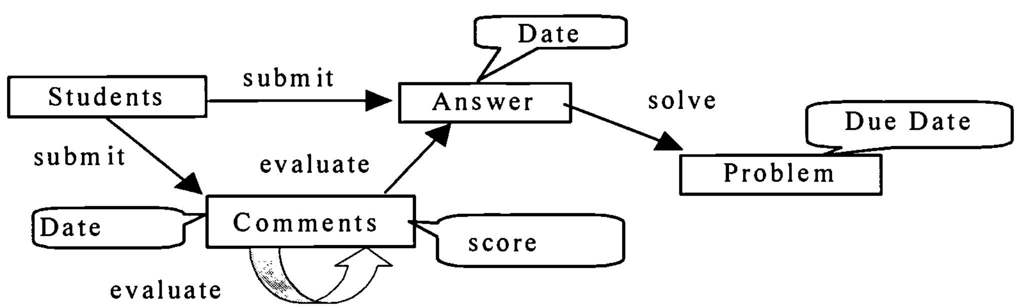

Figure 1: This flowchart of part of a virtual classroom system shows the student's submission of an answer and comments, each date stamped. The comment also assigns a score to the answer.

2 Learn, Teach, and Administer

For different learning tasks different interactivities are appropriate. The book printed on paper remains a valuable tool for certain learning purposes. Through *courseware* the computer supports learning tasks. At its simplest, courseware holds linked text that gives the student a different kind of flexibility with browsing. An intelligent tutoring system uses domain, pedagogy, and student models to simulate a 1-to-1 student-teacher interaction. These student, domain, and pedagogy models can help guide rich, multimedia interactions in the form of virtual realities. However, the cost of building intelligent, virtual reality tutoring systems is currently prohibitively high for most occasions. Adequate standards for the components of these intelligent, virtual reality tutors do not exist. The paucity of courseware standards interferes with the perpetuation of courseware [Rada and Schoening 1997].

Courseware may be used by a lone student or in the context of a classroom. In the classroom, students interact with other students and the teacher. The *virtual classroom* exists on the information superhighway. Groupware technologies are particularly apropos to the classroom. Groupware supports the activities of a group in synchronous or asynchronous mode. The simplest way to do this is to provide for online submission of exercise answers and electronic bulletin boards for discussion of those answers. Students may use a paper book for the core reading material. However, the computer can go beyond this relatively static role and can more directly manage student-student interactions [Fig. 1].

A classroom exists within a school. The *virtual school* is a type of virtual organization. To place a school onto the information superhighway, one needs a model of the school. This model must accommodate students, teachers, administrators, and more. Information systems are commercially available which implement a model of a school and which can be tailored to a particular school's needs. One of the impediments to progress is the idiosyncratic character of individual schools and the corresponding high cost of tailoring an information system to a particular school. With computer networks one could monitor many of the transactions within a school and automatically give feedback about the performance of people within the school.

3 Our Tool Building

For all three activities of learning, teaching, and administering we are building and maintaining educational technology that fits into the workflow of our users. Furthermore, the production of the tool itself can be semi-automated. Figure 2 illustrates how tool building must serve all the activities of delivering education.

We are developing a state-of-the-art, interactive, multimedia course for introductory economics. Students will be given clear instructional objectives that are supported by multimedia exposition. More importantly, students are repeatedly challenged to do exercises for which the courseware knows the correct answer and critiques incorrect answers of the student. The course covers introductory university economics, and part of our target audience is advanced placement, high school students because those students in their own high schools may not have an opportunity to take a course in economics other than through our courseware.

In our virtual classroom developments we have pioneered a quality control system that has students assess the work of other students. On a weekly basis students submit exercise answers and assess the work of three other students to whom they are assigned on a rotating basis by the computer [Fig. 3]. The computer not only monitors that all the assigned work is done in a timely manner and to a certain minimum standard of length

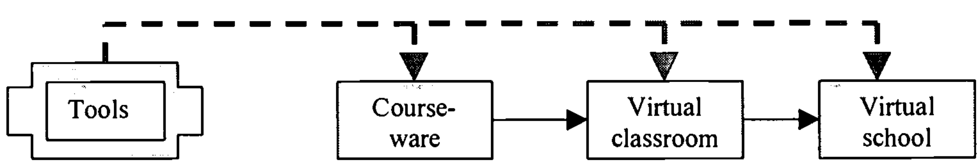

Figure 2: Tools must be built and maintained for each of the basic activities of delivering virtual education.

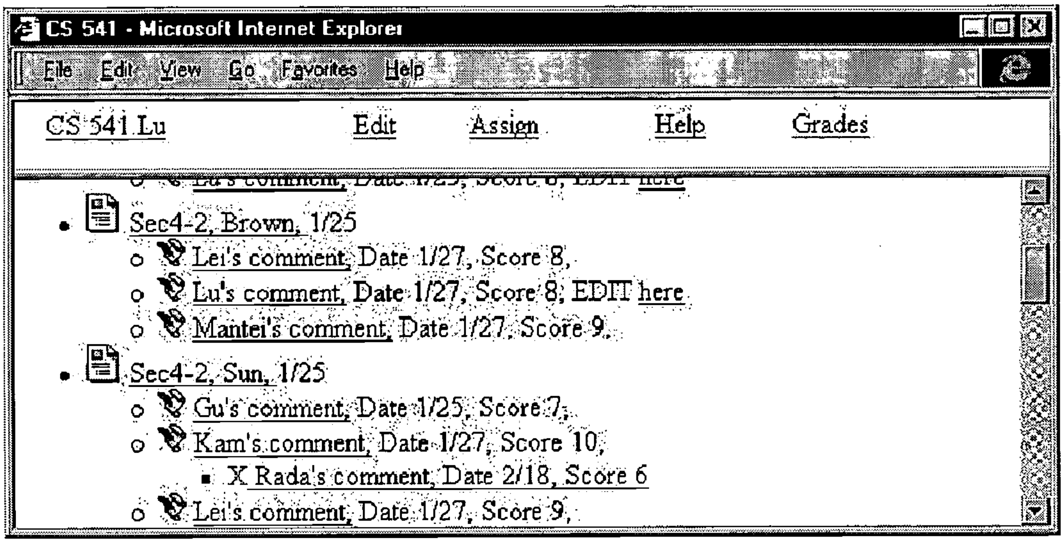

Figure 3: Window from virtual classroom into which student Lu has entered. The top banner gives Lu access to her assignments, to her grade dynamically computed, and to a view of the work of others. The lower half of the window shows the result of searching for answers and comments on Section 4 assignments. The answers are leftmost indicated and comments on the answers are indented underneath the answer along with the name of the submitter, the date, and the score assigned.

but also performs quality control calculations on the numerical assessments that students make of one another. When several students grade another student, then the variance among the grades on the answer should not be great; otherwise, the students are asked to consult with one another via email and to reconsider their scoring. Likewise, the grades assigned by one student to the other students should significantly discriminate answers, and if a student fails to distribute scores in a disciminating way, then the student loses credit. The virtual classroom allows teachers to manage the submission of work and student-student interactions in ways that would be impractical without the computer support [Rada 1996]. In our many experiences with this method of semi-automated quality control the results are pedagogically sound. We are beginning to teach to engineers at factories of the Boeing Company using this method and operating exclusively over the web.

At the school level, we have started a Virtual Information Technology College within the Globewide Network Academy (GNA). GNA was established in 1993 as the first virtual educational organization in the world. Its basic operation is to catalog virtual-mode courses and to provide free access to anyone to this catalogue. The catalog lists about 15,000 courses and receives about 1,000 visits per day. The Virtual Information Technology College provides a filter onto the GNA catalog and is offering further educational services [see http://catalog.gnacademy.org/gnacademy/vitc/].

In addition to semi-automating the work of individual students, classes, and schools as above indicated, we are also attempting to semi-automate the work of organizations that develop the educational technology tools themselves. Figure 4 shows the courseware factory web site that is based on methods elaborated in earlier European Union projects [Rada 1995]. For developing its catalog, GNA operates totally in virtual mode with email programs reminding educational organizations about the maintenance of their catalog entries, editing programs supporting the collaborative authoring of GNA online documents, and so on.

4 Corporations, States, and Brokers

Schools are often sponsored by organizations that have some market to serve [Fig. 5]. One classification of the *sponsors* considers 1) companies that educate their employees or customers, 2) state-supported institutions that offer students in the state subsidized education, and 3) brokers that connect teachers and students. What are the market niches for the schools of these different sponsors?

Many large companies have education programs for their employees, and these employees constitute *a captive audience* for education mandated by the employer. In global companies, the costs of bringing employees together in one place may be prohibitive for education or training that can, however, be cost-

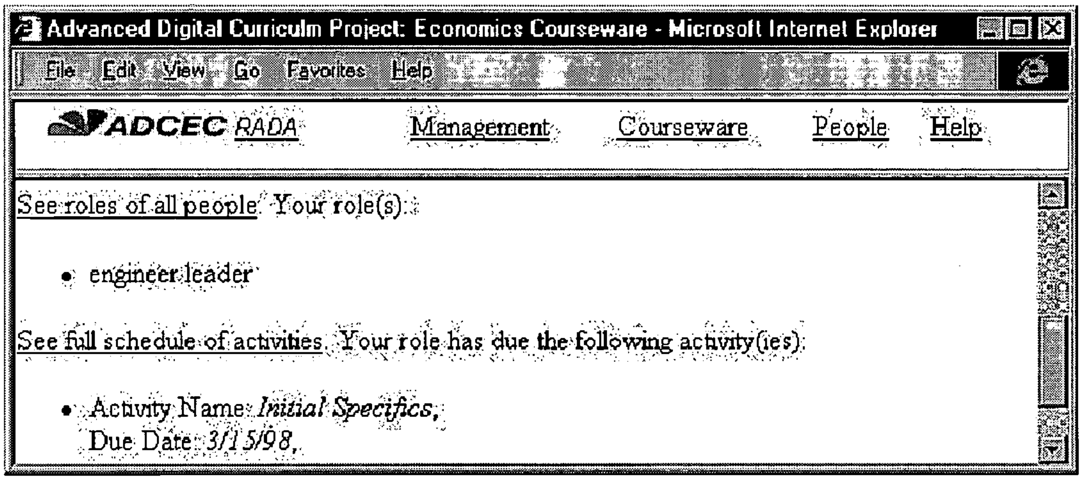

Figure 4: The window onto the courseware factory management system shows that the user Rada has logged onto the system and is assigned the role of 'engineer leader' and has an activity shortly due. The courseware itself is stored in a library on the system and both the people and their product are managed in this virtual mode way.

effectively delivered over a distance. When a course was taught on the Internet to employees in offices of one company distributed around the world, the timeliness of the topic and the low cost of participation more than offset the awkwardness of the technology [Rada 1997].

A company that sells a product has a captive audience for education. Furthermore, providing such education helps the customer use the product and thus improves *customer loyalty.* Novell Corporation develops computer network software and delivers education about networking. Some employers say that a new employee with an education certificate from Novell earns more than a new employee with a Master's degree in Business Administration. Educating customers is part of a broader mission of Novell to increase its market share [Novell 1995]:

> Novell Education's mission is to drive global pervasive computing through quality education programs and products; its purpose is to increase literacy on Novell products and technologies and thereby foster Novell's success worldwide. Novell Education plays a critical role in providing true pervasive computing by building the infrastructure of support and literacy that is necessary to drive and sustain that vision.

In other words, Novell is educating its customers so as to better sell its networking products.

The *state* collects taxes to support education. State schools for children have captive audiences and are

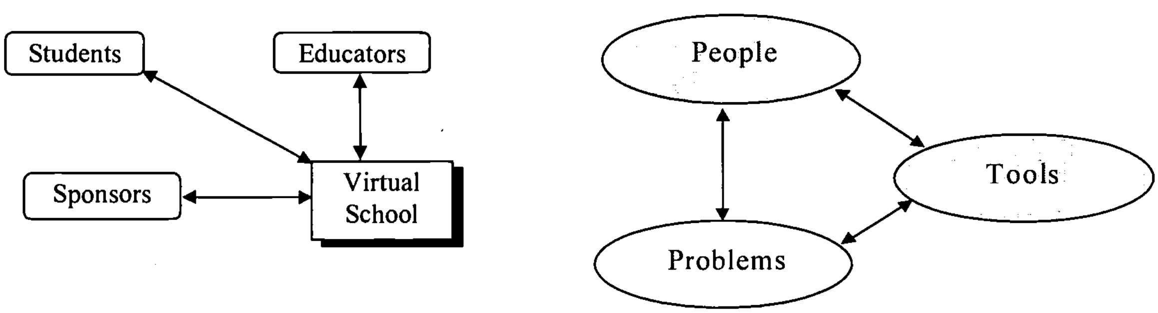

Figure 5: The diagram on the left shows that Sponsors are associated with Virtual Schools that in turn bring Educators and Students together. The diagram on the right shows that People, Tools, and Problems are intimately linked to one another.

often physically very near to the houses of the children. The reasons for virtual education to children are less to do with transcending space and time barriers than to do with duplicating teacher expertise. State universities do not have a captive audience of students in the strict sense. However, the state university is able to offer reduced costs to students from the state. The state is in a strong position to finance virtual education initiatives that bring together state-supported, higher education schools to meet state-specified educational needs for working citizens of the state.

Education brokers link students and teachers. *Brokers* can take many forms. Publishers can take advantage of the information superhighway and become brokers that go directly from the authors of textbooks to the students who study from those textbooks. Professional societies may sponsor education functions for their members and be seen as highly credible.

5 Future

The uses to which information technology might be put over the next five years in education are many and varied. One principle will surely apply: when the technology *fits smoothly into the life style* of the intended users, then success is likely, and otherwise not. For instance, if the target audience has no computers but has to go to special facilities to use them, then some of the advantages of virtual education may be diminished. Likewise for teachers and administrators, if routine computer use is awkward, then the opportunities to have a virtual organization are limited.

One key to a successful virtual educational activity is that the participants are comfortable with information technology and are highly motivated. Accordingly, one discipline that is particularly ripe for virtual education is the *information technology discipline* itself. Where else could one be more assured that the teachers and students would be comfortable with the tools? Plus the demand for information technology education is great and growing! At least in the United States, the traditional, higher education organizations have fallen woefully behind in providing information technology education, and new, virtual-mode, education organizations are entering this marketplace.

The detailed shape of information technology thirty years hence is difficult to predict. Wireless computers the size of a credit card will receive data or multimedia information anywhere and anytime for some people. Artificial intelligence techniques will allow some roles in the organization to be performed by computers. New education marketplaces may rise in prominence over the next thirty years. More and more companies may want to educate customers in virtual mode to improve customer satisfaction. State-funded organizations have rather well defined audiences and boundaries. Companies with a product to sell have different constraints. Virtual *education between company and customer* could become increasingly the mode of continuing and life-long learning in thirty years.

6 Dialectics

Consider the mapping among *tools, problems, and people* from a dialectical perspective [Fig. 5]. If we say that a certain tool supports virtual education, then we mean that for certain people with certain educational needs that a certain tool can help. For other people or other educational needs the tool may well be inappropriate. At any point in time, we could develop an extensive set of maps for various combinations of people, tools, and problems. Now consider *changes across time*. For instance, a new tool appears. This new tool may be better for some combination of people and problems than the tool that they currently use. A tension arises between the established way of working and the new way that uses the new tool. After the tension is resolved, a peace prevails only so long as people, their problems, and their tools stay in harmony.

Bill Gates emphasizes the role of *friction-free capitalism* in the information age. The information highway may extend the electronic marketplace and make it the universal middleman [Gates, 1996]. For this low-friction, low-overhead scenario to attain, market information must be plentiful and transaction costs low. Perhaps for a consumer buying a radio such a friction-free market can exist. However, students usually want education in some organizational context. Marx would say that the state should provide all education [Fig. 6]. Another dimension of the virtual education dialectic appears. What organizations will most control virtual education?

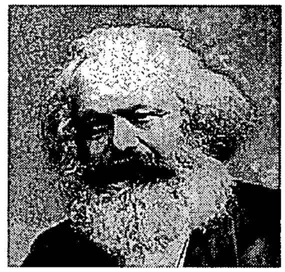

Figure 6: Bill Gates on the left and Karl Marx on the right.

In the open-market of the information superhighway, schools might re-assess their relationships with their students, teachers, and sponsors [Fig. 5]. Schools provide certification of one sort or another and can compete globally relative to their certification. The tension in *competing globally* may drive the adoption of new tools by some schools. Publishers may offer virtual education, and the competition between commercial publishers and state-financed, educational institutions is another change agent in the evolving map of virtual education.

Global companies with captive audiences of employees and customers may increasingly compete with one another through their sponsorship of virtual education. Global companies have different boundaries than those of any particular government but also have needs to perpetuate their own culture. To this end a company may collaborate with state-funded, higher education institutions to better prepare the company's employees and customers to deal with the products and services of the company. This education may go beyond narrow training and may encompass combinations of theory and practice that will be relevant to the day-to-day experiences of the students. This growth in the breadth and depth of *life-long, virtual mode education* will drive the development and adoption of new technologies that address learning with courseware, teaching in the virtual classroom, and administering the virtual school.

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Integrated Design of Real Spaces and Virtual Information Spaces Supporting Creativity and Learning

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In this talk, I will report about new ideas and concepts on extending the scope of human-computer interaction, collaboration and learning support not only from desktops to electronic meeting room or electronic class room scenarios as we and other people did in the past but we will go beyond. While the ideas are based on the results of our past system developments (e.g., SEPIA and DOLPHIN) and their empirical evaluation in experimentally controlled studies, we take now a much more comprehensive perspective resulting in highly flexible and dynamic work and learning environments. This perspective is provided by the notion of "cooperative buildings" which addresses the issues of how to integrate information technology, new work and learning practices resulting from organisational innovation, and the physical architectural environment. Our approach incorporates also ideas from augmented reality and ubiquitous computing resulting in the view that the world around us is the interface to information and for collaboration.

In order to illustrate this perspective, we have developed i-LAND: an interactive landscape for creativity and innovation. i-LAND integrates several so-called "roomware" components into a combination of real, architectural as well as virtual, digital work environments for creative teams. By "roomware", we mean computer-augmented objects in rooms, like furniture, doors, walls, and others. The current realization of i-LAND covers an interactive electronic wall (DynaWall), an interactive table (InteracTable), two versions of computer-enhanced chairs (CommChairs). Furthermore, we developed "Passage", a mechanism for connecting information structures in the virtual information world with real world objects allowing also for physical transportation of digital information. More components are planned. In the following we describe the characteristics and the realization of the "roomware" components we have built so far.

DynaWall

The DynaWall is an interactive electronic wall, representing a touch-sensitive information device with a display size of 4.5 m wide and 1.1 m high and a resolution of about 3000 by 1000 pixels. Since the availabilty of display space is a crucial point of most visually-oriented tasks, the DynaWall enables groups to display and to interact with large information structures collaboratively in new ways. Two or more persons can either interact individually in parallel or they share the whole display space. The size of the DynaWall opens a new dimension in human-computer interaction, where, e.g., information objects can be picked up at one position and dropped elsewhere on the display (pick'n'drop), or thrown from one side to the opposite side, where dialog boxes have to appear in front of the current user(s), etc.

InteracTable

The InteracTable is the first in a series of information devices that investigates general shapes and orientations of interaction areas, e.g. round or oval displays. It has been designed for display, discussion, and annotation of information objects by a group of people sitting or standing around the table. Information objects displayed on the table can be rotated and shuffled across the surface in correspondence to different view perspectives. Manipulation is done by gestures using fingers or pens, annotations by voice and/or pen.

CommChairs

The CommChairs are a new type of furniture. There are two variants: one with integrated pen-based information devices and one with a docking facility for plugging in laptops. Each CommChair has an interface for wireless networks and an independent power supply for maximum mobility. The CommChairs enable people to make private annotations and to connect to shared workspaces, displayed on devices like the InteracTable or the

DynaWall. Localization of the CommChairs in a room, identification of the person in the chair, establishing network connections and shared information displays simply by moving CommChairs together is done automatically. This is based on sensoring devices in the room. Built-in audio and video communication facilities, leaving messages for other people sitting in that chair afterwards as well as tactile notification of incoming calls/information are further aspects to be investigated.

Passage

Bridging the border between the real world and the digital, virtual world, Passage describes a mechanism for establishing relations between physical objects and virtual information structures. Within the framework of computer-augmented reality, so-called Passengers (Passage-Objects) enable people to have quick and direct access to a large amount of information and to "carry them around" in terms of physical representatives. Each Passenger has a physical and a virtual part. Passengers will be placed on so-called Bridges, making their virtual counter parts accessible.

i-LAND serves as a testbed for exploring new ideas on how to support a wide range of different group work and learning situations. This includes a special focus on the development of new computer-based creativity techniques. The design is based on an extensive requirements analysis and interview studies with creative teams in industry and large organizations. The development activities are complemented by evaluation studies to obtain early feedback from users to be used in the redesign process.

i-LAND is an example application of our vision of the Workspaces of the Future where work and learning have to be addressed in a common framework. At the same time, it is a testbed for developing new forms of human-computer interaction and computer-supported cooperative work and collaborative learning.

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INVITED PAPERS

Reuse of Educational Resources through Telematic Means (ARIADNE at HOME)

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Introduction

In this invited presentation, I will present some of the results of our work on *reuse of educational resources*. Most of this work has been carried out in the framework of HOME ('Hypermedia Object Management Environment').

Our basic aim with the development of HOME is to investigate [Hendrikx, Duval & Olivié, 1997; Hendrikx, Duval & Olivié, 1998; Duval, Hendrikx & Olivié, 1998]:

- the application of *database* technologies for hypermedia application development;
- *hypermedia modeling*, based on collections of hypermedia objects in object-oriented inheritance hierarchies,
- *design and (semi-)automatic generation* of hypermedia applications, based on conceptual design models similar to the Entity-Relationship model or more object-oriented variants thereof.

The main ideas behind HOME will be presented briefly, with an emphasis on the applications of HOME in the context of education and training (next section). The main focus will be on the ARIADNE project, where HOME has been used to set up a distributed Knowledge Pool System of reusable multimedia pedagogical documents (last section).

HOME

In general terms, our research focuses on maintainability of relatively *large* and *highly structured* applications. HOME acts as a framework for our research in this area, which is applied in several projects:

- A HOME-based research prototype has been developed on *bibliographical information* in the field of database and hypermedia research <http://www.cs.kuleuven.ac.be/~koenh/home/>. This prototype was the starting point for current developments on an Intranet based information management system for our Computer Science Department.

- AHM is a prototype implementation, based on HOME, of our approach for *adaptive hypermedia* courseware, in which a course is organized around concepts that are explained by documents. Links to concepts and documents are dynamically adapted to individual students [Pilar da Silva, Van Durm, Hendrikx, Duval & Olivié, 1997] <http://miro.cs.kuleuven.ac.be/ahm/>.

- DIGIT is a HOME-based system for the dissemination of information on the *educational application of Information Technology* <http://www.cs.kuleuven.ac.be/~koenh/digit/>.

- A nationally funded research project has just started in which HOME will be used to analyse and monitor social practices that determine the demand for *mobility*.

- HOME LITE is a personalized version of HOME that runs on low-end (e.g. portable) Personal Computers, with very limited system requirements. All information is stored in a light version of a commercially available database management system, and can be synchronised with a central server when the PC is reconnected to the network after stand-alone operation.

ARIADNE

ARIADNE is a European project where HOME is used as the underlying technology for a European Knowledge Pool System. At the core of the ARIADNE project is the idea of *'share-and-reuse'* for the development of courses supported by telematic means [Forte, Wentland-Forte & Duval, 1997a; Forte, Wentland-Forte & Duval, 1997b] <http://ariadne.unil.ch>.The Knowledge Pool System stores both the *descriptions* of educational resources and the resources themselves. As is customary in HOME, the Knowledge Pool System relies on a commercially available DataBase Management System for basic data management and query services. We are heavily involved in efforts to *standardize* the metadata structure of the descriptions, both on a European and on a more global scale. These efforts are important as such a standard would lead to interoperability between Knowledge Pool System-like infrastructures and would allow publishers of educational resources to adhere to this standard and make their material more easily accessible.

An important characteristic of reusable educational components is that they should have *no links to external material*, as this jeopardizes reusability. If such links are included, then it becomes very difficult to ensure that the links will still be relevant at a later time, when a student consults the document. The link target may well have moved, changed or have been removed alltogether. More importantly, a link to an external resource may be inappropriate in a different context, when the document is reused. Finally, a link to an external resource can easily lead to disorientation, as it blurs the boundaries of 'the course' and the vast reservoir of disparate information that the Web currently is.To ensure a critical mass of educational resources, the Knowledge Pool System needs to be deployed on a relatively large scale. Using the current Internet facilities, one central database suffers from limitations on bandwidth and Quality of Service. Therefore, a *distributed* database has been set up so that each local server handles a region of telematic influence. Material introduced at one local site proliferates to a national centre and from there to a central server in Leuven, Belgium. From the central site, descriptions are replicated to all local sites. Documents are replicated if allowed by the rights holder and if the local site has been configured to replicate the document.In order to maintain high quality content, it is necessary to have some kind of *validation* mechanism. We are mostly concerned with a consistent and clear description of the material. For the validation of these descriptions, we distinguish four levels of users, each with well-defined privileges to the Knowledge Pool.The Knowledge Pool System directly interfaces with a number of *'ARIADNE Core Tools'* that enable an end user to describe and insert new educational resources, to search for relevant material through queries on the descriptions, to define the structure of a course, and to automatically generate a Web site from the course structure and the content in the Knowledge Pool System.

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Acadia Advantage – Computerizing a Campus

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Abstract: In 1996, Acadia University joined a small number of North American universities who embarked on a transition to a fully computerized campus. The adopted strategy was to equip each student and faculty member with a personal laptop computer, take advantage of computer technology in most courses, and provide ubiquitous access to the computer network everywhere on the campus.

In this presentation, we will describe the experience of campus computerization, talk about the logistic problems, impact on faculty and students, successes and disappointments, present video tapes showing the use of computer technology in our classrooms, and introduce some of the technical and education-related research that was stimulated by the project.

Introduction

Acadia University located in Wolfville, Nova Scotia, is a small, predominantly undergraduate, teaching-oriented university in Eastern Canada. Its full-time enrolment is about 3,500 undergraduate and some 100 MSc students, for a faculty of about 230. Student-faculty ratios are relatively low, class sizes typically 20 to 30 students, with only a few around 100. The corresponding size of classrooms, labs, and other teaching facilities is generally quite small too. With its small size and focus on teaching, Acadia University has always placed emphasis on instructional style and technology.

In 1996, Acadia University began the Acadia Advantage program (AA for short), an academic initiative that integrates the use of notebook computers into the undergraduate curriculum. Phase I of the program saw 370 students and 45 faculty piloting the initiative. In September 1997, all first-year, full-time undergraduate students and approximately 125 faculty entered the program. By the year 2000, all full-time undergraduate students and all faculty will be involved.

History

The original impulse for the creation of AA can be traced back to difficulties associated with maintaining information resources. During the late '80's Acadia University faced the problem shared by many other North American universities: How to continue providing students and faculty with the information and knowledge resources required to maintain a dynamic academic environment under the conditions of decreasing public grants and increasing costs of purchase and storage of printed materials. At the same time, some faculty members felt that the traditional lecture format needed to be adopted to new technologies to prepare students better in critical areas of communication skills, problem solving, working in groups, entrepreneurial instincts and technological capabilities. In addition to these fundamental challenges, Acadia faced daunting costs in maintaining the traditional computing facilities that students and faculty had come to expect and to depend on.

In 1989, a report entitled The Global Library was prepared at Acadia University by the Director of the Computer Centre and the University Librarian. The document was approved by the Senate and the Board in 1991. Key among its more than 20 recommendations was the goal to provide access to the information highway at the user's preferred location on the campus. As Acadia moved to implement this strategy, it became increasingly clear that all of the objectives could be met through a single project. The first step in the project - identification of what was to become the Acadia Advantage Program - began in August 1995. Through the fall of 1995 and into early 1996, the initial concept was investigated, discussed, refined and developed. The final draft of the plan was presented to an open assembly and approved by the Senate and the Board of Governors in the spring of 1996.

Implementation

The key elements of the project included identification and study of similar projects in North America, identification of material and development needs, design and construction of new teaching facilities in support of the new technology, design of a program to support faculty development, and significant increase of the capacity of the existing campus wide intranet.

While the project was under development, various other universities started introducing "electronic" classrooms [Mühlhäuser 1996], [Shneiderman 1995] where each student has access to his or her computer, either a mobile notebook [Wake Forest, 1997] or a stationary computer (University of North Carolina). In these classrooms, computers are usually networked, allowing students to access Internet. At the same time, various organizations started developing integrated educational systems that provide numerous facilities including access to information about courses such as course descriptions, computerized course materials, discussion groups, chat rooms, on-line tests, etc.

During the summer of 1996, a new ATM backbone was installed beside the existing FDDI backbone. Fibre optic cable was extended to all buildings on campus, and copper wiring was provided to bring data to faculty offices and classrooms. Seven classrooms ranging in size from 30 to 100 were redesigned and provided with network connections to all seats. Each classroom was provided with full multimedia capabilities that are easily operated from an instructor console. Approximately 3000 sites on campus were wired including the library, public gathering areas, lounges, offices and other key locations. In the summer of 1997, 12 more classrooms and several laboratories were renovated, and by summer's end of 1998, 60% of all learning facilities will meet AA requirements.

At the time of this writing, each new AA student arriving at Acadia is provided with an IBM Thinkpad with 24 MB RAM, and 1.2 GB hard disk, a CD ROM drive, and software including Windows 95, Microsoft Office Suite. A host of discipline-specific programs is included individually to satisfy the needs of each department. Faculty and students make use of the computers in both synchronous and asynchronous ways, using them in a standalone or network connected fashion. The majority of courseware is either TCP/IP based or resides on individual laptops and students thus have 24-hour access to courseware material. The hardware/software configuration continuously evolves and selection of a new model with more RAM and disk space for the fall of 1998 is under way.

In terms of faculty development, Acadia faced a fundamental problem faced by all colleges and universities undertaking similar initiatives: What type of support will most successfully help faculty to prepare course material and master the new technical tools available to them for curricular innovation? Students involved in the program have high expectations about the use of the technology (they pay an extra amount in addition to already high tuition fees), and many faculty were rightly concerned with pedagogy and course content. Information on the effective use of computers in education is full of qualitative data, but little concrete information was available to help guide the process. It was clear that faculty should not be required to learn all there is to know about using personal computers, accessing the Web, developing courseware, adapting to new modes of scientific data acquisition, or constructing on-line tutorial or testing programs. What was needed was a place where faculty could go to discuss possibilities and find help in implementing technology-based enhancements to instruction.

To address this need, the university created a central location to support faculty development, the Acadia Institute for Teaching and Technology or AITT, now better known as the 'Sandbox'. AITT is the primary on-campus site for technical support of computer-enhanced learning, research, development, and training. Quite naturally, AITT also came to play a crucial role in the selection and development of educational software. The first steps in the selection of appropriate software included evaluation of numerous commercial packages, as well as software developed at other institutions. Cost, installation, support, and maintenance issues were considered and in the end, a mixture of software with a shared core of applications augmented by discipline-specific applications adopted. Due to the perceived unsatisfactory quality or lack of match with course specific requirements, AITT undertook to develop a core application that would satisfy the shared needs of the faculty across all departments.

The largest Sandbox project in the area of software development to date has been the development of ACME - an Automated Courseware Management Environment [ACME]. ACME (Figure 1) is a Web-based course development package that has now been widely adopted by the faculty; at present, 150 faculty use it in over 450 courses and labs on-line. Its first version was developed over a short period of time, mainly by Acadia University Computer Science students under the leadership of the first author.

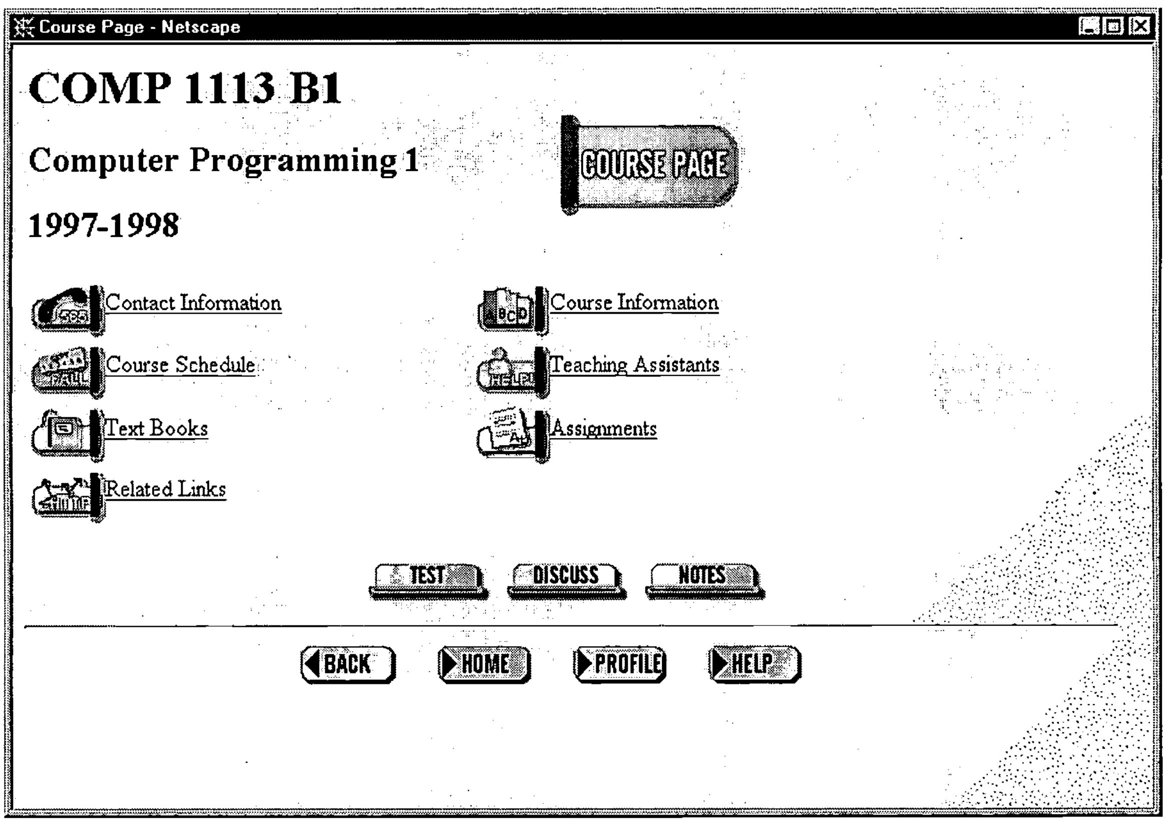

Figure 1. A typical ACME course page providing access to course materials and other facilities.

The main goal of ACME is to make courseware development and use as easy as possible for faculty and students with limited computer expertise. The package provides a directory of registered courses allowing authenticated users to access their personal combination of course materials. The tools provided include access to general course materials, access to the instructor and information relevant to the course provided by the instructor, a discussion group facility, and an on-line test tool.

The early experience with ACME has been positive as both the faculty and students enjoyed the opportunity to access a large amount of material within a fully integrated and easy to use system. Soon, however, users started presenting new demands, asking for additional features and for customization of existing features. This has been positive in correcting initial design shortcomings and helping to discover new possibilities, but it also created problems in that specific features are required only by small audiences and are not economically justifiable. Because of unsatisfied requirements and interest in exploring new directions, various faculty members started developing their own subsystems as their personal research projects. This initiative is currently supported in two ways – by a competitive university Teaching Innovation Fund which supports selected projects in the general area of innovative teaching endeavours (commonly AA-related), and through support provided by the Sandbox. Sandbox support for departmental AA-related activities has the form of allocating qualified students to individual departments for varying lengths of time during the summer, to help with the implementation of AA-based course materials.

Among the education technology-related research activities triggered by the AA initiative, the best known probably is the Digital Agora [Waters et al., 1998], a Web-based interdisciplinary project that aims at shifting the educational paradigm in social sciences from instructor-centered to student-centered (Figure 2). The project allows authorship of hypertext nodes and links (both shared and private), discussion groups, collaborative analysis, simulations such as economic forecasts and population growth, and graphical representations of complex issues using lateral maps built from a dictionary of shared annotated symbols. The project provides access to primary and secondary data, supports quizzes and evaluations, consensus negotiation, collaborative writing, online student newspaper, glossary, calendar, personal annotation, and additional features. The software has been initially used by Political Science students at Acadia University but its use has now grown beyond Acadia University and outside of university educational settings.

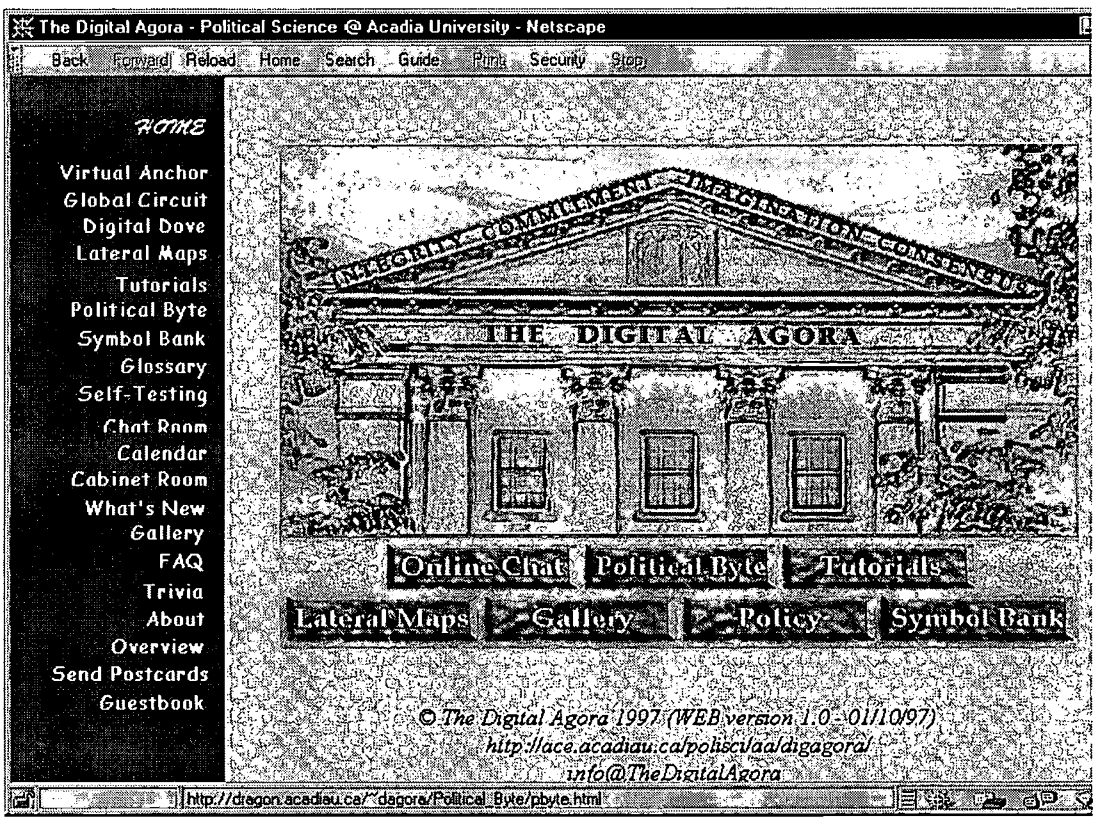

Figure 2. Digital Agora's home page.

Since learning is a collaborative process and since computer networks invite collaboration but don't provide sufficiently sophisticated tools to support it, faculty researched development of collaborative and interactive sharing of tools and collaborative virtual environments (CVEs). In particular, the second author of this paper is involved in research on the following implementation techniques: servlets instead of CGI, RMI or Corba rather than sockets, Java instead of ad-hoc user-defined specialized servers (such as relay servers), and JDBC for persistent data. The cost of this approach is in the need for highly skilled programmers, but the benefits greatly outweigh the cost: The resulting software will be efficient, maintainable, portable and modifiable. The following projects are currently under investigation: (1) Virtual collaborative working environments [Hussey, 1998]; (2) Comparison of RMI and Corba for development of persistent shared workspaces; (3) Comparison of two implementations of Corba: IONA Orbix and Microsoft Com; (4) Integrated Java desktops; (5) Specialized Java servers for workspaces with shared applications; (6) Complete Corba-based educational systems; (7) Balancing the load for client/server systems; and (8) Design patterns and frameworks for access controls for shared workspaces.

In another project, a prototype MOO-based CVE called Jersey [Tomek et al. 1998] has been extended and used to teach three software development courses in which participants did not have to, and occasionally could not, work in the same physical locations (Figure 3). Clusters of virtual rooms including personal offices, document rooms, and meeting rooms were created to support projects, and software agents were implemented to perform tasks such as notification of project events to users who registered interest in them, meeting support, delivery of a weekly newsletter to subscribers, and asynchronous query support. A new version of this environment for use in much larger courses is under development.

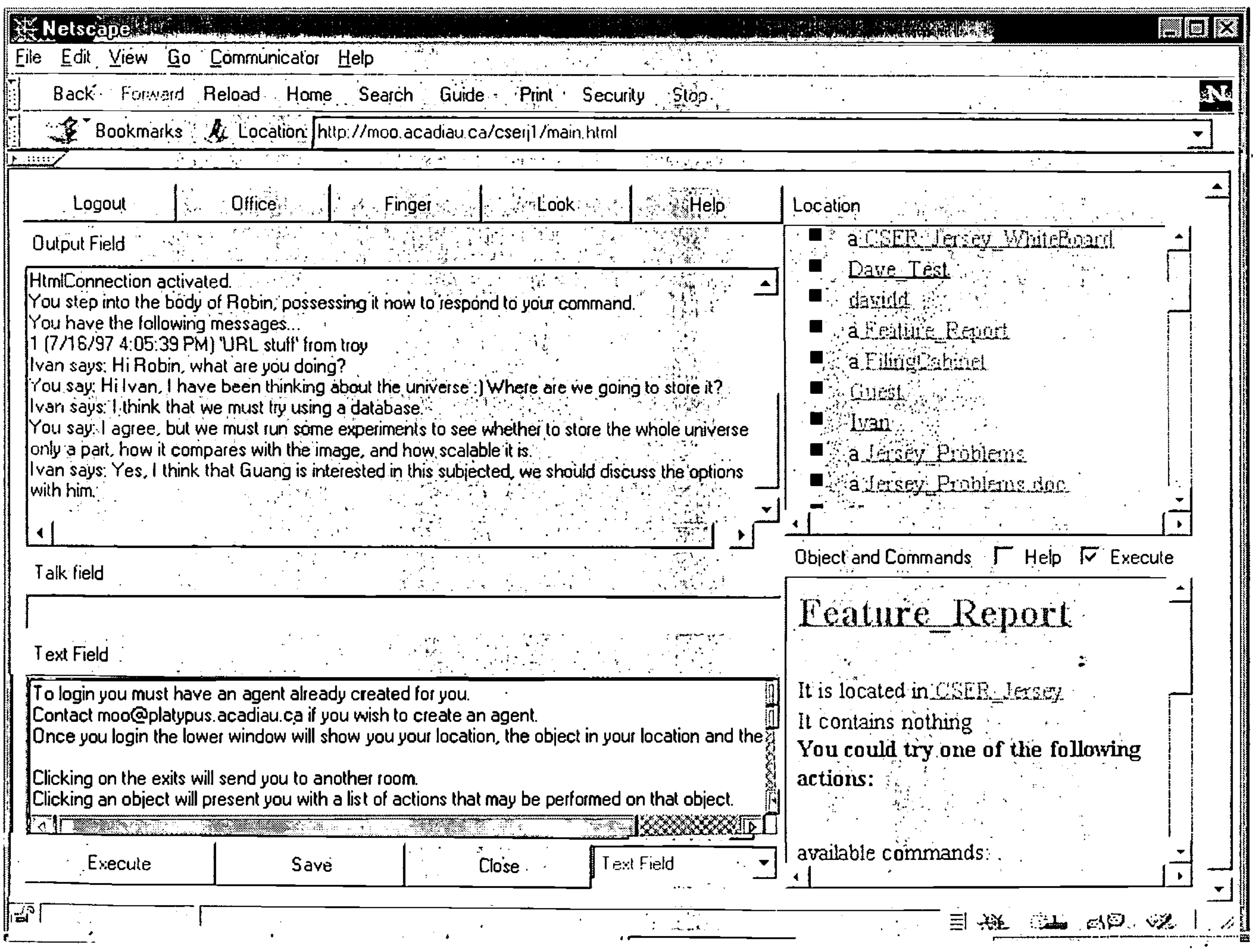

Figure 3. Jersey main window with an output area, talk input field, and workspace on the left, and current room and selected object information on the right.

Conclusion

The Acadia Advantage program, one of the first North American attempts to bring computers into the hands of all students on a university campus, is now nearing the end of the second year of its existence. From a beginning pilot implementation restricted to a few departments and courses, the program has now become universal and all incoming students at Acadia University now obtain a laptop computer with their registration. The initiative required large investments of money and personal time, created internal controversies, and went from apprehension to enthusiasm and critical reappraisal.

In spite of inevitable problems, a large majority of participants consider the program a success. After the initial focus on the use of laptops in the classroom, many instructors have now realized that computer technology does not yet provide the same interactivity as more traditional forms of presentation. In the classroom, the computer has thus become a supplement, an additional tool providing access to large amount of live information and interactivity, instead of being the center of the lecture. More and more instructors are finding that a greater benefit can be derived from the ubiquity of the computer and direct students to use it outside the classroom – as an information accessor, as an interactive tool, and a learning partner with limited intelligence but great power.

The active involvement in exploration of new teaching technologies opened new research avenues for all Acadia University faculty. With continuous hands-on access to computers and with a large student population enjoying the same access, Acadia faculty has started exploring ways in which computer technology can be exploited in university education at a scale that was impossible until now.

From a very pragmatic point of view, perhaps even more important than its presence in the teaching process is the computer's continuous availability. As computer literacy is increasingly a prerequisite to success, employers value extensive experience with information technology, AA students with their 24-hour access to computers can claim this background, and employers appreciate it.

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"Dream or Reality: ICT and Improved Quality of Education?"

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What are the requirements for information society? What kind of skills and knowledge is needed for our future generations to be able to be active and productive citizens? In many studies which relates to education and information society have two different kind of approaches to the requirements of the information society. Narrow interpretation of the skills needed in information society emphasize the need to train citizens how to use technical tools, computers, networks and other media tools which are the most visible part of information society. Campaigns like "Every school should be connected to the Internet before year 2000" and "Internet skills to every teacher" are often closely linked to this narrow intepretation.

Broad interpretation about information society concentrates more deep qualitative changes of the living conditions in information society. The rapid growth of the new society, its digital and global economy and development of media will deeply affect to the culture and skills which are needed in work. It is of course hard to excatly predict the changes but analysing the most advanced working environments and looking the results of future oriented research it is possible to find some trends of changes related to nature of the work and estimate the requirements of learning and education.

The research literature offers several review- and metastudies related to the learning results and Information and Communication Technology. The main result is that ICT and the other arrangements together with ICT in education have a small positive effect on learning. Closer look to those results and studies behind them shows that results from different studies are inconsistent and inadequate. Many of these studies have been done in United States which social situation as well as the role of male and female are quite different than many other countries. More national research is needed to understand better complex phenomena of ICT and learning.

A large research and evaluation project "ICT in Teaching and Learning" is in progress in Finland. The Future committee of the Finnish Parliament proposed this study and it is conducted and funded by SITRA (National Science Fund). More than 50 researchers are committed to provide information and results starting from early childhood up to the senior citizen activities related to ICT. More than 3000 students and thousand of teachers will part of the study and several case-studies related to ICT and eduaction will be analyzed. The aim of the study is to have a broad view to the challenge of information society and look technology as cognitive and social tool. The influences of ICT will be evaluated macro, meso and micro levels in education.

Changing understanding of knowledge is the basic of evaluation-process;

* Technology also changes our understanding of knowledge
* The role of the knowledge is changing the society
* The structure of the society is becoming more networked
* The change of expertises is in progress
* The complexity of society is increasing

First results of the project will be presented, demonstrated and discussed in my presentation at ED-MEDIA 98.

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AWARD PAPERS

Computer Games as a Learning Resource

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Abstract: Playing games is an important part of our social and mental development. The computer games industry has grown swiftly, notably on the Windows95 platform, over the past few years. The aims of this project were to: determine the types of games enjoyed by undergraduate Biology students; evaluate student opinions regarding computer games; develop a game (based on criteria identified by students); and assess the role that such a game could play in teaching students. Students evaluated four commercial games (Sim Isle, Red Alert, Zork Nemesis and Duke Nukem). Results suggest that they prefer 3D-adventure (Zork Nemesis, top-scorer) and strategy (Red Alert) games to other game-types ("shoot-em-up" or simulation). A 3D-adventure game on human evolution was designed, developed and used as part of a first-year Biology practical session. While student learnt equally from the game and the traditional practical material, they found playing the game more enjoyable. Games appear to motivate students intrinsically and represent one of the best uses of multimedia in education.

1. Introduction

Play, especially during early childhood, performs important roles in psychological, social and intellectual development, and could be defined as a voluntary activity that is intrinsically motivating, involves some level of activity (often physical) and may possess make-believe qualities [Rieber 1996a]. These attributes closely match those of modern educational theories where learning should be a self-motivated and rewarding activity.

The advent of advanced personal computer graphic systems has precipitated an explosion in game software. This million-dollar market produces many different kinds of games ranging from simulations through to first-person adventures. Here players are immersed into virtual worlds filled with stunning graphics, compelling, if not additive, story-lines, sound and video. However, many question the social consequences of this new form of entertainment.

Some authors [McKee 1992; Billen 1993] argue that games affect cognitive functions, motivation and remove the player from the "real world". But, games appear inherently to motivate users intrinsically by stimulating due curiosity [Thomas & Macredia 1994]. This may be due to the challenges and elements of fantasy [Malone 1980; 1981a,b]. Carroll [1982], Malone [1984] and Malone & Lepper [1987] argue that intrinsic motivation is also a result of the novelty and complexity of games.

Simulations games, in preference to other game-types, are often used in educational environments as students can be focussed on single goals, there is decreased competition between students and allows them to explore or experiment at their own pace [Roberts 1976]. However, such simulation games are based on the concept that students need to engage in real-world activities and fail to acknowledge that play is part of our everyday lives, it is not the opposite of work as is leisure [Blanchard & Cheska 1985], and appears to be a universally accepted mode of learning.

Games represent one way in which learners can be emersed into constructivist microworlds. Here, users do not study a particular domain but become part of the scenario, thus stimulating interest and motivation. Microworlds differ from simulations in that they present the user with a simple domain that can be reshaped by the user to explore complex ideas [Rieber 1996b]. Also, self-regulation is an important aspect of microworlds. Such learners appear to be intrinsically motivated [Malone & Lepper 1987], metacognitively active, behaviourally active and self-evaluating [Rieber 1996b]. Rieber believes games, rather than simulations, may provide a meaningful way to present microworlds to learners.

The aim of this project was to evaluate the role that games could play in education. The research was broken down into three phases: (1) Identification of attributes, or game characteristics, enjoyed by students; (2) Development of a game containing aspects of human evolution; and (3) Evaluation of this game in a teaching environment. This paper reports on the evaluation of four commercial games by biology students. Here, student opinions with regard to game attributes, including racism and sexism, were obtained using a questionnaire.

Students also ranked the games according to the enjoyment and were asked how such games could be used in education. A Myst-like game was developed that includes exploration of human evolution in a virtual setting. Students played the game prior to a practical session where they were presented with problems related to human evolution. Each phase of the project will be discussed separately.

2. Evaluation of Commercial Games by Biology Students

2.1. Introduction

The objective of this part of the study were to: (1) Determine the type of game enjoyed by the majority of our students; (2) Identify game elements, or attributes, appropriate for South African students; (3) Create awareness of the racists or sexists elements, if present, of games; and (4) Evaluate student opinion relating to the use of games in education.

2.2. Research Methodology

Outline: Four games, representing different types, were played by a small group (n=20) of first and second year Biology students. Each game was played for about one hour and for each game the student completed a questionnaire. In addition, students provided some demographic data.

Student Selection: All first and second year Biology students were invited to participate in the project. From these applications we selected a group of 20 students made up of an equal proportion of the different race groups and an equal number of male and female students.

Game Selection: Four games were selected and included Command and Conquer: Red Alert (strategy) by 3D Realms; Duke Nukem 3D ('shoot-em-up') by Westwood Studios; Sim Isle (simulation) by Maxis; and Zork Nemesis (adventure) by Activision. All games were played under the Windows95 platform.

Questionnaire: The students answered question regarding to their computer experience and a series for each game. Computer literacy was assessed from questions on experience, how often students used computers and for what they used computers. In this section we also asked them to rate the four games. Questions on each game attempted to ascertain whether the game was captivating or addictive, presented challenges and/or contained racist or sexist elements. Also students identified attractive game properties and suggested how such a game could be used in education, what strategies they used to solve problems and if they acquired new knowledge and or skills. Two types of questions were used: ranking (1 to 4) and open-ended. The time spent on each game and the level, or stage reached, were also noted by each student.

Analysis: Ranking questions were calculated as the mean score out of four (maximum). To determine differences in responses by gender, or by race, the Kruskal-Wallis one-way Anova [SPSS] was used by grouping all the questions relating to each game (n=60).

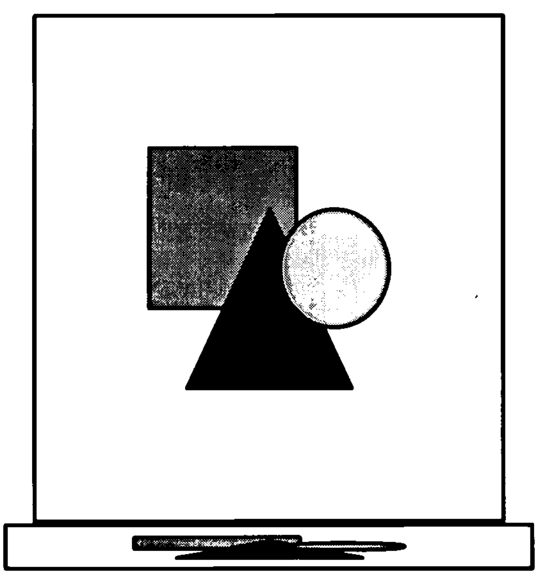

Figure 1. Rating of game aspects by students.

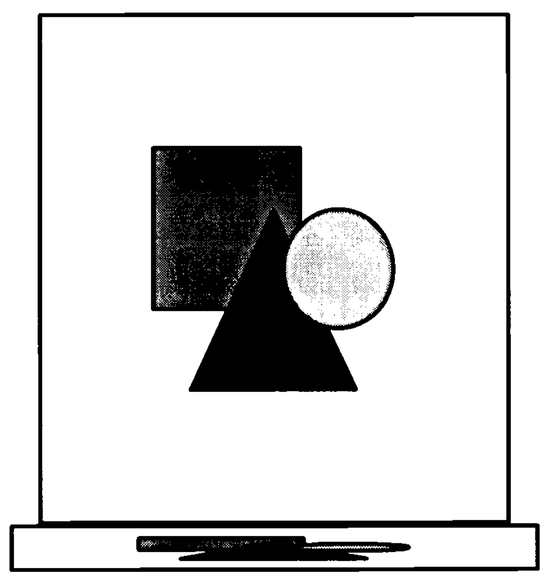

Figure 2. Assessment of skill required to play the games by students.

2.3. Results and Discussion

Of the 20 students who participated in this part of the project, half were female, with an equal distribution among White, Black and Asian. The average age was 19 with most of them having very little computer experience and little exposure to playing computer games. Most students used computers for doing class assignments or for obtaining information. A few students did appear to spend some time playing games.

To determine the type of game elements most appreciated by the students we asked them to rate the games according the fun aspect, sounds and graphics, type of game, game story and use of technology. Zork Nemesis scored the highest in all aspects, closely followed by Red Alert, Sim Isle, on the other hand, was rated poorly by the students [Fig. 1].

As a number of different skills are required to play games, students were asked to assess the importance of some skills (logic, memory, visualization, and mathematics, reflexes and problem solving). The game that required the widest variety of skills was Zork Nemesis followed by red Alert [Fig. 2]. Few of the games required mathematical skills, while reflexes were necessary in Duke Nukem and problem solving was rated highest for Zork Nemesis and Red Alert [Fig. 2].

Students were also asked whether the game was easy to play, addictive, too long, challenging, confusing, too difficult, illogical, difficult to play or manoeuver and if their performance increased with continuous play. Except for Sim Isle, students were able to play the games successfully (see too easy and too difficult); found them addictive, challenging and not boring; were not totally confused; and found that practice makes perfect [Fig. 3].

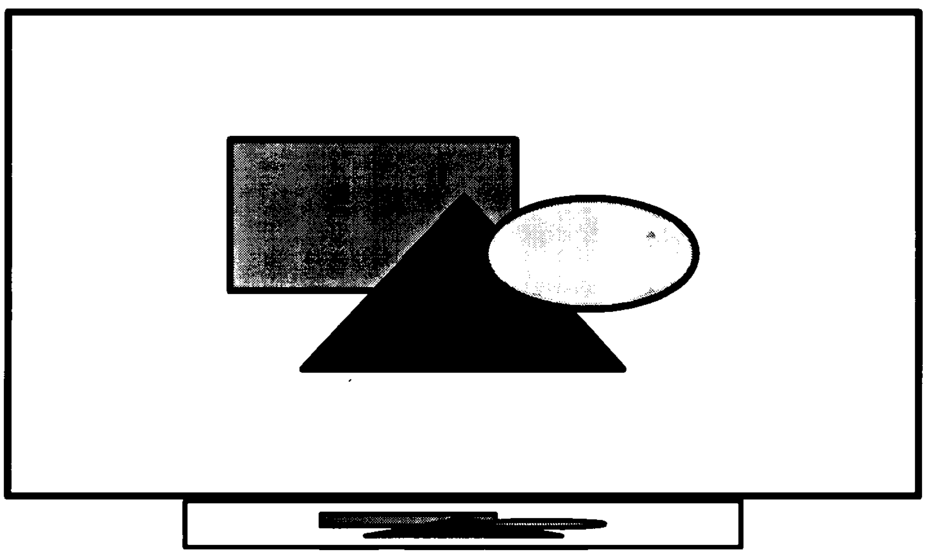

Figure 3. Evaluation of game play by students.

Generally students appeared to enjoy Zork Nemesis and Red Alert the most, and did not enjoy playing the simulation game Sim Isle. The student ranking of the different games supports this conclusion (from best to worst: Zork Nemesis ➔ Red Alert ➔ Duke Nukem ➔ Sim Isle).

Statistical analyses of student opinions according to gender, or to race, showed no differences. It appeared that males played the games longer than did the females and therefore completed more of each game.

Students were also asked two open-ended questions dealing with sexism and racism in the games. Only 15% of the total sample indicated that there was evidence of sexism in the games. For Zork Nemesis comments that there was "no character stereotyping" and that "the main character could have been female" was made by one student. Duke Nukem elicited the greatest response with four students making comments. The most evident response was that of degrading, pornographic portrayal of women (expressed by both male and female students). This game was also seen as being "male dominated with rough, violent behaviour". The theme of Red Alert was seen as some what male-orientated but did have both a male and a female in the leading role. No sexism was found in Sim Isle.

Few students commented on racism in the games. However, those that did, showed insight into the underlying cultures that are represented by these games. Duke Nukem was seem as the most racist ("all the characters were white"; "villains always seem to be dark skinned than the main player or 'hero'"; "hero that wasn't white would be a welcome change"). In Sim Isle "agents were white .. making decisions about island" and "three out of 25 agents were non-white". Characterisation in Zork Nemesis was seem as appropriate "seeing someone of different colour would have made the game difficult to believe" as the game is based on "'white's beliefs" and "wizards". Only one comment was made with respect to red Alert: do "not see any blacks or non-whites in the game".

Generally students enjoyed Zork Nemesis and Red Alert the most. The game requiring the greatest skill was Zork Nemesis. The game least liked was Sim Isle. There appears to be little different between how male and female students viewed the games and the responses according to race groups were similar. These result also suggest that simulation-type games are not appreciated by our students. Therefore, based on these results, we used the 3D-adventure genre to develop a game to solve particular educational needs.

3. Game Development

Outline: In consultation with departmental subject experts, a story line was developed based on the adventure-type game. The pilot game was authored to run on the student LAN (Windows 3.11), but is designed in such away that 3D-virtual worlds can be created for the Windows95 platform.
Technology: Graphics were created in 3D-Studio Max (Kinetics) and the game-engine in Delphi (Borland). When necessary, graphics were edited in Photoshop (Adobe). The game was created using tools that added navigation and other elements to each game page and created the game files. The game player was programmed to read and display these game files.
Basic Story: The player is sent to an island that has been evacuated because of a viral infection. Here, within a single museum-like building the player, wearing a biohazard suit, explores the different levels to discover clues and objects that will be used to create an anti-viral protein in the final episode of the game. In the pilot program only one such level has been built. In the helmet of the biohazard suit the ambient temperature and oxygen levels are also displayed. During game play the temperature changes, depending on the location of the player and the oxygen level decreases with time. Also, e-mail messages are sent to the player. The control panel, at the bottom allows the player access to e-mail messages and the collected objects. The basic design of the game interface in shown in Fig. 4.

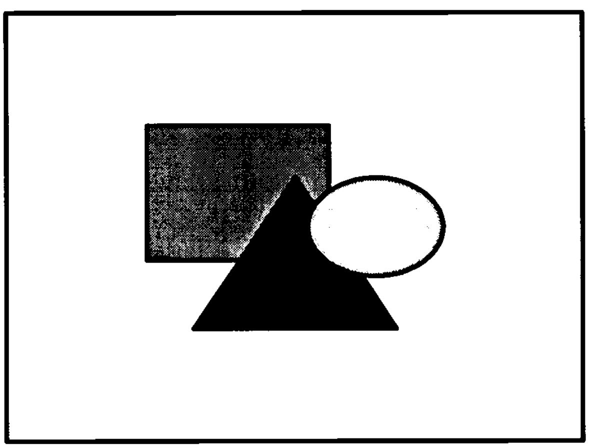

Figure 4. Interface of the game showing a view through the helmet of the biohazard suit.

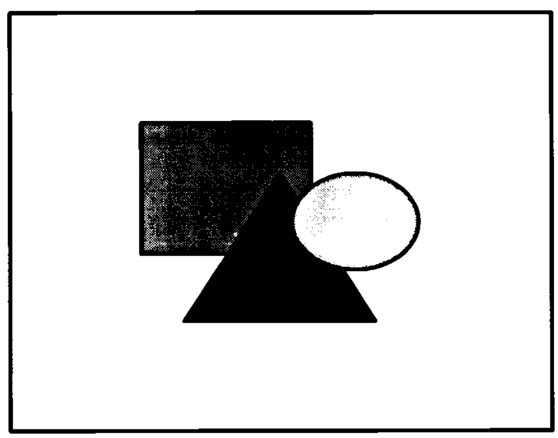

Figure 5. Percentage difference between pre-(■) and post-(■) test.

4. Use of Games in Education

4.1. Introduction

To evaluate the role that games can play in the teaching of Biology, a first year student practical session was redesign to include two elements: (1) Playing of the game; and (2) Practical work on problems relating to human evolution. To determine student knowledge a pre- and post-game test was used. Student attitudes with respect to this activity were obtained using a questionnaire.

4.2. Research Methodology

Outline: Before the start of the two practical sessions, Environmental Biology 1 students (n=58) were asked to complete a number of multiple-choice questions on the evolution of man. During the first practical session students played the game, developed by the research group, for a minimum of 2 hours. In the second session students were presented with a number of practical problems that they had to solve. Thereafter, the students answered the same multiple-choice questions.

Pre- and Post-game Tests: Here knowledge obtained from the game, practical handout and practical session was assessed. Individual students were scored on their success in answering the questions.

Questionnaire: Opinion relating to the use of a game to help in the teaching of human evolution was obtained from the students by means of a short questionnaire.

4.3. Results and Discussion

To assess the use of the game as a viable teaching method, students answered a number of multiple choice questions testing knowledge provided either by the game or during the practical. The mean and standard deviation for the pre-test was 44.13±12.27 and for the post-test 60.07±12.48. While not significantly different, student did perform better in the post-test. Test questions related to knowledge learnt from the practical material or game were separated and plotted as the difference in mean percent for each question (Fig 5). Students appeared to learn information equally from both forms of material (no significant difference between groups, t-statistic: 0.24).

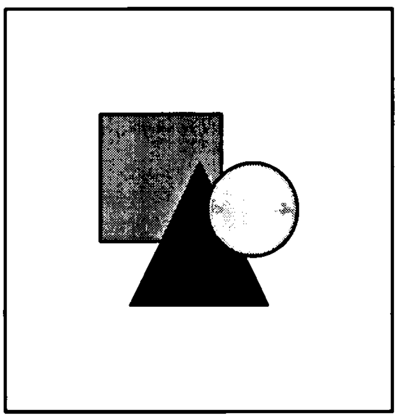

Figure 6. Rating of Zadarh aspects by students.

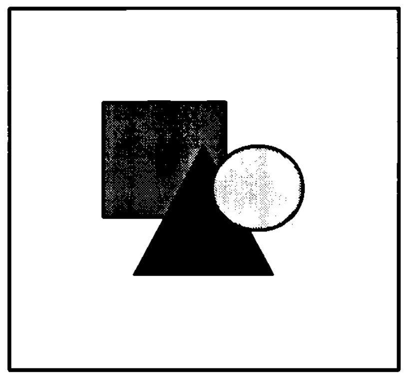

Figure 7. Assessment of skill required to play Zadarh by students.

Game evaluation was by means of a questionnaire similar to that used for commercial games. Students were asked to rank Zadarh according to their impressions [Fig. 6] and skills required [Fig. 7]. Rating scores were similar to Red Alert but not as good as for Zork Nemesis (see Fig. 1 and 2).

Table 1. Student answers to the question: "What was your motivation to play the game?".

Motivation	Number of similar answers
Curiosity and Interest in topic	26
Game Completion	12
Course requirement	10
Fun	8
Puzzles and clues	7
New study technique	4
Graphics	4
Informative	3
Interest in computers	2
Assisting in practical course	1
Exploration	1

In addition, we asked them if the game improved their understanding of the course material, if it is a good idea to include games in courses (3.2), if games made learning more fun, if they would prefer written material and if the game allowed them to explore and learn at their own pace. The scores, out of a maximum of 4 were 3.0, 3.2, 3.2, 2.4 and 3.1 respectively.

Two open ended question were asked. The first: "What do you think you learnt about human evolution while playing the game?" elicited a variety of answers with "Phylogenetic grouping and origination" and "Facilitated understanding" being the most popular. When asked what their motivation was in playing the game a number of answers were given [Tab. 1]. The majority of the student appear to be intrinsically motivated to play the game, except 20% who stated that they played the game is was a course requirement.

These results suggest that student enjoyed playing an educationally based game, appeared to be motivated by the "fun" aspects of computer technology and gained knowledge.

5. Conclusions

First and second year biology students appear to favour 3D-adventure (Zork Nemesis) and strategy games (Red Alert), were critical of the racism and pornographic elements in the first-person "shoot-em-up" Duke Nuken and found the simulation game Sim Isle unsatisfactory. The development of an adventure game by the research group was used to test the applicability of such technology in education. The pilot project on integrating information into an adventure type game was enjoyed by most students and they also learnt knowledge while playing.

Acknowledgements

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Give Girls Some Space: Considering Gender in Collaborative Software Programming Activities

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Abstract. Equitable computer collaborations in mixed gender teams have been a pressing issue for many years. While some have argued for creating single-gender teams or girls-only computer activities, our approach was different. The current study examines a three-month software design activity in which mixed teams of girls and boys [10-12 year olds] designed and implemented multimedia astronomy resources for younger students. In this context we assessed how students' levels of access to technology were impacted by gender differences at the project outset, and how these participation patterns changed throughout the project duration. We found that the documented positive change in girls' access was impacted by the configuration of social, physical, and cognitive "spaces" in the project environment. We discuss the implications of these results in regard to issues surrounding the development and maintenance of gender equity in computer use and further research.

As recent research has shown, the road toward becoming technologically literate and scientifically competent has been a "leaking pipeline" for girls and women in particular, from the elementary schools where girls feel disenfranchised in science and technology, to universities where fewer female students choose science and engineering majors [Camp 1997]. A variety of explanations have been offered for this trend, ranging from different attitudes toward computers [Shashaani 1994] and different levels of participation in computer and science courses [Chen 1985; Linn 1985], to cultural and social conditions found in the respective domains [Sadker & Sadker 1994] and different representations of women in media publications [Heller, et. al. 1994]. While each of these variables alone or in combination have an impact on situating girls' interactions with computers, we examined more closely girls' access to computer resources in classroom activities and collaborative groups. With the increasing use of computers in classrooms, there remains the issue of whether all students participate equally and receive equal benefits. We were particularly interested in identifying the kind of activities and support structures that can be used in helping girls break down barriers to technological access and expertise in a variety of mixed-gender settings.

Toward that end, we investigated students' activities and collaborations during a three-month long computer project. In this project mixed-gender teams of fifth and sixth graders used Logo Microworlds™ in their classroom to design multimedia encyclopedias about their astronomy unit for use by younger children. We paid particular attention to the status of girls in these mixed-gender teams--their status positions at the outset, the change most girls experienced in going from low status to high status designers, and the means by which these changes were accomplished. In examining this last factor, we outline several support structures which emerged over the course of two projects to address girls' needs. Finally, we conclude this paper with a discussion of the implications of our findings for developing gender equity in educational technology use.

Theoretical Background

Many girls are not receiving the same kinds of opportunities to become technologically skilled as boys are [e.g., Wellesley College Center for Research on Women 1994]. Boys develop alliances with computers largely due to their extensive out-of-school computer experiences. Boys are more likely to attend summer computer camps than girls, more boys than girls have their own computers at home, boys play more video and computer games than girls do, and boys are more likely than girls to see themselves depicted as male main characters in these games [Sadker & Sadker 1994]. These factors relating to amount of experience with computers have a significant effect on students' attitudes and perceptions. In a survey of high school students, boys had higher ratings than girls on all of the following: perceived competence with computers, positive attitudes toward computers, and perceived utility value of computers [Shashaani 1994].

Gender differences also arise when boys and girls use computers in the school context, even though so-called 'equal opportunities' may be presented. Studies of computer use at school have found that when computers are used during class time, boys tend to dominate computer space [Sadker & Sadker 1984]. In observations of student dyads working on the same computer, boys were shown to use more aggressive tactics to gain control, such as grabbing the mouse and pulling it away from their partner. Girls used more 'non-contact' methods such as verbal requests [Inkpen, Booth, & Klawe 1991]. Boys also are more likely to initiate and maintain control of school computers during non-classroom hours such as lunch time and before or after school [Canada & Brusca 1991].

Studies have shown, however, that when girls have as much exposure or interactions with computers as boys do, gender differences tend to disappear [Linn 1985]. In learning situations in which children can work on computers at their own pace and engage with tasks according to their interests and styles, girls tend to be as proficient as boys in programming [Harel 1991; Kafai 1995]. Giving opportunities for access thus seems to be a crucial aspect in overcoming the widespread gender differences as well as finding computational activities that appeal to both genders [Spertus 1991]. Access, however, is often hard to come by---both in activities with computers and those without.

Even when computers are not involved, putting students in mixed-gender teams for collaborative work can result in very different experiences for boys and girls. Research shows that gender is often a strong predictor of status in heterogeneous groups; thus, girls' contributions to group work end up being less valued than boys' [Cohen, 1994]. These gendered interaction patterns sometimes have consequences for girls' ability to make the most out of collaborative work, as evidenced by subsequent knowledge assessments [Webb 1984]. Even when academic acheivement is not affected by these differences in interaction, girls' self-esteem and interest in the subjects in question may suffer [Wilkinson, Lindow & Chaing 1985].

It appears that bringing together collaborative work situations with computer use amplifies some of the gender issues found in either situation alone. In attempting to ensure that girls will have the opportunities they need, some researchers and practitioners have taken the approach of providing "female only" environments. Whether this means pro-active technology intervention programs that are exclusively for girls [Martin & Heller 1994] or forming single-gender collaborative groups in after-school computer clubs [Wood 1996], the assumption in most cases is that girls will have a more positive experience in the absence of male computer users. While these programs represent important steps in introducing girls to technological activities, we find that eventually girls will have to learn how to negotiate access in mixed-gender settings. Our aim in this project was to find out how girls [and boys] might react to the challenge of working with programming technology in mixed-gender groups in a classroom setting. Based on the existing research, we anticipated that at the outset of the project girls would occupy lower-status positions in their groups; however, we hoped that through careful attention to addressing their needs in the project, girls' status would change.

Research Participants, Context, and Methods

The software project from which our gender study comes is based on the model of 'learning through design,' in which students simultaneously learn new information and design a relevant product reflecting their knowledge [Harel 1991; Harel & Papert 1990; Kafai 1995]. The project took place in an urban elementary school that functions as the laboratory school site for UCLA. The participating classroom was equipped with seven computers, one of each was set up as a workstation for the seven table clusters. An additional seven computers were in an adjacent room and were mostly used for related Internet searches.

An integrated class of 26 fifth and sixth grade students participated in this project. There were 10 girls and 16 boys of mixed ethnic background (19 Caucasian; 2 Hispanic; 3 African-American; 2 Asian) ranging between 10 and 12 years of age. With the exception of 10 students—8 had participated in another design project the previous year and 2 knew programming from home—none of the other students had any programming experience before the start of the project. All the students had used computers in school and were familiar with word-processing packages, graphics software, Grolier's Multimedia Encyclopedia™, and searches on the WWW.

Heterogeneous groups of 3 to 4 students each were arranged in seven teams according to the following criteria: one "experienced" designer who had participated in the previous design project, mixed gender, and different academic skill levels. Over the course of several months students created their own research questions about astronomy, researched these questions using various sources, and represented their findings in a group software product. Students worked 3-4 hours per week on the project for a period of 3 months spending 46 hours in total, of which 23 hours were dedicated to programming. Science instruction and programming time were combined. Groups were videotaped regularly and their activities were documented via fieldnotes on a daily basis.

Defining Status

In most previous studies of collaboration, groups of students are engaged in a single task such as solving a math problem or writing a story. In the learning through design environment, however, the final task of making a multimedia encyclopedia requires many different kinds of activities in order to be accomplished. Observations led to the conclusion that students' own conceptions of status in this more complex environment were based on what activities were most desirable and who had the most opportunity to do them. Activities were classified into the scheme in Table 1 via the first author's observations of student arguments over "who would get to do __ today" and conversations with students about the desirability of certain activies.

Table 1. Activity Status Classification & Coding Scheme

High Status Activities	Medium Status Activities	Low Status Activities
Microworlds programming	Grolier's Multimedia Encyclopedia	Book Corner research
Internet research	Asimov CD ROMs	Drawing screens on paper
Leading software demo	Word processing	Team progress reports
Helping others program	Watching someone program	Doing nothing

For data analysis, students received status codes based on whether or not they typically engaged in high, medium, or low status activities. Fieldnotes and videotapes taken during two time periods were coded. The first time point [T1] was after the first 3 weeks of the project, and second time point [T2] was approximately two weeks before the end of the project. On each day during the two selected time periods, students' activities were catalogued and coded according to Table 1. For each instance a particular student was present in a set of fieldnotes or tape on a given day, he or she received a 3 for engaging in one of the high status activities in Table 1, a 2 for medium status, and a 1 for low status. Sets of notes and videotapes were then aggregated, and students received a single status score for the aforementioned two time segments. We then conducted multiple regression analyses to determine what factors predicted status at T1, predictive factors at T2, and change in status levels over time.

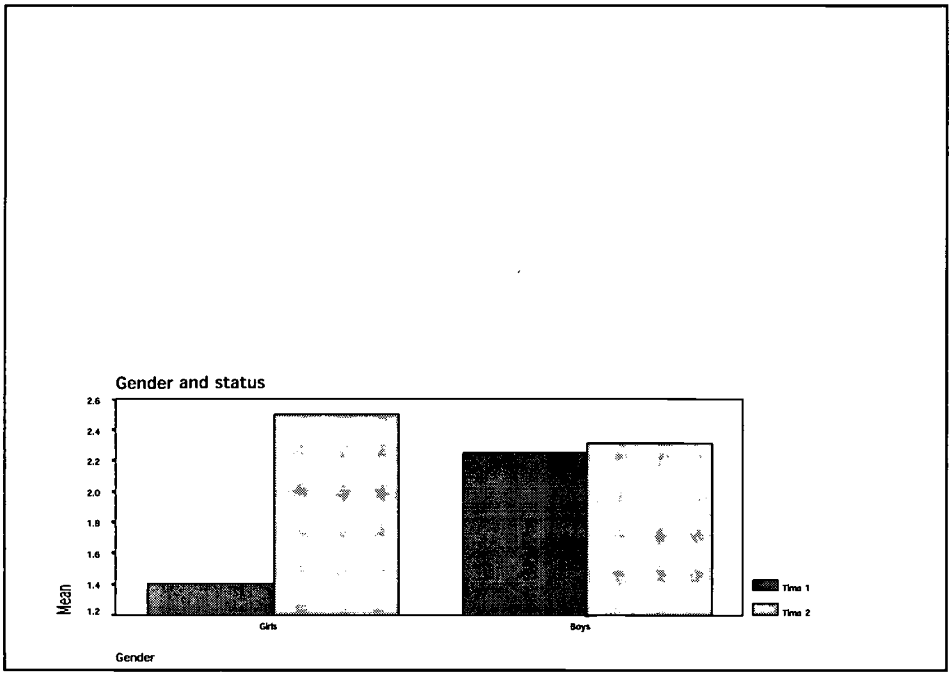
Results

Gender and Status

The factors of age, gender, previous design/programming experience, and academic achievement were analyzed via multiple regression for their predictive value for status at T1. Gender was the only significant factor [$p < .001$]. Statistical results confirmed what we had observed during student work time: a significant number of girls were engaged in low status activities which afforded little access to new technologies.

Students' status levels did not stay the same throughout the project. At T2 status was measured again and found to be not significantly correlated with status at T1 [Pearson correlation = .1880; $p > .100$]. Furthermore, the composite of leadership and gender was not significant as a predictor of status at T2 [$p > .05$]. Girls' status, in particular, changed greatly from T1 to T2 [see figure 1]. While at the beginning of the project all but three girls had low-status group roles affording very little computer access, at time 2 the majority of girls were engaged in high status activities. Girls were seen taking more leadership roles in demo sessions and programming on the computer more frequently. It appears that the software design project provided girls an opportunity to change the pattern typical of girls in mixed-gender teams of remaining low status throughout the duration of group projects.

Figure 1. Changes in Status Over Time for Each Gender



Give Girls Some Space

So how did these status changes for girls take place? Status changes began gradually occurring as features were added to the project to address girls' emergent needs. We refer to the process of changing the classroom design studio to reflect diverse needs as "creating spaces" on the social and physical planes of the environment. Within these "spaces," girls (and some boys as well) found contexts which were more compatible with their own ways of interacting, working, and thinking than they had encountered in the initial structure of the design environment. In this next section, we describe the "spaces" that were created, and we discuss how they emerged and their subsequent effects on girls' attitudes and behavior in the design project.

Social Space

Early in the design project, the task of organizing and reporting on groups' progress toward product completion was assumed by girls. This task required talking to everyone in the group about what activities they were engaged in and what their goals and plans were. Girls experienced frustration with this activity, due to the fact that many boys did not want to sit down and discuss anything if it took time away from programming. Girls were also concerned with resolving interpersonal problems within teams right away when they arose, whereas boys focused more on getting computer work finished and would keep right on working and ignore problems that came up, even to the extent of not listening to girls when they attempted to talk about these issues. After observing these interactions for several weeks, we saw a need for a specific "space" on the social plane of the design project which could be an appropriate time and place to air personal conflicts and frustrations in a safe and mediated environment.

Our solution was to create group meetings which were mediated by either the classroom teacher or a researcher. These meetings occurred about once every 10 days. Students were told that each person in the group would have a chance to say what was bothering them and then the whole group would address each issue. We found that while we had initially instituted the sessions to ensure that girls would be listened to by boys in airing their complaints, boys also had many issues they needed to work out, but which they hadn't been addressing during computer work time. Issues the boys were upset about concerned Internet use for legitimate research versus "surfing" for fun, ownership and piracy of ideas, and accusations of "goofing off." All groups came to some resolutions through these discussions, and most boys and girls subsequently reported that there were less conflicts in their groups as a result of the meetings. Thus although the "social space" of group meeting time was initially created as a place to address girls' concerns, boys benefited from this development as well.

Physical Space

The majority of computer environments take the form of individually segregated workstations; this arrangement tends not to appeal to girls and their preferences for a work style characterized by more social networking [Canada & Brusca 1991]. In our design project the group stations were spread throughout the classroom, making it difficult for students in different teams to communicate with one another without leaving their seats. We found that when girls had opportunities to work at the classroom computer workstations, they often got much less accomplished than boys did in the same amount of time due to frequently showing off their new work to friends and getting up to view one another's screens. Thus the arrangement of physical space in the classroom seemed to be holding girls back--until they changed it.

The physical arrangement of the lab was such that computers were lined up in rows right next to each other along the walls, rather than being spread out. Girls began moving files back and forth from lab computers to group workstations via file sharing or floppy disks. Upon seeing how well this arrangement worked for those girls, coupled with the fact that most students had finished the research phase of their work, we opened up the lab for regular Microworlds use. Changes took place almost immediately. Rather than waiting to be *told* what to do by boys and whether or not they would be *allowed* to work in Microworlds™ for the day, instead many girls often grabbed their floppy disks and headed off to the lab with a long list of things they wanted to accomplish on their own.

Creating a new "space" on the physical plane of the design environment in which to do programming allowed individuals to work and help one another in the way they felt most comfortable. Most boys worked at their own individual stations, which were spread out across the classroom, and would call one another over for help with specific things. Many girls (and a few boys), on the other hand, worked collaboratively and used the space in the adjacent computer lab, so they could talk and give programming/design advice by glancing over at one another's screens while they were all working together. This arrangement seemed to encourage those involved to stay on-task longer and develop innovative ideas so they could be shared with the rest of the community. Thus the addition of another "space" in which to program allowed students of either gender to find a workplace which was compatible with their own preferences.

Discussion

In our analysis of results, we paid close attention to the various factors that helped girls change their status. In the following discussion we want to address several key issues in designing and implementing computer-based learning environments, consideration of which can help support girls and boys equally in their learning endeavors.

Timing of Interventions

One issue that needs to be addressed concerns the place and timing of interventions. Previous intervention models such as science and technology after-school programs and summer camps try to reach out to female student populations in high schools and colleges. These are important programs, but we hold that the timing of such interventions is too late, considering that girls form many beliefs about themselves and subject domains during the elementary school years. For that reason we propose to situate interventions much earlier in development, thus providing younger girls with opportunities to interact with advanced technologies and science in substantial ways. Furthermore, we find it important that girls are not only introduced to technology as consumers; hence our focus on students as *producers* of software artifacts such as multimedia resources or software games [Kafai 1995].

New Era, New Questions

Education is currently in the throes of a trend in project-based learning [Blumenfeld, et. al. 1991] for computer use to be integrated into long-term, multifaceted projects such as the one documented here. Computers no longer reside solely in a distant laboratory, with few if any ties to other classroom activities [Kafai 1995]. These new developments have staggering implications for the way we think about gender and computer use. If girls have little access to computer resources in these integrated classroom settings, they not only miss out on the opportunity to develop technological literacy, but they also risk missing out on learning other subject matters being mediated by computer use as well. Even when it appears that girls are spending an equal amount time in front of the computer, advocates of gender equity still should not be entirely at ease. In our project, which was supposed to provide students with creative and innovative opportunities, girls' initial computer work consisted mostly of word processing and consumer-based use of software encyclopedias. These results are cause for concern. We are reaching a point in gender and technology research where the issue may no longer be about *if* girls are using the computer but rather *how* are they using it. Results from our study confirm this, in that there was an initial division of labor where boys dominated all of the available 'cutting edge' technology such as the Internet and the programming software. Through creating new spaces in the environment to address girls needs, we found ways to alleviate male domination of technology and provide opportunities for girls to gain access. We would also argue that such measures are not only helpful but necessary to continue to address issues of gender equity in technology environments.

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The Digital Lecture Board - A Teaching and Learning Tool for Remote Instruction in Higher Education

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Abstract: This paper presents a novel, integrated teaching and learning tool - called digital lecture board - which takes into account the requirements of synchronous, computer-based distance education. For almost two years, the TeleTeaching project Mannheim-Heidelberg has been using video conferencing tools for transmitting lectures and seminars. These tools prove to be insufficient for the purpose of teleteaching since they are not powerful enough to support team work, they are not flexible enough for the use of media, and are somewhat difficult to handle by non-experts. We discuss shortcomings of the existing tools and disclose features we had in mind while designing the digital lecture board. Embedded in a teaching and learning system, the digital lecture board even allows for asynchronous usage modes, for instance, the preparation of lectures. Moreover, we cover implementation issues of the current prototype.

1 Introduction

The advent of powerful hardware and advances in high speed networks enabled synchronous learning, with teachers and students being geographically distributed but connected via computer networks. Compared to traditional distance learning, this allows for a higher degree of interactivity and collaboration but still entails crucial drawbacks compared to the traditional classroom situation. Today's synchronous learning systems are mainly based on video conferencing technology which provides audio, video, and joint editing of documents only, but does not take into account the specific requirements of teaching, for instance, controlling the course of instruction, raising hands, or reference pointing. A shared whiteboard for transmitting slides is often the core part of these systems but mostly also the bottleneck, since the teacher is forced to tailor his or her course to the limited features of the whiteboard software. The *digital lecture board* presented in this paper is a novel, integrated teaching and learning tool which is basically an extended whiteboard tailored to the needs of synchronous teleteaching.

2 Background

The development of the digital lecture board is based on the experience we gathered in the TeleTeaching project Mannheim-Heidelberg. The project aims at an improvement in the quality and the quantity of lectures by using multimedia technology and networks for the distribution of lectures and seminars. We have implemented three different instructional settings - as indicated in [Fig. 1] - which are characterized by their scope of distribution, interactivity, and individualization of the learning process.

In the *Remote Lecture Room* (RLR) scenario, audio/video-equipped lecture rooms are connected via a high speed network, and courses are exchanged synchronously and interactively between participating universities. *Remote Interactive Seminars* (RIS) are a more interactive type of instruction where small groups of participants are distributed across seminar rooms connected by a network. RIS focuses mainly on the co-operative, on-line construction and presentation of reports. *Interactive Home Learning* (IHL) copes with maximal geographical distribution of all class participants: Each student learns asynchronously as well as synchronously at home in front of his/her PC. Obviously, the IHL scenario makes the greatest demands on technology (e.g. low-bandwidth transmission of video) and pedagogy (e.g. controlling the course of instruction and/or human interaction). For a description of pedagogical, organizational, and technical issues of the project refer to [Eckert et al. 97].

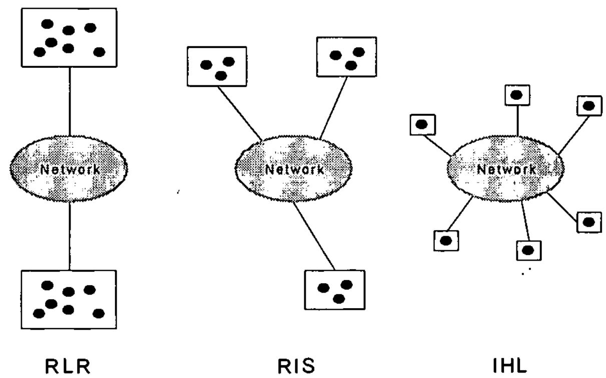

Figure 1: Instructional settings in the TeleTeaching project Mannheim-Heidelberg.

So far, we have been using the Internet and the MBone video conferencing tools *vic* (video conferencing tool), *vat* (visual audio tool), and *wb* (whiteboard) for remote lecturing [Macedonia & Brutzman 94]. Observations, surveys and interviews with the students and lecturers during the last two years indicate that these tools can provide satisfactory results if the lecturer adapts the layout of the lecture exactly to the limited features of these tools, but are far from optimal for teleteaching since they have not been designed for this purpose. This concerns specifically the whiteboard which can be considered to be a substitute for the traditional blackboard. Along with audio, the whiteboard is most important for conveying knowledge to distributed participants. In order to overcome the weaknesses of the whiteboard, we decided to develop the *digital lecture board (dlb)* which will better satisfy the needs of the instructional settings RLR, RIS, and IHL.

3 Design Considerations

In this Chapter, we present, in more detail, the shortcomings of the existing MBone tools [1], and we discuss the most important features which we had in mind while designing the dlb.

- **Integrated User Interface**: The MBone tools do not provide an integrated user interface. Teachers and students complained about many confusing windows and control panels which are not important for learning and teaching but make it more difficult to operate the tools. Since teleteaching at the university level should not be restricted to computer experts, we find it especially important that the dlb provides an easy-to-operate user interface which integrates also audio and video communication. Moreover, in order to allow the interface to adapt to different instructional settings, it should be configurable. RLR, for instance, mainly focuses on presentation of knowledge to passive receivers and, therefore, receivers do not want to see tool or page selecting options on their screens.
- **Media Usage and Handling**: The MBone whiteboard wb is very limited concerning the use and handling of media: only postscript and plain ASCII text are supported as external input formats, and later editing (besides move, copy and delete) of the built-in graphic and text objects is not possible. In addition, wb does not support joint editing of these objects. For instance, it is impossible for a distributed group to create a common text, or to modify objects created by different participants. Since media are very important for a modern instruction, the dlb should support a variety of media formats such as GIF, JPEG, MPEG, AVI, HTML, AIFF etc. as well as many built-in object types such as lines, rectangles, circles, freehand drawings, text etc. Technically, objects are required to be editable by every participant and the dlb should provide functions like select, cut, copy, paste, group, raise, lower etc. similar to a word or graphic

[1] The described shortcomings are not limited to the MBone video conferencing tools but concern also other systems like NetMeeting, CUSeeMe, ProShare, etc.

processing software.

- **Workspace Paradigm**: The shared workspace of wb is limited to a two-layer concept with a postscript slide in the background and drawings and text in the foreground. It is, for instance, not possible to render two different postscript slides onto a single page so that results of two distributed work groups may be compared. Moreover, wb adheres to the strict WYSIWIS (What You See Is What I See) paradigm. Thus, participants cannot have a private workspace where they can prepare materials, for instance, when doing on-line group work. Teleteaching software requires a more flexible workspace concept with multiple layers where arbitrary media objects (audio, video, images, animations, etc.) can be displayed, grouped, raised, lowered, etc. Single participants or small groups should be offered private workspaces (invisible to the rest of the whole group) in order to allow for modern types of instruction such as group work. The outcome of the group work can be transferred to the shared workspace so as to allow a wider discussion of the results.
- **Collaborative Services**: Today's teleteaching systems suffer a lack of communication channels compared to the traditional face-to-face instruction, since most systems support only audio, video, and joint editing of documents. Social protocols or rules control the human interaction and the course of instruction in a classroom. These mechanisms are difficult to reproduce in a remote situation and include, for instance, raising hands, giving rights to talk or to write on the blackboard, setting up work groups, and reference pointing. Collaborative services provide mechanisms to support the communication of persons through computers and to increase social awareness. Basic services such as floor control, session control, telepointers, or polling should be supported by the dlb. A detailed analysis of collaborative requirements in teleteaching indicates that the following situations should be supported by computer-based teaching and learning systems [Hilt & Geyer 97]:

  - Joining a session at the beginning or later
  - Leaving a session at the end or earlier
  - Removing a participant from the session (e.g. by the moderator)
  - Raising hands (signaling)
  - Drawing back signals
  - Removing signals by the moderator or teacher
  - Selecting participants (with and without signal)
  - Selective granting and removing of permissions (floors)
  - Returning own permissions
  - Pointing to shared instructional materials
  - Creating, joining, and closing sub-groups (for group work)
  - Private discussions and co-operation
  - Nominating moderators for sub-groups
  - Surveying sub-groups and participants (super user role of the moderator)
  - Granting of permissions (floors) for work areas and materials to sub-groups
  - Accessing work areas and materials without a moderator in order to enable internal group discussions

  It is interesting to note that most of the computer-based tools for remote instruction are ignoring these types of interaction completely. In the dlb project, we attempt to build, and experiment with, electronic surrogates for social protocols.
- **Synchronized Recording and Playback of Sessions**: The dlb should also provide the possibility to record a transmitted lecture or course which can then be stored on a server for playback. Students will then be able to retrieve the lecture in order to review certain topics or the complete lecture if they have missed it. Recording should include all transmitted data streams, i.e. audio, video, whiteboard actions & media, telepointers, etc. In order to achieve a synchronized recording, data has to be time-stamped. The data streams could then be recorded by existing systems like the VCRoD service (Video Conference Recording on Demand) [Holfelder 97]. These systems rely on the Real-Time Transport Protocol RTP for synchronized recording [Schulzrinne et al. 96]. The current release of the MBone whiteboard wb does not support the RTP standard.
- **Storage and Retrieval of Pages and Teaching Materials**: Lectures or courses given with the computer need to be prepared in advance, i.e. producing slides, images, animations, etc. The preparation of materials with the MBone whiteboard is limited to a list of postscript files which can be imported by mouse click

during a running session. In order to allow for a better preparation of on-line lectures and for saving results after a lecture, the dlb should support storage and retrieval of pages and objects in a structured, standardized file format such as SGML. Dlb documents would then be readable and modifiable by the human user or by other programs (e.g. a viewer software for lectures). Moreover, it would also be desirable for the dlb to have access to a multimedia database which stores teaching and learning materials of teachers and students. Such databases are also a research issue in our TeleTeaching project [Eckert et al 97].

- **Network Transmission**: Scaleable and efficient transmission of data to a group of participants is only possible using multicast. Since we rely on the Internet for remote lecturing, we need to employ the Multicast Backbone (MBone) for multicast data delivery, as do the MBone tools vic, vat, and wb. Basically, multicast IP is an unreliable, packet-oriented protocol. In contrast to audio and video data, lecturing materials need to be transmitted reliably. Following the ALF concept (Application Level Framing), wb implements reliability within the application [Floyd et al. 95]. We think that separating the reliability issue from the application is a more appropriate approach for our dlb since this eases implementation and also allows other applications to use reliable transport services. Another important issue is security. We believe the dlb should support encryption in order to allow private sessions and billing. Prior to joining a specific course, students would have to register in order to receive an access key.

4 Usage Modes in a Teaching and Learning Environment

A teaching and learning environment consisting of a full-featured dlb (according to [Design Considerations]) along with a recording facility (e.g. the VCRoD service), a multimedia database for teaching materials, a WWW server, a VCRoD editing tool, and a WWW dlb document viewer would allow for several synchronous and asynchronous usage modes [Fig. 2].

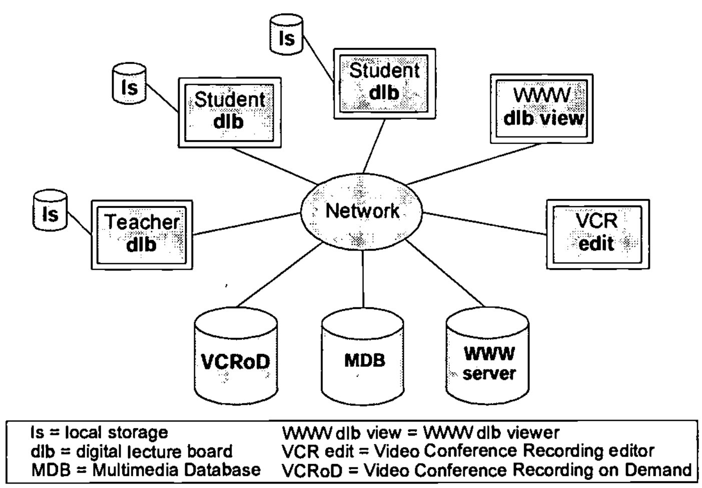

Figure 2: Teaching and Learning Environment.

1. **Preparation/Pre-Authoring (asynchronous)**: Teachers and students use the dlb for the preparation of material for the synchronous teleteaching mode. They may access a multimedia database (MDB) or a local storage device (ls) for the retrieval of multimedia material needed for teaching and learning. The outcome of this mode is an off-line *dlb document* which can be, for instance, a complete presentation for RLR, a small report prepared by students for RIS, or a piece of group work for IHL. The dlb document can be stored locally (ls) or on the multimedia database (MDB).
2. **Transmission/Teleteaching (synchronous)**: The prepared dlb documents are used as a basis for synchronous teleteaching in the three instructional setting RLR, RIS, and IHL. The material is transmitted to the entire class. Teachers and students can then employ the advanced synchronous features of the dlb such as, for instance, reference pointing (telepointer), forming sub-groups (session control), annotating (drawing tools), controlling the course of instruction (floor control), on-the-fly development and import of

materials (drawing tools and access to ls or MDB), or discussions (audio and video). The result of this mode is on the one hand a *modified dlb document* which can be stored by both teachers and students in order to save results. On the other hand, the VCRoD service allows for the recording of the complete teleteaching session including all media streams (audio, video, telepointers, dlb actions, etc.).

3. **Revision/Post-Authoring (asynchronous)**: Based on the materials obtained from the transmission mode (*dlb document* and *VCRoD recording*), a complete multimedia document, enriched with further multimedia components (e.g. animations), can be produced by using the dlb, a VCRoD editor, or further authoring tools. The multimedia document can be distributed off-line by CD-ROM or on-line via WWW. Obviously, the advantage of this approach for authoring is that production time is considerably reduced since material obtained from usage mode 1 and 2 is basically a spin-off of synchronous teleteaching [2]. In addition to the publishing issue, students may also use the *modified dlb documents* of usage mode 2 in order to produce individualized, annotated lecture notes with the dlb, e.g. for the preparation of exams.
4. **Retrieval (asynchronous)**: A light-weight WWW dlb viewer can be employed for retrieving lecture notes (*dlb documents*) from a WWW server for the purpose of viewing and printing. Moreover, the VCRoD service offers students who missed the lecture or who want to review a certain difficult topic the possibility to playback recorded lectures (*VCRoD recording*) as originally captured. The VCRoD service supports random access, fast-forward and rewind to arbitrary parts of the lecture [Holfelder 97].

5 Implementation Issues

We have implemented a prototype of the dlb which fulfills most of the requirements mentioned in [Design Considerations]. Audio and Video are not integrated yet and a module for synchronized recording (VCRoD service) is in progress. Since the source code for the MBone whiteboard wb is not publicly available, we had to develop the dlb from scratch. To allow for a high degree of portability, we implemented the prototype in C++ and the Tcl/Tk scripting language [Ousterhout 94] and we took great care to reuse only components which are available on all major hardware/software platforms (e.g. ghostscript for rendering postscript pages). The current version has been successfully installed on the Unix systems AIX (IBM), IRIX (SGI), Solaris (SUN), and Linux (PC).

To satisfy the collaborative requirements of the dlb, we have developed a so-called *collaborative services model* (csm). The csm is implemented as a separated service application which can be accessed by multiple clients through a well-defined application programming interface. As indicated in [Design Considerations], collaborative services provide an electronic surrogate to compensate as far as possible for the lack of inter-personal communication channels. The csm implements enhanced floor control and session control mechanisms and policies. Floor control realizes concurrency control for interactive, synchronous cooperation between people by using the metaphor of a *floor*. A floor is basically a temporary permission to access and manipulate resources (e.g. a shared drawing area). Session control denotes the administration of multiple sessions with its participants and media. Session control increases social awareness in distributed work groups because members gain knowledge of each other and their status in the session. The csm keeps the collaboration state (the relationships between participants, floors, resources, and sessions) in a single object-oriented model. The model is replicated on each participant's workstation and held consistent by using an optimistic synchronization scheme. Applications using csm get either messages about the collaboration state or they can explicitly send queries to csm, e.g. to ask if the floor for drawing on the shared workspace is currently available. The csm supports the following features:

- Administration of participants, groups, sub-groups, and super-groups,
- management of resources and assignment to participants, groups, and sessions,
- participants with different roles and privileges (e.g. teacher, student, etc.), and
- different floor control policies (e.g. implicit control, explicit control, chair control, etc.).

For a more detailed description of the csm see [Hilt & Geyer 97].

[2] This procedure is very similar to the „Authoring on the Fly" concept but differs in that our approach does not limit the recording to the teacher's actions [Bacher & Ottmann 96].

6 Related Work

Besides various existing video conferencing systems such as NetMeeting, CUSeeMe, ProShare etc., which provide audio/video transmission, application sharing and standard whiteboard features, we know of two approaches closely related to ours. The „Authoring on the Fly" (AOF) [Bacher & Ottmann 96] concept merges broadcasting of lectures with authoring of CBT software. With AOF, lectures are transmitted by means of an extended whiteboard to a number of receivers. Interactivity is limited to the audio and video channel, modifications to the transmitted material are not possible for receivers. Thus, collaborative types of instruction are not supported. The sender's (teacher's) media streams are recorded locally. The synchronized recording together with lecturer slides and additional media, such as animations, are then transformed to a CBT course which can be either published on a CD-ROM or accessed through the WWW. The Interactive Remote Instruction (IRI) system developed at Old Dominion University [Maly et al. 96] provides a very powerful, integrated teleteaching environment. The system can be used to view or make multimedia class presentations, to take notes in a multimedia notebook, and to interact via audio/video and shared tools. Furthermore, it provides class management and floor control. The system differs from ours in that IRI partly relies on analog transmission of NTSC video signals and that collaboration is limited to application sharing.

7 Conclusion

Experiences in the TeleTeaching project at the universities of Mannheim and Heidelberg indicate that standard video conferencing software is insufficient for the purpose of computer-based distance education. As a consequence, we decided to develop the digital lecture board (dlb), an integrated teleteaching tool, which takes into account the requirements of synchronous, remote instruction. The dlb supports multimedia presentations in RLR up to modern, collaborative types of instruction in RIS and IHL. As a part of a teaching and learning system, it allows for pre- and post-authoring of teaching and learning material. The current implementation presented in this paper already supports most of the envisaged features. In the upcoming semester, we intend to employ the dlb for a few trials in a distributed seminar for evaluation purposes. Future work will concentrate on the integration of audio and video communication in the dlb's user interface, and on extending dlb's media capabilities. Moreover, we also plan to work on integrating animation and simulation facilities.

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Java Teachware - The Java Remote Control Tool and its Applications

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Abstract: Multimedia allows for new forms and techniques of teaching. Modern educational material no longer only consists of text and some figures but also includes audio, video, animations and simulations. We decided to use Java in our distance learning projects because it becomes increasingly important in the World Wide Web. Although Java applets can easily be inserted into asynchronous material like hypertext pages, it provides no mechanisms to use it in synchronous scenarios. We therefore developed the *Java Remote Control Tool* with the help of which distributed Java applications and applets can be controlled and synchronized.

1 Introduction

During the last two years distance learning became an important application for the Internet. Since 1996 our institutes are exchanging complete lectures on regular terms by using the MBone technology (see Section 2). At the same time, several animations and simulations were developed and added to the educational material on our Web-servers. Because of its platform independency we decided to use Java for our animations and simulations. Furthermore, we wanted to put these applets into action during the teleteaching lectures. Since no means for distributing Java applets were provided in early 1997 we were forced to develop the Java Remote Control Tool which allows us to control and synchronize animations running on several distributed machines.

This paper is structured as follows: Section 2 gives an overview of the Tele-Teaching Project between the Universities of Heidelberg and Mannheim. Several scenarios that are to be implemented will be described shortly. Before explaining the architecture of the Remote Control Tool in Section 5, we briefly mention several projects related to our approach and discuss „Shared-X" as an alternative approach. Section 6 provides some example animations and simulations before the conclusion and outlook in Section 7 finish the paper.

2 The TeleTeaching Project between the Universities of Heidelberg and Mannheim

In January 1996 the universities of Mannheim and Heidelberg started a joint Tele-Teaching project. In this project, we planned to implement three different Tele-Teaching scenarios. The first scenario was the *„Remote Lecture Room Scenario"* in which whole lectures are transmitted via the Internet. The MBone tools (vic, vat and wb) [McCanne and Jacobson, 1995] are used to transmit video, audio and postscript slides. The second scenario we have also explored actively is called the *„Remote Interactive Seminar"*. During the winter-term 1996/97, a joint seminar on „Digital cash in the Internet" took place in Mannheim, Freiburg and Karlsruhe. Again, the MBone tools were used to transmit the talks. In contrast to the „Remote Lecture Room Scenario" the seminar was much more interactive and a discussion between the three sides took place after each talk. The organizational, pedagogical and technical aspects of the first two scenarios are discussed in more detail in [Eckert, Geyer, and Effelsberg, 1997]. The third scenario which has not been implemented yet is called the „Interactive Home-Learning Scenario". Here the target groups are typically students running Windows95 or Linux on their PC with an Internet connection via ISDN. This scenario has the most widespread distribution of members. It can be divided into two periods:

1. In the asynchronous period, production and consumption of the educational material take place at different times. The material is offered to the students on the World Wide Web. Aside from hypertext we concentrate on animations and simulations as new teaching technology. We already developed several Java applets for a physics and a computer science lecture. As a further add-on we plan to integrate several recorded and digitized audio and video shots which were added to the hypertext material.
2. In the synchronous learning period, production and consumption of the lectures take place at the same time. In this period, we plan to transmit lectures not only live to the remote lecture rooms but also live to the students at home. The required Internet connection will be based on ISDN. In this period we also want to

make use of the Java applets we developed during the asynchronous period. Therefore we developed the Java Remote Control which will be explained in the following section.

3 Related Work

The roots of our Java Remote Control Toolkit date back into the early days of 1997. Meanwhile several other projects pursue similar goals three of which shall be mentioned in this paper: S. Shirmohammadi and N.D. Georganas developed a Java-Enabled TeleCollaboration System (JETS)[1] at the University of Ottawa. JETS is an API that supports the development of collaborative Applications. A similar project called Haberno was started at NCSA[2]. Habanero is a framework for sharing Java objects. Included, or planned, are networking facilities like routing, arbitration and synchronization mechanisms which are necessary to accomplish the sharing of state data and key events between collaborator's copies of a software tool. Javasoft started a research project named "Java Shared Data API (JSDA)"[3] with the goal to provide an API for A Shared Data Multi-point Delivery Service for Java, JSDA concentrates on multipoint data delivery and provides services for multipoint communication among an arbitrary number of connected application entities. These approaches are designed to facilitate the development of shared application, e.g. shared word processors. On the other hand, our goal is the development of an API which allows synchronization of animations. Therefore these approaches do not exactly match the needs of our scenario.

4 Java versus alternative approaches

The problem of remotely controlling applications running on other computer systems had to be solved from the beginning of networked computing. However, with the advent of object oriented GUIs, the problem became much more difficult since programs became heavily interactive. Although some GUI systems are already originally designed to run across networks, e.g. X11, these solutions require large bandwidth which were not available in our Home-Learning scenario. (Experience shows that e.g. mouse movement in the X11-environment can consume up to 20KBit/s!)

One of the first multi-user remote GUI systems is a Shared-X environment [Baldeschweiler, Gutekunst, and Plattner, 1993]. Several people on different computers in a network can jointly use an X-application. As described above, running X across networks requires large bandwidth. Several research projects [McCanne and Jacobson] [Minenko, 1996] have worked on restricting the current protocol to a low bandwidth version. Typical approaches to reduce the bandwidth are data-compression and delta-encoding (XRemote). A newer approach called Low Bandwidth X (LBX) uses short-circuiting, reencoding and motion event suppression mechanisms. Further information about LBX and shared-X can be obtained in [Mauve, 1997].

Only recently, Microsoft discovered the need for remotely and jointly controlling GUI applications. Their NetMeeting[4] products might become a valuable tool for TeleTeaching and Teleworking scenarios.

However, all these solutions suffer from a crucial drawback. Most applications that are to be used jointly across a network were designed for local, single-user access. If they are to be used by a group of people, access-restrictions and synchronization problems become an issue of great importance. Implementing different access levels for different GUI elements and advanced synchronization also require substantial chances to the original application. Furthermore these solutions are no longer platform independent, which is an important issue in case of the Home-Learning Scenario where Unix Workstations (at the class room) as well as Windows95 and Linux PCs (at the student's home) are used jointly.

5 The Java Remote Control Tool

In Section 2 we described the scenarios we want to enhance with shared animations and simulations. We therefore decided to implement the following functionality within the Java Remote Control Tool in order to accomplish the task:

1. The first basic functionalities needed are methods to *exchange data between the distributed applets*. Based on this core functionality, methods of higher abstraction level can be implemented.

[1] Further information can be found at http://www.mcrlab.uottawa.ca/jets/ and [Shirmohammadi and Georganas, 1997]
[2] Further information can be found at http://www.ncsa.uiuc.edu/SDG/Software/Habanero/
[3] Further information can be found at http://www.javasoft.com/people/richb/jsda/
[4] Further information on NetMeeting can be found at http://www.microsoft.com

2. To implement a shared application, we have to find ways to *control several remote applets*. Events must be caught and sent to the other participating applets. This must be accomplished through secure channels of communication because the loss of a single event will result in inconsistency of the distributed applets.
3. The next step after sharing of events will lead to *floor control mechanisms* in order to prevent contradictory events. It is necessary to decide who is in control of the shared application at a certain time: E.g. suppose two users want to move an object on a shared drawing canvas at the same time. In case of our synchronous learning scenarios, the control of the animations must reside by default at the teacher's side. He may give the floor to a student for a short period of time but he must have the ability to reclaim the floor whenever he wishes. Further issues of collaborative services in distributed learning environments are discussed in [Hilt and Geyer, 1997].
4. Unfortunately Java applets will run differently on different machines. E.g. the drawing of a line takes much longer on a PC then on a workstation. Therefore it is not sufficient to share events; *rather synchronization mechanisms* are a prerequisite in order to have the applets running consistently.
5. All these mechanisms must be designed in a way to allow the easy adaptation of already existing applications (e.g. animations and simulations).

We decided to insert this basic functionality into our API. Methods on a higher level of abstraction may be included at a later time.

5.1 Conceptual outline

According to the above outlined specifications, we decided for a solution that adds means for distributed control to the GUI of an existing applet. The main features are:

1. Different users sign up for participating interactively (e.g. automatically by invoking a web-page that contains the applet).
2. They then receive all GUI interaction commands via network which forces all the applets to behave coherently. (The applets will not run identically since processing speed on different machines might be different. Methods for synchronization will be explained below).
3. Floor control has to be implemented: If a user wants to control the applet, he can apply for being granted the control (e.g. by pressing a control button). A master program (on the server providing the applet) checks the request and eventually hands the floor control over to that user. The user who possessed the control before looses the control over the applet.

If the ``apply for control"-button is placed in a separate window, the GUI of the applet need not be changed. This entirely conserves the web-pages' layout allowing for an easy migration towards distributed control. The web-server providing the applet's class code is in charge of distributing the GUI events among the applet instances and grants the different users the right for controlling the applet.

5.2 Technical outline

Since changing specifications is one of the biggest sources for software malfunction, the changes required to adapt existing applets should be as small as possible. This goal was met by a solution that in fact requires no changes in the applets at all. We defined a class DistributedControl that besides from its constructor only needs one method, the handleEvent method. Applets that are to be controlled distributively, will instantiate one object of that class and send every event to that object. Processing of that event will then take place in the DistributedControlWindow that will be explained in a moment. As a result of this minimal interface construction, it is even possible to introduce distributive control into classes for which no source code is available. This can be done by overriding handleEvent for that class, invoking DistributedControl.handleEvent and then calling super. On instantiating a DistributedControl object, a DistributedControlThread is started, the purpose of which is to hold contact to the control server via a socket connection. Another feature of the DistributedControl class is that if it is called as application, it will work as control server, i.e. it suffices to place the class files on the web-server and start DistributedControl there. Coordination of all the parties joining will then be handled automatically. This feature is achieved by additionally supplying a main method for DistributedControl.

The DistributedControlWindow acts as local control unit. At first, it blocks all GUI events for the applet by disabling its GUI. It then pops up a window with the 'get-control'-button and a status display. If the user presses the button, a request for floor control is sent to the server. The server then notifies the applet that holds the floor control to release the control. Finally the floor control is handed to the applet that applied for the control and its GUI elements are enabled.

A time-out mechanism is required to cope with network breakdowns. If the applet holding the floor control does not release it on request, the server will close that connection. Unlike in the normal case, events might be lost leaving this applet in a possibly non-coherent state. All other applets, however, remain coherent. But since the server logs all events of a session allowing for 'coming late to a lecture', a reconnect is always possible.

5.3 Synchronisation

Event handling has thoroughly changed between Java 1.0.2 and Java 1.1. During release time, we were working on a first version and were hence forced to re-implement the scheme described above. We used this chance to extend our concept towards synchronized distributed control as follows.

Many simulations not only rely on user input but also on random numbers to simulate effects. Together with different processing speeds on different platforms, this leads to diverging applet states. This need not be a principal problem. In fact, the model described above usually suffices completely. For the cases where identically running applets are required, we introduced a `broadcast` method that broadcasts objects e.g. random numbers, user input, GUI events. Instead of writing `z=Math.random()` we write `z=(Double)distributedControl.broadcast(new Double(Math. random()))`[1]. As one can see implementation has become easier due to RMI.

Synchronization is now also easily handled by inserting a `distributedControl.broadcast(null)`. Hence properly programmed applets i.e. applets that do not use local events or random numbers but only the broadcasted objects will now always run identically.

6 Examples

Now that we have described the Java-Remote-Control in the previous section, we will introduce some example animations and simulations. Throughout the lectures we make use of simulations. Students can now make hands-on experience during the lectures and explain their questions directly using the object. The following subsections illustrate this approach by giving three examples we developed. The examples can be retrieved from our world Wide Web Servers. The section will be rounded up by a short example of a shared application which can be controlled by the Java Remote Control Tool.

1. In the computational physics lecture, students can easily test different sets of parameters. This can amount to a feeling for the physics behind it.
2. The examples from the computer networks lecture are aimed to illustrate algorithms and protocols. Students can either view a pre-defined example for illustration, modify certain settings or create an entirely new sequence.

6.1 Simulation of AVL-Trees

An AVL-tree is an elementary data-structure usually introduced to students of computer science during the first basic courses. The basic concept is a height balanced binary tree. After each insertion or deletion of an element rotation-algorithms are used to rebalance the tree [Ottmann and Widmayer, 1993].

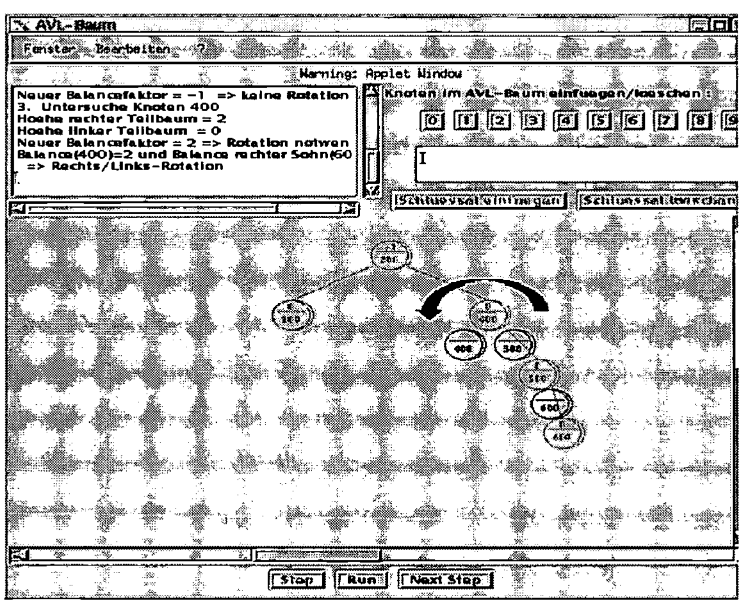

Figure 1: The AVL Tree Simulation

[1] In order to save bandwidth we had rather broadcast a Random object than the random numbers themselves. But this example is only for demonstration.

The applet concentrates on the visualization of the rotation operations[1]. It supports two steps in the learning process of a student: In the first step the algorithms are explained in that way that an example tree is build by the applet itself. In the second step, the student can freely build and change a tree by inserting and deleting elements. The applet animates the rotations after each insertion/deletion. While it is the goal of step one to demonstrate the mechanisms of the AVL-tree, the second step gives the student the opportunity to get acquainted with the concepts of the AVL-tree. The simulation can be suspended at any time for reading the explanations for each step of the algorithm which are displayed in a separate text field. [Fig. 1] shows the screen during a rotation.

It is planned to implement a third step of the learning process by enhancing the applet with a test mode. In the test mode the student is asked to insert or delete elements and then has to rebalance the tree by hand executing rotation operations. The goal of step three is to give feedback about the success of the learning process.

6.2 Molecular Dynamic Simulation of a Polymer Chain

Interest in the physics of polymers was pushed by the need for new materials in all fields of everyday life. Prominent examples for this are plastic bags made of polyethylene or compact discs which mainly consist out of Bisphenol-A-Polycarbonate (BPA-PC). The properties of these materials were investigated by experiments and for some of these materials a theory has been established. Nevertheless computer simulations can give a more detailed picture in this context. Polymers can be modeled for computational purposes in a variety of ways. Depending on the kind of question and the degree of abstraction, one has the basic choice between a lattice model and a model in continuum. If one wants to stay as close as possible to the chemically realistic chain, it may be of advantage to remain in the continuum (i.e. real space).

The Java application simulates a single polymer chain in real space using the united atom model [Bishop, Kalos, and Frisch, 1979] with molecular dynamics[2]. In this model, linear polymers are represented by chains of mass points. The masses are connected by springs. Moreover, angle forces, torsion forces and van der Waals forces between the masses are used. The program reads configurations in some formats and can change the physical parameters even during the simulation which is very useful to demonstrate special effects. As important physical parameters, e.g. potential and kinetic energy, are calculated and plotted during the simulation, it can be used to demonstrate the effect of different forces and the time development of certain observables. The on-line visualization of the polymer chain enables by a hands-on training an intuitive understanding on the interplay of the different parameters of the model and leads to an understanding of the behavior of a polymer chain.

6.3 Enhancing an applet into a shared application

These educational examples can easily be turned into shared applets. Only three modifications are necessary:

1. Instantiation of the Remote Control Object (RCO)
2. Addition of all components that are to be controlled remotely
3. Transportation of all objects that are to be shared via the RCO

This simple mechanism provides all means for a really shared applet even within the Java 1.1 event handling scheme.

7 Conclusion and Outlook

In this paper, we described the Java Remote Control Tool along with some example applications and their field of activity in Tele-Teaching scenarios. The main advantages of our approach are the low bandwidth need and the ability to handle different access restrictions (floor control). Furthermore, our implementation of the Java Remote Control Tool can easily be adapted to already existing Java applets. With the adaptation towards Java 1.1. we could make use of RMI and therefore work with standardized protocols. We believe that the Java Remote Control Tool is an easily adaptable API to produce shared applications which are not necessarily restricted to educational simulations.

Tests over low bandwidth channels - e.g. ISDN and modem - will be necessary to proof the usability of the system in our Interactive Home-Learning scenario. Furthermore, some more extensive performance measurements and results about the scalability of the server-based model we chose for the Remote Control would be desirable and may lead to a more distributed way of communication.

Future work may comprise an API containing high level methods for simulations and state control in order to allow the fast programming of interactive simulations. The concept of Java-Beans [Mauve, 1997] is interesting in this context. Lastly it would be desirable to adapt the Java Remote Control to the MBone-VCR [Holfelder, 1997]. This would enable us to easily record audio explanations of our simulations.

[1] URL http://www.informatik.uni-mannheim.de/~cjk/java/animation/avl/}

[2] URL http://wwwcp.tphys.uni-heidelberg.de/java/md/

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Organizing and Sharing Information on the World-Wide Web using a Multiagent System

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Introduction

The Internet revolution has made a wealth of information resources available for direct and easy access on the user's desktop. However, finding, organizing, and sharing appropriate information when needed has become a significant problem for many users, including teachers, students and researchers. Organized information spaces are easier to search, but finding or authoring these organizations is difficult. Our research focuses on three areas which require significant technological advances: (1) finding information relevant to users' needs; (2) organizing information for facilitating access in various contexts; and (3) collaborative information sharing. Current WWW search engines allow users to locate information of interest, but often return vast amount of irrelevant information. On-line centralized catalogs (like Yahoo) provide more relevant and well organized information, but they are costly to author and not customizable to individual users needs. More recent information discovery and filtering technologies attempt to provide relevant information to users by learning from their previous queries or from other users' queries and feedback, but results are still preliminary [Balanovic 1997][Moukas 1997]. Yet users need an easy way to access information relevant and adapted to their current task and interest at any time.

Once relevant information is found, pointers to it must be locally organized and stored in a manner that allows rapid and effective access for both individuals and workgroups. Current personal information organizing schemes on the WWW are mostly limited to bookmarks (also called hotlists, or favorites). Bookmarks provide an easy way to organize URLs in a hierarchical manner, and to attach personal comments to them. However, hierarchical bookmarking schemes are monolithic, can be tedious to navigate, and cannot be easily shared with other users. They do not support fast changing rate of information, nor multiple uses of information under various contexts or by various users. Recent approaches to organize information at the level of collections of documents rely on metadata standards (W3C Resource Description Framework (RDF)), which require additional authoring effort from Web pages authors, and only support contexts of use anticipated by the author. There is also a critical need for tools supporting collaboration among distributed users with similar interests, or who are part of the same workgroup. Individual users can author and publish Web pages containing lists of related links. Some of them can be quite sophisticated, organized under single categories, or in tables with multiple categories. However it takes time to author and maintain these lists in a textual format. Sharing a common repository of information is a first step, but doesn't scale up to large distributed and informal groups. Collaborative tools themselves need to be distributed and dynamic, and support collaborative learning and discovery of information.

DIAMS: A Multiagent System for Organizing and Sharing Information

What if you could share your bookmarks with other users with similar interests as easily as you can share/publish Web pages? We propose to combine the advantages of organized published catalogs, personal bookmarks, and the distributed/collaborative aspect of the Internet. We augment hierarchical bookmarking with multiple indexing, facilitate the authoring of organized information spaces by taking advantage of the Web's inherent distributed nature, and support users in finding and reusing other users' information spaces. We have developed a first Java prototype of a distributed and collaborative information multiagent system, called DIAMS, which supports dynamic and flexible organization of personal information repositories, distributed over the World-Wide Web [Fig. 1]. These repositories in turn enable sharing between users at the knowledge-level, and automated discovery of new relevant information through collaborative information exchange between software agents. Each DIAMS agent learns from a user' preferences for organizing information, and provide dynamic views of information according to current user' needs. DIAMS will integrate knowledge-based, neural networks and genetic algorithms technologies to develop an ecology of users and agents that evolve over time, and to promote the emergence of collaborative groups of users.

DIAMS is directly accessible from Netscape browser toolbar menu and provides the following capabilities to users: Indexing of bookmarks under multiple hierarchical categories/folders to organize one's personal memory (URLs repository); Direct access to and browsing of other users' memories and display of their associated categories - other users' memories are displayed in the same information space using a different color scheme for each user; Automatic creation of aliases by dragging other users' URLs or entire folders into one's personal memory, or duplication (copy) into one's memory; Narrowing/Expansion of the current information space by selecting different sets of categories from various users - this supports incremental refinement of search results over time; Indirect access to other users' memories though intelligent agents that perform behind the scene categories searches and translation on other users' memories, and find memories of users with similar interests (matchmaking); Importing of existing Netscape bookmarks already organized into hierarchical folders.

We previously developed an adaptive indexing and retrieval agent (ARNIE), which enable users to categorize and share information of interest under various contexts, and is able to learn users' interests based on how they organize information, rather than what they search for [Mathé & Chen 1996]. ARNIE encodes information relevance and structure in a neural network dynamically configured with a genetic algorithm. This core technology was successfully integrated into several applications: NASA/JSC Adaptive HyperMan Electronic Documentation system in use at JSC Mission Control [Rabinowitz et al. 1995], and WebTagger TM (an adaptive bookmarking service on the Web) [Keller et al. 1997]. WebTagger is a personal bookmarking service that provides both individuals and groups with a customizable means of organizing and accessing Web-based information resources. Individuals may access the service from anywhere on the Internet. However, these systems were relying on centralized group repositories for sharing, and offered multiple indexing, but no hierarchical organization.

DIAMS extends the previous architecture with multi-attribute network objects, added semantic knowledge and symbolic processing capabilities. We are developing new information access methods which provide dynamically organized views of personal information repositories using knowledge-based and neural network representation and indexing. We will implement advanced techniques for sharing and gathering of information using knowledge-based, distributed automated agents. In particular, we will use a knowledge exchange protocol for inter-agents communication [Bradshaw et al. 1997], and take advantage of existing agents technology for matchmaking and referrals to find users with similar interests [Foner 1997][Kautz et al. 1997]. Finally, DIAMS design puts emphasis on a modular architecture with flexible interface protocols. The system can hence take advantage of existing tools with capabilities such as text search and automated categorization, and interact with established on-line dictionaries, thesauri, and knowledge bases.

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Supporting Hypertext-based Argumentation Skills

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Overview

In the information society, the ability to search for information in electronic repositories effectively, to evaluate claims accurately, to ask the „right" questions etc. are important cognitive skills which need to be trained and facilitated. In an ongoing empirical project, we are concerned with the question how the layperson can be supported in evaluating claims made in the mass media about certain environmental risks (mainly oil accidents in the oceans). In particular, we are looking into the following issues:

- What advantages has the active selection of information (within the framework of hypertext systems) compared to being confronted with a sequence of information that is selected? According to constructivist principles of learning and information processing [Duffy & Cunningham 96], active modes of information selection/retrieval should have clear advantages concerning knowledge measures.
- Which cognitive skills are needed to search for information in hypertext systems in order to scrutinize and/or build arguments and how are these interrelated? We will present a heuristic, process-oriented approach to problem solving in ill-structured domains which encompasses relevant concepts from the area of critical thinking [e.g. Brookfield 87; Ennis 95; Halpern 96] and informal reasoning [Voss, Perkins & Segal 91]. We extend former theories of critical thinking and informal reasoning by taking into account external information sources and the influence of external representations of arguments.
- How can the empirically and normatively derived skills be improved using computer-based cognitive tools ['mindtools'; Jonassen 96]? Though this question can only accurately be addressed by having a sufficiently detailed theoretical framework of the users cognitive strategies at hand, some preliminary considerations and their practical implications will be presented.

Improving informal reasoning by actively searching for information in Hypertexts

In our first study participants had to critizise and extend an argument about a certain environmental risk which was graphically represented as a concept map. Subjects had to add nodes and relations to the initial argument structure. We investigated the effect of different modes of information availability on (1) the increase of actual and perceived knowledge about the subject-matter and (2) the quality of the final argument structure.
Different modes of information access were realized by a yoked-control-design. In the first experimental group called „active group", subjects had access to a hypertext-system which comprised background information on the subject-matter as well as relevant media reports about environmental catastrophes [Bosnjak, Reimann & Wichmann 97]. In the second experimental group, the „passive group", participants were confronted with the sequence of information displays a *corresponding person* in the active group had selected. Thus, each passive subject was "yoked" to an active information searcher. The rationale behind this design is to analyze the influence of information access - active vs. passive - while keeping the information each subject receives in the two conditions identical. In a third group, the control group, subjects had no access to additional information. Influence of prior knowledge was controlled by assessing it in the course of pre-testing. Our main findings over 33 participants (11 in each group) were the following:

(a) *Minimized „illusion of knowing" by actively using the provided hypertext-system.*
Though there were no significant differences in the actual gain of new knowledge from the information system between the groups „active" and „passive" (as assessed by comparing pre- and post-test scores), the „active group" had a more *accurate certainty* of their acquired knowledge. At the beginning and end of the

experiment subjects had to assess their subjective feeling of being informed on different environmental topics. Members of the active-group perceived themselves significantly more informed on the topics which were actually covered by the hypertext-based information-system (pollution of seas, oil-tanker-average), the passive group perceived itself as being better informed even on topics that were not addressed by the hypertext.

(b) *Quantitative differences between the developed arguments with superior measures in passive-mode.* The passive group added more new nodes to the argument structure than the active group, which in turn added more arguments than the control group. Using a graph-theoretical measure, we found that overlap between the initial and the final argument structure was stronger for the control group than the passive group, with the active group lying in-between. Concerning the depth of the argumentation, computed with the graph-centrality-index (diameter of the argument-structure), no differences between the active and passive-group could be observed.

(c) *No significant qualitative differences between the argument structures in active and passive mode.* A qualitative assessment of the developed argument structures was performed with respect to topics covered, relevance/soundness, and the balance of the argument structure. The last two dimensions have strong relations to the concept of soundness proposed by [Voss, Blais, Means, Greene & Awesh 89] and [Voss & Means 91], which consists of the criteria „acceptability of reasons", „relevance or support the reason provides for the claim" (grounding) and „extend to which reasons supporting the contradiction of the claim (counterarguments) are taken into account". For these three qualitative dimensions, no significant differences between the active and the passive group could be discovered.

How can these unexpected observations - (a) the passive group worked quantitatively slightly better than the active group, and (b) no significant differences between the two groups with respect to qualitative measures - be explained? We hypothesize that this is mainly caused by differences in cognitive load [Sweller & Chandler 94]: Whereas the passive group could concentrate solely on processing the linear sequence of information, the active group had in addition to plan for navigating through the non-linear hypertext. In addition, both groups had little knowledge about the domain area, which may make linear presentation of information (as in the passive group) more suited for (initial) learning [Zink & Schnotz 95]. However, in the real world and in particular in widely used information repositories such as the World Wide Web, information does not come in a nicely sequenced format. How can layperson be supported in coping with insufficient initial domain knowledge and working memory load in the context of interacting with hypertext-like information systems? Our first step to answer this question is to build a normative model of a "good information searcher", building on psychological and instructional research.

A Process-oriented heuristic model of critical thinking abilities for the active use of Hypertext-systems in Argument-development

With the dissemination of actively usable information systems – especially over the internet or as CD-ROMs – informal reasoning abilities (e.g., to evaluate given statements, verifying their veridicality and soundness, as well as generating new arguments and counterarguments) become core competencies and crucial components of information literacy. Psychology has analyzed comparable cognitive processes in the course of research on reasoning, critical thinking, writing, and argumentation skills. However, from analyzing this research work we find a lack of consideration for the influence of external representations in form of information resources (databases, hypertext, World Wide Web) and in form of external representation of reasoning (e.g., argument structures). Building on theories of critical thinking skills [Brookfield 87; Dewey 33; Ennis 95; Garrison 92; Henri 91] we want to come up with a process model of informal reasoning and argumentation which takes into account external information ressources.

Our heuristic model on „ideal" informal reasoning processes supported by an externalized information system comprises three main layers: argument-development, internal cognitive processes and operations within the hypertext-system. Internal cognitive processes, which have a mediating function between the externalized information, the argument development and the users domain specific knowledge, are described as successive phases which are initially triggered by the presented argument structure. In the first phase, a user should develop a representation of the given argument and decompose it for evaluation according to it s veridicality and soundness. The evaluative phase itself should trigger exploratory behavior (explicitly searching and asking questions), which is aimed at finding confirming and/or rebutting arguments relevant to the topic. At the last phase – but not exclusively there - subjects should integrate their (newly acquired) perspective into the given argument-structure.

Given this heuristic model, we currently attempt to empirically determine in which phase(s) of argument development and/or usage of the hypertext-system participants have major difficulties. Based on these findings, testable hypotheses about how to facilitate the informal reasoning process most effectively by computerized cognitive tools [„mindtools"; Jonassen 96] will be derived.

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Network Based Delivery and Automated Management of Virtual University Courses

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Abstract: *Factors such as increasing class sizes, expanding curriculum, added time pressure on students and lecturing staff, contention for library resources and study space as well as the cost of educational administration have prompted the application of advanced technology to both enhance the pedagogical aspects of teaching and relieve administration and management resources. However, no single technology is appropriate to support both the pedagogical requirements and administrative imperatives required for course delivery in a virtual educational environment. This paper identifies student and course delivery management requirements and describes the seamless integration of appropriate multimedia and groupware technologies to support course delivery within a virtual student desktop. The paper presents the resulting experiences and lessons learned in delivering educational services using virtual environments based on the execution of three trials involving over 300 students in Trinity College Dublin.*

1. Pedagogical and Administrative Requirements for Course Delivery

A University setting where class sizes are large and schedules are tight provides a unique opportunity for developing courses using a range of advanced information technology. Yet such a scenario places many requirements on the *administrative*, *pedagogical* and *support services* in order to successfully execute technology based courses.

There have been many experiments of tele-education in the US and in Europe [Schank 93][Soloway 93] and many institutions have developed IT based educational material e.g WWW educational sites and multimedia materials [WLH 97]. The growing availability of authoring tools e.g. [WBT 97][Learn 97] should increase the number of such educational resources; however, these facilities are seldom part of an integrated educational system where the education is formally managed and administered.

For the educators or tutors, participation of class members should be manageable e.g. course registration, controlling access to class discussions, automatic collection/distribution of assignments and projects should all be functionally accessible to the tutor. Computer facilities for courses should also provide a means of monitoring each students usage of the educational resources and comprehension of the content. Educators and course administrators need well defined systems for the certification and assessment of a students progress [Hamalainen et al. 96][Carroll et al 95]. Techniques for ensuring that only students who participate in the course for its duration and achieve the desired results have yet to be properly defined and accepted.

New ways of stimulating and motivating course participants are required which make use of these 'tele-technologies' [Tuckey 92] and early experiments have proved that course composition, presentation and assessment have to be redesigned in order to produce effective courses [Turoff 95]. Tests carried out between two groups of students participating in a traditional educational course have shown that the students who had access to *supplemental* multimedia (e.g. video, audio and animation) and simulation environments [UTOR 95], did significantly better than the students who did not have access to such material [Kaplan 97]. Students require flexibility in the timing of course delivery and desire the opportunity to participate in the course away from the university campus [Prospect 95]. Existing courses try to reduce the users requirements on hardware and software and allow them choose the time and place more freely [ELMA 96]. Thus course delivery must be configurable to a wide range of computing environments which offer both a uniform interface and the option of personal mobility [Trollip 96]. An on-line support service is beneficial from an educational and technical point of view [Fitzgerald et al. 95][Sherry et al. 96] as this allows any difficulties or problems that arise during delivery of the course to be easily notified and efficiently handled. Technical support staff in educational institutions identify reliability, configurability and administration as vital elements in course delivery [Prospect 95]. Both educational and technical support must be successfully integrated into the university organisation for any large scale implementations of Internet based education.

2. Motivation and Objectives

In the TCD computer science department, there are several taught courses in database technologies given as part of the daytime and evening Computer Science, Maths, & Computer Engineering degree programmes. Several of these courses cover similar material, namely an introduction to SQL (relational database query language). Therefore in order to reduce the time pressure in lectures, reduce redundancy in preparation/delivery of lectures, 'improve' interaction with and dissemination of educational material, and provide more in-depth exposure to subject material, a 'self learning' student-centered course was developed for delivery in a virtual learning environment. Other motivations were to reduce the contention on library resources, automate the process of tracking, monitoring and testing/evaluating student knowledge and to provide a basis for course development across the different degree programmes.

The course was designed as a 'Self Learning' course concerned with the theories & practical skills (application) of relational database management systems. The Self Learning course was run in parallel to lectures (over a 5 week period) and sought to:

- Provide good overview of subject which can be integrated into different degree courses
- Provide persistent access to educational material
- Stimulate student 'innovation' and 'discovery'
- Capture requirements for tools needed to support such courses
- Integrate educational and communication paradigms into a single virtual environment
- Extend classroom learning paradigm
- Stimulate student experimentation
- Provide greater time flexibility
- Provide a 'Living' course content
- Capture student usage & student feedback
- Provide online management of students work and course delivery

3. Virtual Educational Environment

One of the key requirements for delivery of the course is the ability for students to easily access and load a virtual student environment without needing to install customised or specialised software or hardware. For this reason the Virtual Student Desktop (VSD) was developed to provide a single environment from which a range of courses could be delivered and within which the various technologies needed to support pedagogic paradigms and administrative systems are seamlessly integrated. The VSD is accessible using standard WWW browsers e.g. Netscape 3.x (or higher), HotJava browser or Internet Explorer. By accessing a particular WWW site, the VSD is automatically launched on the students machine. This enables the course to be delivered and auxiliary administrative/management systems to be initiated at the remote (educational provider's) site. All pedagogical and administrative systems (on the educational provider site) are executed transparently via the VSD, giving a single 'look and feel' to the virtual environment.

All student interaction is facilitated via the VSD. The VSD is rendered (by the student WWW browser on the student's machine) as a set of WWW windows, frames, tool bar and icons. All native WWW browser buttons are suppressed (hidden) so as not to distract the user from the main goal of education. A tool bar specially designed for educational use is provided by the VSD at the bottom of the screen and provides an interface to the administrative systems. From this tool bar the student is able to contact tutors or fellow students, access external systems, as well as navigate and interact with the educational course material.

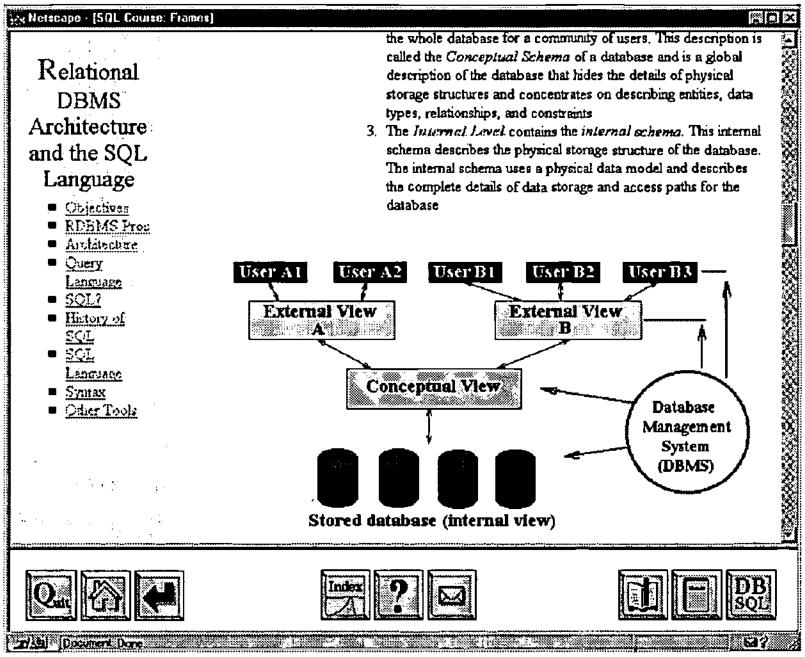

Figure 1: Virtual Student Desktop

3.1 Virtual Course Content & Student administration

The course content comprises of text, graphics, and animation and is divided into sections, with each section consisting of a small number of modules (a module typically being 1 - 5 pages). The virtual course trialled is concerned with the understanding of Relational Databases and the usage of Relational Database Language (SQL). On accessing the course for the first time, a student is asked to authenticate themselves using a unique user id and password (distributed previously). Then the administrative systems are engaged and the student is subscribed to a course and the appropriate student monitoring systems are loaded. Each student must authenticate herself/himself each time s/he logs onto the course. This allows a log of each students interaction with the educational material to be automatically maintained by the system for later analysis (in conjunction with tutorial results and evaluation forms). This information can be analysed for various pedagogic reasons (student usage, pattern analysis) and administrative motives (accounting for usage of course content and auxiliary systems).

Overall the course comprised five different types of information: Administrative (i.e. how to use the course etc.); A database of (self contained) modules; Indexes or Roadmaps of specific courses through various modules; Project Assignment specifications & Evaluation Forms; Case Study.

The roadmaps were important as the modules can be combined in several ways to satisfy the different requirements for different degree courses (e.g. business students, computer science students etc.). Each roadmap corresponds to a different learning objective of the RDBMS course. Thus the roadmaps provide a means of re-using existing modules with as little redundancy as possible of educational material and administrative overhead.

A significant feature of the system was to provide direct access to a real 'commercial' RDBMS via the same interface as the educational course. As with the administrative services, the relational DBMS is seamlessly integrated into the student educational desktop. Thus the tool bar offered by the student educational desktop contains an icon which allows students to issue SQL queries on a live database. The idea of this is to deliberately blur the distinction between the educational environment and the 'target' systems. This encourages students to 'try out' various parts of the course before attempting a larger project.

Another feature of the virtual educational environment is the ability of the student to store references to distinct locations in the course material (bookmarks). Traditionally these are stored locally on the student's machine. However this has disadvantages as students rarely use the same machine all the time. The VSD allows such bookmarks to be stored within the educational service and are thus (privately) accessible to an individual student at any time. Also if the student has logged off the course and logs back on, the VSD allows him/her the ability to resume at his/her most recent position or restart at the beginning.

Various forms of on-line tutorials are embedded into the course. 'True or False' and 'Multiple Choice Questions' are supported, with automatic correction and notification of marks to the student. Form based (short unstructured text style) answers are also facilitated in some tutorials. In these cases the student answers are automatically delivered to course tutors for subsequent correction. Also integrated into the course are evaluation forms which, when completed, are automatically submitted and stored for later analysis by course tutors.

The VSD provides buttons to contact other class members or to seek tutor assistance. Again, this is offered via WWW forms and integrated transparently with an email delivery system. The course also provides several larger project specifications one of which each student is required to implement. The implementation of the projects could also be done via the educational interface, providing better pedagogical support for the project implementation.

4. Implementing the Student Virtual Desktop

As described earlier, the course is delivered using WWW technologies. The WWW is based on a client server architecture. Requests are made by the client side (student) browser to the initial VSD engine which sets up the functionality of the student desktop. The server delivers this in the form of HTML, CGI and JavaScript. From this point on, all other requests are made by the client and returned by the VSD server. The tutor(s) are always directly accessible from within the VSD.

Scripting in the client side monitors the users progress through the course material and stores user preferences for each user. At the start and end of each session the user information is retrieved and stored respectively at the server side for future use. In this way the educational environment fully supports the mobility of users between locations. The advantage of client side scripting being the reduction in network bandwidth due to the avoidance of continuous client server communications. The individualised usage data provided by the client side monitoring system enables the tutor to check on each students progress in the course. Information that is stored are user bookmarks, last page visited by the user so that they can return directly to this page at the start of the next session, total time spent on each module which is useful in determining any specific problem modules and the number of times each module was accessed by each student.

A simulation environment is also enabled by providing a gateway between the educational student desk and a real life commercial database. This was achieved using the VSD engine combined with CGI scripting as the middleware between the desktop and the database. Students could query an example database straight from the educational environment thus blurring the distinction between theory and practice. Tutorial questions, project assignments and an evaluation form were also handled online via CGI scripting with feedback to the students and correction by the course engine. Off site access to the virtual desktop (and hence course delivery) was facilitated by ISDN or dial-up modem access to the campus network on which the educational site was available.

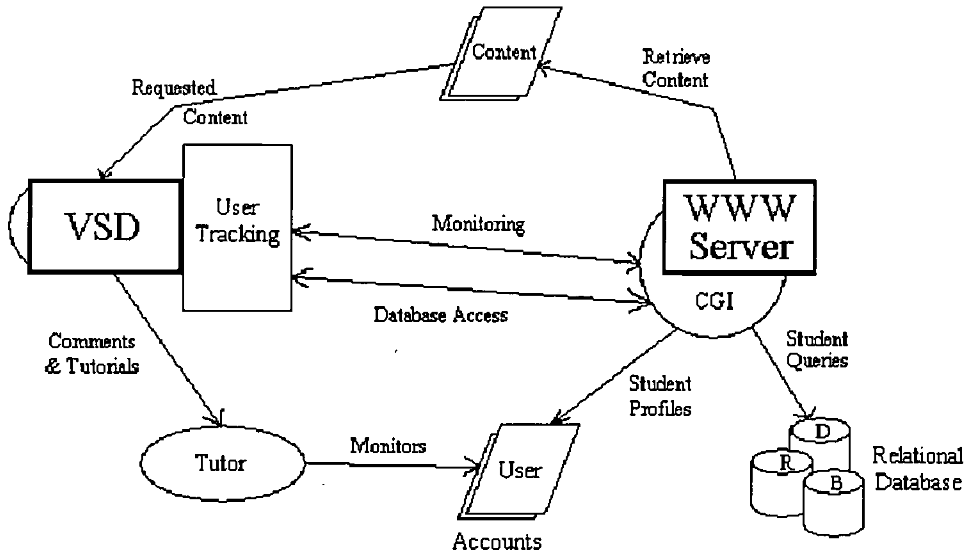

Figure 2: System Architecture

5. Trial Execution and Evaluation

The RDBMS course is currently in it's third year of academic trials involving a total of 300 students. The first trial (performed in 1995) used a basic text/graphic WWW interface. Having captured and evaluated feedback on the first trial, a second trial was performed in 1996. A third trial has been completed in December 1997. [Table 1] provides a summary of the objectives and an assessment of these objectives based on the experience of those sitting the course (harvested via evaluation forms and student interviews).

Original Objective	Assessment
Topic Covered Comprehensively	Students were able to complete, competently, a medium sized project with little further background reading other than a RDBMS systems User Manual (available on line). Also students undertook an oral exam to evaluate the effectiveness of the course. However, there are always a few topics which could be added!
Extend Classroom Learning Paradigm	It considerably improved the original method which consisted of several tutorials (paper based) and a couple of unsupervised labs. It generated much greater usage, understanding and questioning of the course as the students knew their work was being automatically monitored and assistance was 'virtually' close at hand.
Provide greater time flexibility	Most students appreciated this, especially as the term during which the course was taken was heavily timetabled with other lecture courses and project deadlines. However a few students indicated a preference to have their day scheduled for them!
Persistence of Educational Material	The educational course was available (and was used!) 24 hours a day, and was still available in the run up to end of year exams. Thus the course also served a purpose as revision material
'Living' course content	This was surprisingly useful as new information became available during the course execution. Also any 'errors' in the material could be corrected and advertised immediately (unlike the old situation which relied on printed handouts)
Stimulate student innovation discovery and experimentation	This can be achieved (to a degree) via on line tutorials (with immediate feedback), access to external resources e.g. access to 'case studies' of real-life situations (commercial DB with application data and example usages). The blurring of the division between the 'real world systems and information' and the educational material is particularly important in this regard.
ine management of course delivery and students work	On-line subscription to the VSD and account/usage monitoring of the VSD and course material were the main administrative system implemented and reduced greatly the time overhead in concurrently delivering the course to in excess of 100 students. However full integration of these administrative systems with college wide administration systems has not yet been perform although this can be done.
Integrate	By keeping the same 'look and feel' to the educational environment, whether sending notices

educational and communication paradigms into a single virtual environment	to tutors or colleagues, communicating with external systems, or interacting with course material, the student is not burdened with multiple program interfaces or interaction paradigms. This was reflected in the student responses and questionnaires which complemented the easy to use/no manual needed approach to using the VSD.
Capture requirements for tools to support WWW based educational courses	These requirements were captured from students taking the course using evaluation forms and interviews. The results can be tabulated and stored in databases to facilitate subsequent statistical analysis. Also during development of the course several useful tools became apparent e.g. automatic tutorial builder, road map generator etc.

Table 1 Assessment of Objectives

The overall reaction by the students to the 'Self Learning' mechanism employed by the RDBMS course was very favorable. It succeeded in many of its objectives and provides a firm basis for future development.

6. Associated Trial of Educational Service

The work already described to implement a campus-based educational service has been extended to play a role in a wider project which is concerned with commercial applications of tele-education in a pan-European context. The Prospect project [Wade 96] has been examining the issues which would be involved in realising an open service market place where various value added service providers may offer a customised educational service implemented on top of network connectivity services (usually offered by public network operators or enterprise network providers). The Prospect consortium implemented a Tele-Educational environment which provides educational services across pan-broadband networks. This Tele-educational environment provides features to support group lectures using video and audio conferencing, a slide presentation mechanism and also group projects which additionally used a shared whiteboard [Riordan et al. 97]. The VSD has been successfully integrated as part of this Tele-Educational Environment without requiring any re-implementation.

On entering the system a student is presented with a floorplan which shows a lecture hall, a self-study room, a group exercise room and a set of tutors offices. On entering a particular room an appropriate set of support applications were launched to allow the desired interaction to take place. For example, on entering a group exercise room, audio and video conferences are started between the people in the room. A shared whiteboard application is also launched showing the exercise to be completed. The students can then communicate in a whole set of modalities while attempting to solve the exercise.

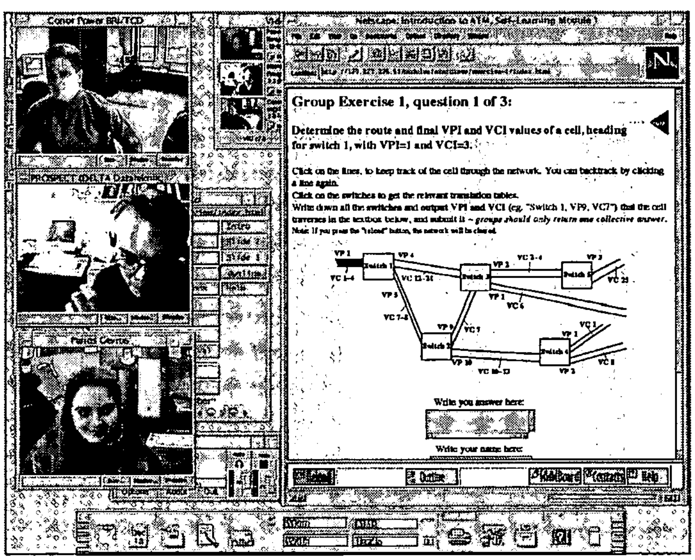

Figure 2 Prospect's Tele-Educational Environment

7. Conclusions and Future Work

Our experience has shown significant benefits in using WWW technologies in supporting a virtual educational environment. The virtual environment facilitates the seamless integration of many different technologies to support both pedagogical and administrative systems in a university environment. The success of the trials have shown that network centered virtual educational environments can have a major impact on reducing the pressures of increasing class sizes, time pressure on students and lecturing staff, contention for library resources as well as the cost of educational administration. The trial based experience has also shown that an iterative approach to course design, feedback and then redesign/extension is very important. It is simply too expensive, in terms of development time to attempt the development of sophisticated virtual environments in the first year. A more practical and less risky approach is the iterative, cyclic approach which although facilitating only modest pedagogic benefits in the early years gradually provides a platform and expertise for more rapid growth in later years. The development of several other virtual courses in currently underway, and it is expected that the development time for these courses would be much shorter as the VSD is already implemented and templates and expertise exist for the development of subsequent course materials. A third conclusion was the significance of the linkage between the educational system and adequate administrative systems e.g. student monitoring, project/tutorial correction, course subscription. This is especially true for large size classes and for 'off campus' students.

Our future research will involve enhancing the existing course including some adaptivity features and the development of appropriate tools to aid the development of such virtual courses. This would include tools for the auto generation of roadmaps for different applications of the course material. The overall aim of this is to remove much of the manual work from the educator, thereby freeing them to concentrate on the more important pedagogical aspects.

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FULL PAPERS

A Visual Tool to Define Multimedia Exercises

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Abstract: A flexible CAL system should provide teachers with mechanisms to adapt the courseware to their own methods as well as to their students' needs, without being aware of the system architecture and implementation issues. Taking as starting point this premise, we present a general model for describing training material and our experience in the development of a visual tool to generate multimedia exercises. The tool is embedded in a hypermedia learning environment called CESAR and it includes modules to easily define exercises that can be solved applying different strategies.

1. Introduction

The usefulness of computers as educational support tools seems to be unquestionable. Computer Aided Learning (CAL) environments can profit from the use of multimedia contents, insofar as making several senses pick up different stimuli of the same concept can strengthen, within our brain, the connections that make up our knowledge about that concept.

The need for involving teachers in CAL systems has been continuously stated, arguing that a successful introduction of new technologies in traditional classrooms requires the commitment of teachers [Brown 1994]. Teachers can get involved in the development phase of a CAL system in such tasks as creating didactic material, providing valuable information about the needs of students, proposing learning strategies and giving their opinion about the system utility and usability. Nevertheless, most CAL systems are addressed to broad communities and, therefore, it is not realistic to expect all teachers taking part in the development phase either agreeing with the product. In this case, a flexible CAL system that can be adapted to different educational methods would be regarded as a helpful tool. Moreover, it will promote a positive teachers' attitude as far as it provides them with means to adapt the courseware without being aware of implementation details.

In this paper we describe a model that offers a formal framework for the specification of training material. We also present our experience in the development of a visual tool, based on this model, that is aimed at providing teachers with mechanisms to easily create multimedia exercises that can be solved applying different learning strategies. This tool is embedded in a hypermedia learning environment called CESAR [Aedo et al. 1997] oriented towards helping hearing-impaired children to learn the sign and written languages.

2. A General Model for Specifying Trainings

In this section, we present a model that can be used as the starting point of the development of trainings, since it offers a general framework to describe didactic material. In order to provide a formal description of the model, their elements are described using the EBNF (Extended Backus-Naur Form) notation (see [Tab. 1]). Some elements are not completely specified since their definitions depend on the characteristics of the educational application to be developed. In particular, elements that appear in the formal definitions in italic have to be instanced. Their formalisation within the CESAR environment is shown in [Instancing the model for CESAR].

<table>
<tr><th>Symbol</th><th>Description</th></tr>
<tr><td>< ></td><td>Begin and end symbols that enclose no terminal elements</td></tr>
<tr><td><<>></td><td>Begin and end symbols that enclose terminal elements</td></tr>
<tr><td>::=</td><td>Decomposition symbol, where the left part is made up of the elements in the right part</td></tr>
<tr><td>|</td><td>Exclusive symbol (OR)</td></tr>
<tr><td>{ }</td><td>Repetition symbol; the elements enclosed are repeated from 0 to N times</td></tr>
<tr><td>( )</td><td>Associative symbol</td></tr>
<tr><td>[ ]</td><td>Optionality symbol; the elements enclosed are optional</td></tr>
</table>

Table 1: EBNF Notation

Learning environments should encourage an active student involvement [Quentin-Baxter and Dewhurst 1992] since the passive reception of information does not generate knowledge [Schank and Kass 1996]. Trainings can improve the learning process by proposing students the challenge of using their knowledge and skills to solve practical problems. Thus, the first element of the model is the *Training*, defined as a set of exercises oriented towards reaching a particular educational objective. Depending on the particular application to be developed, the training definition can be increased with different attributes (e.g. objective, methodology). Thus, the formal description of a Training includes two elements one of whom will be instanced for the CESAR environment in [Instancing the model for CESAR]:

```
<Training>::=<Training_Info> (<Exercise> {<Exercise>})
```

An *Exercise* is a learning activity that elicits an active involvement of students. As in [Celentano 1995], the exercise is divided into two parts: information items (e.g. text, image and video) that are called Information Objects; and the logic of resolution that is called Strategy. The same as the Training, the Exercise can include also some additional information as it is shown in the following formal description:

```
<Exercise>::=<Exercise_Info> (<Strategy> {<Strategy>})
                (<Information_Object>{<Information_Object>})
```

The separation between information objects and strategies brings three main advantages:

- the same knowledge can be approached from rather distinct ways by combining the same information objects with different strategies;
- the most appropriate strategy can be assigned to each student and, therefore, different learning styles can be taken into account, as stated in [Allinson and Hammond 1990] [Barker 1993]; and
- students can exploit the same procedural knowledge about the strategy to solve different exercises, if the same logic of resolution is applied to different information objects.

Those information items that are used in the exercises are grouped by means of *Information Objects*. An Information Object embodies all the representations of a particular concept by means of attributes (e.g. a car can be an information object that includes attributes such as a textual description, an image and a video) and it also can have some other information. The formal description on an Information Object is the following:

```
<Information_Object>::=<Object_Info> (<Attribute>{<Attribute>})
```

The *Strategy* defines the logic of resolution to be applied in an exercise [Díaz et al. 1998]. Strategies are specified through a Generic Model of Strategy (GMS) which defines: how to deliver information items to the student (Presentation Process); how to react to the students' interactions (Interaction Process); and the actions to be carried out when the student gives an answer to the exercise (Checking Process). The GMS allows the presentation, interaction and checking processes to be adapted to each student, providing a flexible way to gather different learning styles.

```
<Strategy>::=<Strategy_Info> <GMS>
<GMS>::= <Presentation> <Interaction> <Checking>
```

The *Presentation* process generates the exercise statement that consists of combining a number of multimedia items, that are references to attributes of existing Information Objects, and other additional elements (including explanatory sentences). The *Interaction* process is responsible for managing the reactions to the students' interactions, in such a way that a distinct behaviour can be defined for each item included in the exercise statement. Finally, the *Checking* process contains the actions to be carried out when the student gives an answer to the exercise. The specification of these three processes depends on the type of actions supported by the system and, therefore, they can not be generalised in this model but instanced in the next section according to the CESAR environment characteristics.

This model, that complements the one presented in [Aedo et al. 1997], has been used to create a tool integrated into a hypermedia learning environment aimed at helping hearing-impaired children to acquire the necessary skills in sign and written languages (CESAR).

3. A Tool to Create Multimedia Exercises

In this section we present the Visual Tool developed for creating multimedia exercises within the CESAR environment. Firtsly, the general model presented in the previous section is instanced taking into account the services offered by the tool. Then, the tool architecture and functional modules are described.

3.1 Instancing the model for CESAR

CESAR [Aedo et al. 1995] [Aedo et al. 1996] [Aedo et al. 1997] is a learning environment that makes use of hypermedia stories to initiate the deaf child to the story structure and provide him or her with the necessary experience. Children are presented a library where each book is structured in two parts: the story and the training. The story is based on the book metaphor and the training part, which is the main focus of this paper, includes a *Training* addressed towards learning the sign and written languages. The general model can be instanced as follows:

```
<Training_Info>::=<<training_id>>
<<training_id>>::="linguistic competence"
```

This training includes a number of *Exercises* each one belonging to a different category. Each category reinforces a particular type of knowledge. For instance, exercises included in the "Vocabulary" group are used to extend the child vocabulary with the terms used in the story. The definition of Exercise is completed as follows:

```
<Exercise_Info>::=<<exercise_id>>
               (<<category_id>> {<<category_id>>})
<<category_id>>::= "vocabulary" | "understanding_questions" | "regulators" |
                    "values_motives_consequences" |"narrative_structure" |
                    "expressive_elements" | "grammatical_elements"
```

A combination of different media (text, image, and video) is used to represent the book concepts. In particular, each *Information Object* is assigned five attributes: a graphical representation, a signed form, an animation, a written form and a textual definition of the concept. Thus, the formal description of Information Object is instanced as follows:

```
<Object_Info> ::= <<object_id>>
<Attribute> ::= [<<image>>] [<<written_form>>] [<<signed_form>>]
                    [<<description>>] [<<animation>>]
```

More than fifty different *Strategies* have been designed according to the particular contents to be presented to the child and to his/her specific needs. Each strategy has a simulation that acts as a stimulus and indicates how the exercise must be solved. The result of instancing the general model is the following:

```
<Strategy_Info> ::= <<strategy_id>> <<simulation_id>>
```

In the *Presentation* process, several elements can be delivered to the child by specifying their identifier, position and role in the exercise statement (comment, question or answer). The Presentation composition is then the following:

```
<Presentation> ::= <Presentation_Element> {<Presentation_Element>}
<Presentation_Element>    ::=    <<object_id>>    <<position>>    [<<size>>]
[<<text_style>>]
                                 <Type>
<Type> ::= <<comment>> <<question>> <<answer>>
```

In the *Interaction* process, a reaction or a set of actions is defined for each element included in the exercise statement. The instanced Interaction is the following:

```
<Interaction>::=<Interaction_Element> {<Interaction_Element>}
<Interaction_Element>::=<<Object_Id>> <<Reaction>>
<<Reaction>>::=list of actions
```

Finally, the *Checking* process is defined as a list of actions carried out when the student gives an answer. The definition of this process is:

```
<Checking>::=<<Reaction>>
```

3.2 Description of the Visual Tool

The tool is composed of five modules that make possible to create exercises that can be used in the CESAR environment. This tool is embedded into the Training System of CESAR as it is shown in [Fig. 1].

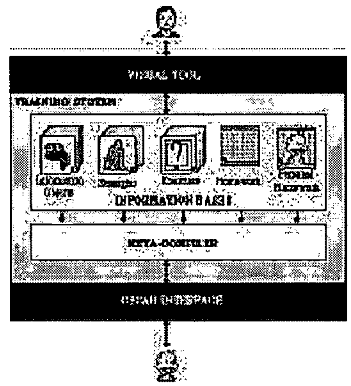

Figure 1: Tool Architecture

Students will interact with the Training System by means of the CESAR Interface, where they are offered the possibility of going to the training part from any page of the book. When a student chooses the training part in a CESAR book, the Meta-Compiler module retrieves the exercise identifier from the Personal Homework where the exercises assigned to the student are held. If there is no assignment for that student, the Homework is accessed to retrieve the exercises tied to that page of the book. Then, the strategy and the information objects involved in the exercise are retrieved. The processes that control the exercise execution are created by translating the visual language used by the teacher to specify the strategy into HyperTalk, which is the programming language of CESAR. The Meta-Compiler sets a frontier between the Training and CESAR, which makes the former independent from the learning environment. In this way, a simple specification language can be offered in order to encourage teachers to get involved in the learning environment.

Teachers will use the Visual Tool to generate the information bases used by the Meta-Compiler to create an exercise, that is: Information Objects, Strategies, Exercises, Homework and Personal Homework. These modules are described below.

3.2.1 Information Objects Management Module

Teachers can manage the information objects used in the exercises by means of this module, that includes tools to add new objects, delete objects, modify their attributes or access them (see [Fig. 2]). Apart from the object identifier, all attributes are optional and can be modified. Images and animations can be visualised by clicking the radio button on the left of the corresponding attribute. PICT and QuickTime formats are supported for both types of contents.

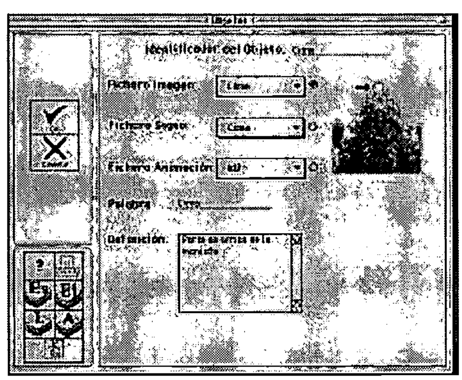

Figure 2: User Interface for an Information Object

3.2.2 Strategies Management Module

Strategies can be created, accessed, modified and removed. To create a new strategy the three processes of the GMS have to be specified. Teachers can manipulate and drag objects in an area that represents the student's screen and they can assign properties (type, occurrence order, delivering properties, reactions, etc.) to these visual objects. Allowed objects in the Presentation process are shown in [Fig. 3].

Word	Definition	Image	Animation	Sign
				

Figure 3: Visual objects in the Presentation process of a strategy

For instance, [Fig. 4] shows the Presentation process of an exercise that presents a description, by means of an image and an animation, three words and their signed forms. The first definition is used to ask children to select the word/sign that corresponds to the description.

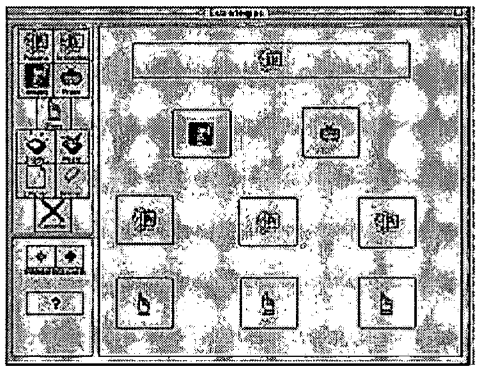

Figure 4: User interface for the Presentation process specification

To define the list of actions included in the Interaction and Checking processes, teachers can use a set of predefined functions that represent the most common operations in an interactive environment like CESAR. Nevertheless, they can program their own HyperTalk handlers.

3.2.3 Exercises Management Module

Teachers can establish the relationship between information objects and strategies in an exercise. With this purpose, they are presented a screen with a series of holes that represent the visual objects defined in the Presentation process. Teachers are asked to assign an existing information object to each hole. The object attribute matching the type of content previously defined is used to fill the hole and make up the exercise statement (see [Fig. 5]).

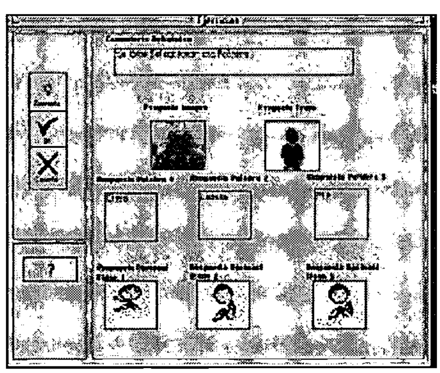

Figure 5: User interface for the Exercises Management module

3.2.4 Homework Management Module

Once the exercise is defined, it has to be assigned to the pages of the book, so it can be directly accesed by the child. One of the main requirements of CESAR is that the training area is specific to each story and its exercises are related to the story contents. With this purpose, teachers can use the Homework Management module that allows to define the exercises that will be tied to each page. This module provides teachers with the list of exercises defined for each category so they can specify the Homewok for each page of the book by means of a series of pop-up menus that make possible to select the book, the page, the category, the exercises and the strategy to be assigned.

3.2.5 Personal Homework Management module

The assignment of exercises to book pages can be particularised for each child by means of the Personal Homework Managament module, that also offers a number of pop-up menus that allow to select the student, the book, the page, the category, the exercises and the strategy to be applied.

4. Conclusions

This Visual Tool provides teachers with a series of mechanisms to define the set of solving strategies and exercises that will be used to reinforce the learning process of their students. Teachers do not need to be aware of details concerning the environment architecture and implementation to create new training material. In addition, they can generate a richer exercises base by making profit of the separation between the information objects and the solving strategy, since different combinations of strategies and contents define distinct exercises. In addition, the most appropriate strategy can be assigned to each child. The use of different strategies to solve the exercises was positively considered during the CESAR evaluation [Aedo et al. 1996], although the Visual Tool should be empirically evaluated to assess its usability.

Although the Training System is currently embedded in an environment oriented towards learning the written and sign languages, its architecture and the GMS are generic and they can be used in other kinds of subjects and in different learning environments.

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CREATING A GLOBAL EDUCATION NETWORK PARTNERSHIP: THE MUCIA GLOBAL/ITM MODEL

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Abstract

This paper reviews the application of a unique combination of distance education methodologies by MUCIA Global Education Group, Inc and the American Degree Program at PPP/ITM in order to alleviate critical deficiencies in human resources and curricular content found at the latter. The introduction describes the growing crisis in higher education in Malaysia, in particular, the dilemma of addressing increasing enrollments with limited resources. The paper then reviews the decade of cooperation between MUCIA and ADP PPP/ITM that eventually led to the application of distance education methods and practices. Finally, the paper reviews the MUCIA Global/ADP program by examining each of its components and assessing its strengths and weaknesses as well as those of the program as a whole.

1.0 Introduction

The *demand for higher education* and advanced technical training around the globe is growing at an exponential rate. The United Nations Education, Social and Cultural Organization (UNESCO) reports the number of students enrolled and projected to be enrolled in higher education worldwide as follows:

1970	28 million persons
1991	65 million persons
2000	79 million persons
2015	91 million persons

UNESCO also reports that the greatest growth in this student population has been and will continue to be in less developed countries, where enrollments stood at only 7 million persons in 1970 compared to 30 million persons in 1991.

An even more urgent picture emerges when increases in enrollment rates are compared to increases in school-age population in the developing world to form a ratio of access to higher education. According to UNESCO's data, this ratio has actually declined from 15.1 percent in 1980 to 14.1 percent in 1991. Therefore, although the student enrollment continues to increase in real terms, access to education is actually declining since enrollment rates cannot keep pace with school-age population growth rates.

This rapidly increasing demand for educational services has been met thus far in three ways. First, local governments have made serious efforts to build and expand their national educational systems. Second, some countries have sent substantial numbers of students abroad for higher education training. Third, educational institutions in the developed world, mainly the United States and Europe, have exported educational services in the form of technical assistance and other offshore programs. In the future, these options will lose much of their viability from a cost perspective given the rapidly increasing costs of higher education and the projected exponential increases in demand. For example in terms of increased enrollments,

- In the last 30 years, Malaysia higher education has evolved from a single university, University of Malaya, enrolling less than one thousand students in 1960, to more than ten state universities enrolling nearly 100,000 students in the 1990s, with an additional estimated 70,000 students studying overseas.

- ITM alone expects to increase student enrollments from approximately 50,000 students today to 100,000 students by the year 2000.

- The current average annual cost of maintaining a foreign graduate student at a US university has reached US$25,000.00. (The figure is somewhat lower for undergraduate students.)

- Since the 1960s, Malaysia has sent an estimated 30 to 60 thousand students abroad at a drain of more than US$.5 billion. Given current estimates, Malaysia will spend approximately the same amount in the 1990s alone.

Regarding faculty and staff development costs,

- The current average annual cost of maintaining a US professor abroad (with dependents) to teach in a foreign institution is approximately US$225,000.00.

- If staff requirements double in line with student enrollment increases, training 15,000 faculty members through the Masters Degree level (approximately 2 years each) at U.S. universities would require approximately US$ .4 billion.

- If those individuals were replaced while on 2-year study leave by U.S. faculty members costs would exceed $3.37 billion, if all of these U.S. professors were accompanied by dependents.

These data clearly indicate the magnitude of the problem facing the future of higher education in Malaysia. In short, they depict a growing demand for education and training that is quickly outstripping the capacities of traditional educational delivery systems, not only within Malaysia, but also in countries, such as the United States, who provide the technical assistance. However, it is essential that the training take place if Malaysia is to sustain its long-term economic development plans in the future.

In response to this situation, the Malaysian government has attempted to curb the outflow of undergraduate students studying overseas and yet maintain and even increase the quality of such instruction. Thus, educational institutions have to formulate new strategies and foster new techniques. PPP/ITM is no exception. Foremost among the new approaches is the ITM/MUCIA Global educational partnership that evolved out of a decade long partnership.

2.0 PPP/ITM and MUCIA partnership

2.1 History of American Degree Program and MUCIA

The Midwest Universities Consortium for International Activities, Inc (MUCIA) is the oldest and most experienced of several university consortia involved in international development and education in United States. MUCIA represents the Big Ten University Conference and includes ten of the largest and most prestigious public research institutions of higher education in the United States. Its members are: University of Illinois, Indiana University, University of Iowa, University of Michigan, Michigan State University, University of Minnesota, The Ohio State University, The Pennsylvania State University, Purdue University and University of Wisconsin-Madison. MUCIA's partnership with PPP/ITM began with the first admission of students in 1985.

During the initial phases of this program, students at PPP/ITM were prepared for two years in Malaysia and were provided with an Indiana University transcript with which they could enter American universities or colleges as transfer students. Over the duration of the program, more than 3,500 students were successfully placed at US universities and have earned bachelors degrees in a range of majors. In 1987, a process of "Malaysianization" began in which responsibility of the program was gradually taken over by PPP/ITM. The process was completed in June 1993 when the American Degree Program (ADP) received its first intake of students.

Currently, ADP prepares students for undergraduate studies at American Universities. Students enter the program in Shah Alam and after two and a half years of preparatory courses which include freshman and sophomore courses, they are transferred to selected universities in the United States to complete their Junior and Senior years. The disciplines, courses and curricula offered by ADP are adapted from the MUCIA program.

New courses are added in line with developments with American academic programs. Courses are implemented and facilitated by qualified Malaysian lecturers many of whom were MUCIA/PPP/ITM faculty. A few American faculty remain as lecturers on its academic staff.

2.2 Creating a Global Education Network

MUCIA's response to the emerging crisis in higher education in Malaysia is to apply existing and emerging educational and communications technologies in the creation of a new program that seeks to provide:

(a) an immediate input to meet the content deficit being experienced by many students at ADP PPP/ITM and,

(b) a long-range program aimed at building ADP's capacities to serve its own educational goals as well as those of the global academic community into the 21st century.

Implemented and managed by the MUCIA Global Education Group, Inc., this program is structured around the development of a MUCIA Global Education Network. Using satellite and other emerging telecommunications technologies for distance education, students receive much needed course content while university administrators and faculty members participate in a broad-based institution development program, all in-country and at costs well below those of other models. The MUCIA Global Education Network delivers all the required training to students at their home campus in Shah Alam, and ADP issues the course credits and degree. As ADP takes over more of the direct educational offerings, the *Network* courses will become more advanced, in many cases transitioning to the graduate level. At the same time and using the same technologies, ADP participates in institutional development seminars and conferences designed:

(a) to increase its capacities to maintain and support itself and its programs, and

(b) to assist in further integrating it into the international academic community.

The advantages of the MUCIA Global Education Network approach are threefold. First, costs to students are lower because they receive expanded course content without leaving ADP or Malaysia and without having to support an expensive staff of expatriate instructors. Second, the ADP, and by extension PPP/ITM, is strengthened, initially because it grants the course credits, and in the longer term through the *Network's* institutional development program will eventually award the full degree. Third, the institutional certification process provides ADP with the means to enter the global academic community as an equal participant and partner.

MUCIA Global and the American Degree Program, PPP/ITM, launched the Global Education Network on 24th January 1997 as an extension of their decade long partnership in education. As such, ADP students have become leading pioneers in international distance education.

The ADP Program entered the new era of distance learning in Spring Semester 1997. The first course of study to adopt these new techniques was the business major with 22 students. These students enrolled in four courses: Principles of Management, Principles of Marketing, Principles of Finance and Intermediate Microeconomics. These four courses were taken in Spring1997. The students continued in the Fall 1997 with three more courses: Money and Banking, Production and Operations and Marketing Communications. Eight distinguished MUCIA Global American professors participate in this distance learning education.

3.0 The MUCIA Global/ITM Model

The MUCIA Global/ITM model of distance education incorporates high quality and interactive education components.

Each teleclass comes complete with:

- a video component (30-40 videocassettes with approximately 40 minutes of content)
- support materials for facilitators
- a course manual
- lecture transcripts
- sample exams
- quizzes
- homework
- student support materials (including Internet and Web-based coursesites and courseware)
- interactive components including:
  - ✓ *direct email* to instructors for specific communications and responses to questions drawn from video lectures
  - ✓ *Internet Relay Chat (IRC)* for holding of virtual office hours.
  - ✓ *Classroom Discussion Groups* with weekly discussion questions posted by the instructor to facilitate multi-site group discussion and to foster the building of cross-national peer learning communities
- technical support for course administration.

These video-classes incorporate the latest multi-media technologies available in order to meet the wide range of student learning preferences. By utilizing the latest emerging technologies, MUCIA Global can provide a learning environment that equals, and in most cases exceeds that of the traditional classroom! The end result is an affordable and high quality educational resource that often leads to increased student recruitment and retention.

3.1 Videotape Lectures

The course syllabi are identical to business courses in a typical American university. Each course consists of approximately 35 videotapes at 35-45 minutes each. The teleclass are produced by skilled and qualified MUCIA Global production teams and incorporate a variety of multimedia including graphics, text, animation, whiteboard, video clips, and simulation. ADP students view the tapes under the supervision of the local instructors who assist them from time to time.

3.2 Supplemental materials

Taped lectures are supported by various electronic and print materials including: a course manual that incorporates transcipts of the video lectures as well as course handouts and problem sets. A course website provides course lecture notes and transcripts as well as self-tests, related external links, homework assignments, class announcements, and an area for asynchronous electronic class discussions.

3.3 Electronic mail

In addition, the students have the opportunity to communicate directly with the professors through electronic mail in order to seek direct information or course assistance.

3.4 Internet Relay Chat (IRC)

Internet Relay Chat, or IRC, provides the opportunity for students to interact in real-time with their MUCIA Global professor. IRC may best be understood as "Virtual Office Hours." During IRC, students have the opportunity to ask questions pertaining to homework, exams, lectures, class projects, and a host of other topics that are usually addressed before and after class, in the hallway, or at the routine office hours of professors. Through IRC, MUCIA Global provides Network students with the opportunity to attend "virtual office hours."

IRC provides a flexible and useful method for:

- professors and students to establish rapport,
- students to ask about upcoming exams and exam reviews,
- professors to work through a homework problem step by step in order to assist students in understanding complex concepts, and
- professors to question students about their class projects.

Interaction is an *indispensable* aspect of MUCIA Global's courses. IRC is just one of the many options available to our students for quality real-time and off-line interaction. Such interactive techniques, in combination with MUCIA Global's Course Manual, and Course Websites place MUCIA Global and ADP at the cutting edge of 21st century education.

3.5 Roles of Local Instructors

Local instructors facilitate the implementation of the teleclasses on-site. Their roles include playing the video lectures, facilitating classroom discussion, administering exams and the final, providing homework assignments and many other classrooms activities. The facilitators work closely with the MUCIA Global faculty to successfully implement the teleclass. Facilitators are also responsible for grading exams and assignments.

4.0 Future Expansion to the program

The MUCIA Global/ITM Model has been in operation for two semesters with some difficulties. Being pioneers, the students and the professors have to get used to the new technologies and methods of instruction. Despite the minor problems, several advantages have accrued from the partnership.

In addition, possible expansion to the existing program would be:

- To expand the existing courses up to Sophomore year
- To have better interactive communication in the form of sound and video, not only text
- To have the courses eventually made available on satellite so that occasional live sessions may occur. In this manner, interactivity between the students and the professors can be enhanced considerably
- To include more majors such as Engineering, Sciences and other courses
- To have local staff serve as instructors for some of the modules

The MUCIA/ITM's partnership will be strengthened well into the next decade with these possibilities brought by distance education technology.

5.0 Conclusion

The MUCIA Global/ADP distance education program has now been in operation for two academic semesters with the participation of 22 students located in the American Degree Program at PPP/ITM. At this time, although some difficulties have occurred, the program may be viewed as an unqualified success.

Experimenting Web Technologies to Access an Opera Theatre

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Abstract: A historical opera theatre is a complex reality to communicate in all its facets. We developed an application based on web technology to allow virtual visit and interactive involvement among remote users, for the Teatro alla Scala in Milan. Two modules, based on QuickTime®VR and VRML technology, realise a visual reconstruction of the theatre: present and past days appearance of the building inside and outside with different degrees of interaction. Text, images, audio, video and voice is also used to emphasise appropriately the messages. Animation of scenes, simulation of audio and lights effects in the space are made possible by VRML and virtual dancers on stage can be controlled interactively by users.

1. Introduction

Internet launches the challenge of an open theatre, distributed over the territory and the entire social body [Mitchell 96]. This is particularly relevant in the case of classical theatre, traditionally conceived as a closed space, both physically and socially: the theatre was hosted in a building in a given urban setting and was identified with a well defined social class. Indeed, the new media are also suitable for the transmission of a message intrinsically multimodal. Opera, ballet and music are expressive languages related to different sensorial spheres and that adopt different means of expression: literary text, sound, human voice, mimicry, gestures, costumes and scenography.

Our attention has been driven by the Teatro alla Scala, which is an important historical theatre for the Italian melodrama, based in Milano and very popular among citizen: designed by G. Piermarini (1731-1808) at the end of the XVIII century, after a fire that destroyed the older Regio Teatro Ducale, whose seasons started in 1589. In the application here described, we provide a variety of remote services: some related to performances on calendar and other current activities (exhibitions, lectures, announces, press releases etc.) and some to the theatre history and cultural heritage.

We face two objectives: to promote an active behaviour in the public and to increase its involvement. Therefore, we want to provide languages through which users can act upon objects to transform them. To this end, we selected among available technologies those resulting more seductive: in this prototype we used text, audio, video, voice, images besides QuickTime®VR (QTVR from now on) and VRML 2.0 (Virtual Reality Modelling Language).

In this paper we describe the application, LaScalaWeb, the web site of the theatre, and we analyse it, considering it as a composite object that can be read following different keys: functional, symbolic or historical etc.. We propose a structural analysis of narrative in terms of its syntactic-semantic relationship [Prince 93]. The understanding of a communicative artifact emerges following the inverse procedure adopted by its designer during construction: a composition of basic elements following given rules in order to produce the integral object providing meaningful effects. Users have to de-compose backward the object discovering its deep structure and finding out values underlying the object surface. We will apply this methodology to a specific section of the application: the virtual visit.

2. LaScalaWeb

The web site of Teatro alla Scala [LaScalaWeb 95] provides historical information on the theatre, a multimedia presentation of the season, access to the theatre database, news from the press office, biographies of artists, mailboxes, ticket office information, news about audits and a virtual shop.

The events are presented to the general public on a day-to-day base, as the calendar evolves. The performances are documented by giving the program, the subject, the performing cast of the day, pictures taken from the stage documenting artists and the scenography, audio or video clips, pictures of costumes and their sketches. For operas the web site often offers the complete list of discography and bibliographic references.

The theatre manages a database that is used for internal administrative purposes. The web interfaces the information that are interesting to the public about performances held in the theatre since 1953. One can query about an author, an opera or a specific artist; one can also read about the orchestra composition and compare it with present days choices. To this respect the Teatro alla Scala is the first theatre to allow consultation of its archive via the network and the service has been welcomed by users, researchers and scholars but also opera fans. The virtual shop opened quite recently and it sells books edited by the theatre, together with programs of performances, photos and videos.

During these past three years, since it started to be operative, the web site has proved to be an important channel of communication between the theatre and its public. Mails, that in the beginning were mainly general compliments or to point out mistakes, are now used to ask more precise questions and show a high and focused level of interest. Often mails are sent by scholars searching for information about historical performances or news about artists.

3. The Virtual Visit

The virtual visit to the theatre is made possible by a combination of two different applications, integrated with text and different media, returning a virtual reconstruction, which is finalised to increase the quality of virtual engagement in users and to document the historical evolution of the theatre. Our goal is to convey an image of the theatre that goes beyond the building, as it appears nowadays, into its symbolic meaning, as it grew through centuries of art performances, exhibitions and collective imagery. To this end we provide a virtual reconstruction of the exterior and the interior of the building by a 3D model, texts with different level of information accessed opportunely at convenient time during interaction, voice in the background to call attention from users visually involved by applications, audio clips to evoke important events in the theatre and so on.

The sense of history and evolution in time is given through a selection of original drawings and texts reporting some citizen impressions of the building at its first construction. Some alternative projects of the building are also documented, together with a reconstruction of the neighbourhood, which does not exist anymore after a square has been open in its place.

To show the theatre *machina* and to offer users clues of the complexity of the theatre life, we provide a series of still images of the theatre at work behind the scenery. Moreover, we draw the 3D model of the scenes of the opera *Armide* by C. Gluck (1714-1787), the opening opera of the past season, in order to allow their movements as during the performances. This animation can also be explored interactively by users, providing a new experience for the virtual spectators, different and more complete than the actual one. In fact spectators may not fully appreciate the complexity of the process of staging a performance and have little idea of the backstage. Virtual dancers can also be positioned on the stage and instructed to perform a baroque dance.

For virtual reconstruction present technology opens at least two possibilities: QuickTime®VR technology [Shenchang 95], that allows to return a powerful impression of the outlook of objects to be rendered, and VRML

2.0 [Ames et al. 97], that allows to implement interactive 3D environment returning spatial cues. The experience in using both technologies has shown advantages and limits, depending on the message that the designer chooses to communicate.

QTVR is perfectly suited to give a synthetic view of a complex environment. The public can navigate the space by selecting viewpoints, panning and zooming. Activating the context links another interior of the theatre is displayed. A different reconstruction of the space is achieved by VRML: placing different textures on the 3D model of the theatre we can return different levels of perception and information. In the VRML application we programmed animation, audio and light effects to convey better cues of the space.

Moreover, QTVR is less expensive than VRML, in that it takes less time to develop, and its transmission over the net is cheaper, because files are in average smaller. VRML requires more time also because it is based on a 3D model; the optimisation of the 3D model for effective Internet browsing is still critical. Both technologies can be make available for low cost computer platforms, but efficient VRML modelling is better done on high end graphics workstations.

3.1 The QuickTime®VR module

We recall briefly that QTVR is a technology that allows to render a 3D space or an object by photographic techniques, using an image rendering method, by texture mapping a series of pictures on a cylindrical space and by removing artefacts due to the mapping process. A detailed description of the methodology can be found in [Shenchang 95]. An accurate colour balance has been necessary to optimise the colour perception and to render the real space.

A sequence of snap shots have been taken to reconstruct a possible visit of the theatre starting from the square, in which the theatre is located, namely Piazza della Scala. The 360° panorama are taken from strategic points in thetare, from the stalls and the balconies, from the foyer and from the stage, describing an architectural promenade. A specific node from the stage gives the unusual perspective of the scenery seen from the back looking at the stalls. Hotspots are implemented in the node to reference external documents, giving more details in text or photo formats about the theatre.

Fig. 1: Interacting with QTVR panorama of Piazza della Scala while browsing through historical documents

3.2 The Virtual Reality Modelling Language module

A 3D model of the theatre has been constructed from technical drawings adopting AutoCAD 13. The model has been converted into VRML 2.0 by saving the AutoCAD model in 3DS format at first, then saving it into VRML 2.0 format. The subsequent activities on the module have been done adopting CosmoWorlds and by explicit programming. CosmoWorlds has been used mainly to apply texture maps on the model surfaces, and to program some simple animation. Explicit programming has been necessary to create menus and commands to offer users the possibility of selecting options. To this aim script nodes have been implemented also by means of Java scripts. Acoustic cues have been implemented by using VRML 2.0 features for sound spatialization.

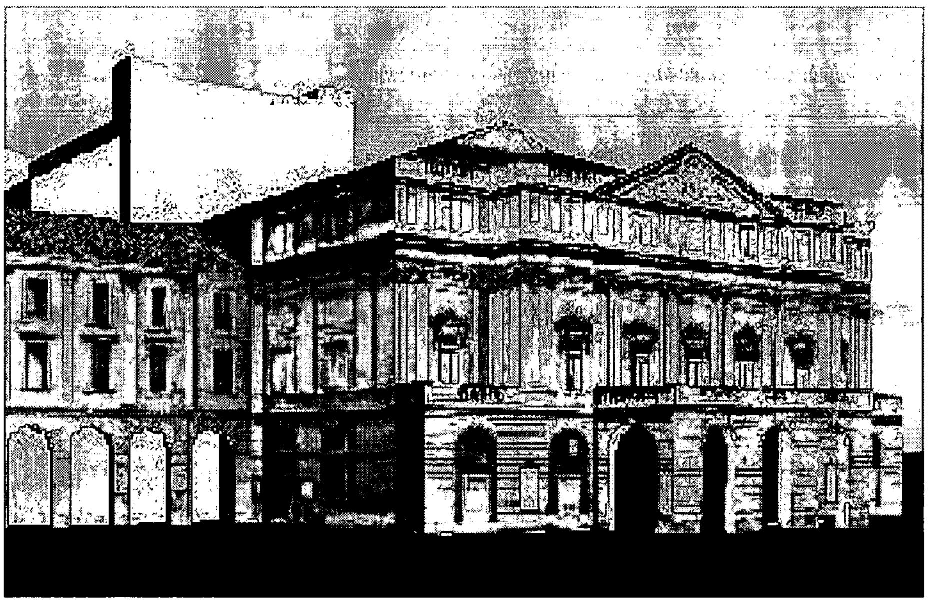

Fig. 2: The VRML model with texture maps

The immersive experience offered to users has been augmented by simulation: the sounds of instruments being tuned, the dimming of the lights, the curtains being raised give the emotion of the onset of the performance. The performance is documented by showing the scene movements and video sequences of the actual performance are displaied on the virtual stage.

The VRML application can be visited by the public in two ways: by direct interactive navigation or by executing pre-programmed visits and animation.

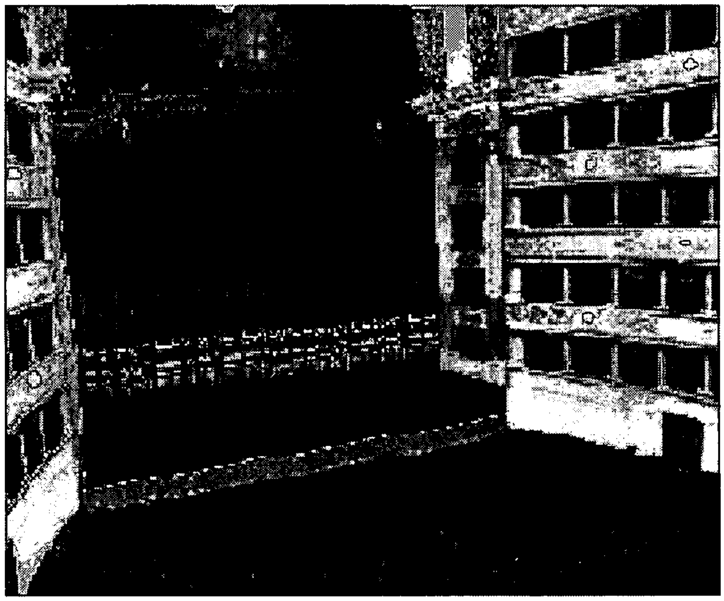

Fig. 3: The interior VRML model

4. Analysis along the Subject-object Relationship

Let us now describe the application focusing on the subject-object relationship, where subjects are of course users and the object is the application, considering two points of view: interactivity and hyperlinking features, engagement and iconicity.

As for the first point of view, interactivity is a category describing users behaviour while hyperlinking features describe the nature of object. We state that active vs. passive behaviour in users is a function of the presence vs. absence of specific characteristics in the object. Active behaviour is promoted by the presence of hypertextual links, implemented in different ways according to interface and technical requirements as buttons, textual links, hot-spots and so on. In some cases, such as in QTVR or VRML applications, a high interactivity is granted even without explicit links: in QTVR samples users can interact, with 2 degrees of freedom, turning left/right and zooming, while in VRML users can navigate freely in the 3D space.

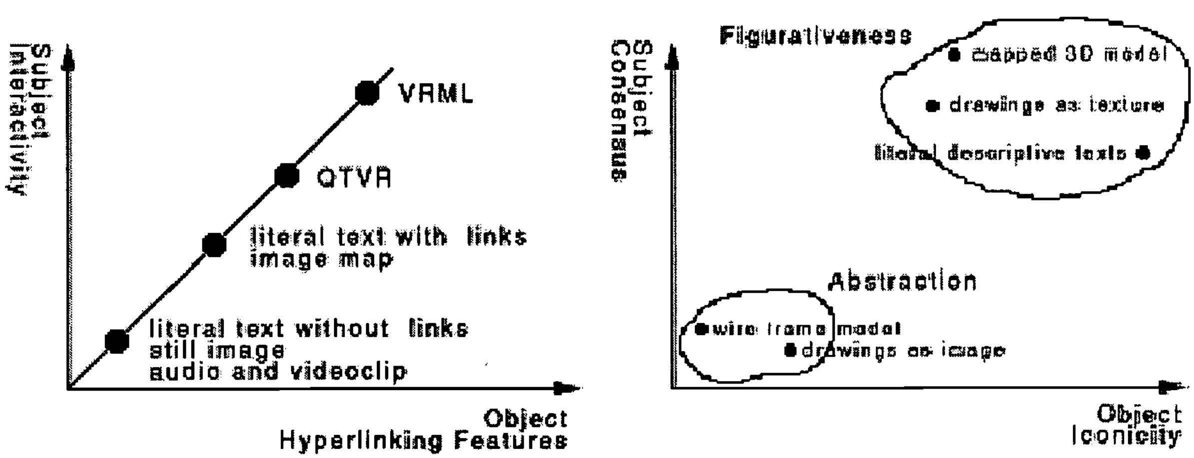

Fig. 4: analysing texts according to subject-object relationships

As for the second point of view, iconicity is a type of speech which is finalised to produce varying degrees of reality mimicry in order to gain users' consensus and emotional adhesion [Marsciani & Zinna 91]. The communicative object is designed and created with different reality-effects to enhance growing involvement in users. Any media (text, images, sound, voice, 3D models ...) can be tuned along the iconicity axis, whose extreme points are abstraction and figurativeness.

In our application, we mostly adopted highly figurative texts[1], allowing us to convey our interpretion of the essence of the theatre or its *scaligerità*. In Fig. 4 we plot on the subject consensus - object iconicity axes some partial texts, showing their degrees of figurativeness. We want to emphasise that, given a partial text, its degree of figurativeness can vary according to its occurrence. For instance, as it is shown in the figure, we used the original drawings by Piermarini in different contexts: as mere gif or jpeg images and as textures in VRML models. In the first occurrence, even though drawings are rather figurative, because they convey the idea of history and tradition through the pencil stroke and colour for instance, they are more abstract than in the second one, where they convey also spatial cues.

Moreover, for a given meaning there are several nuances, that we tried to convey by selecting appropriate technology. For instance, to express the *scaligerità* we distinguish between history and present time and according to the point of view we adopted different techniques. We used VRML to give the idea of the evolution of the building through the centuries, or even of the building that has been projected but never built, in synergy with highly figurative literal texts, rich of names, place and time references. Whereas, we preferred to use QTVR to describe the theatre present status. The intrinsic QTVR nature, based on image rendering technique, offers a satisfying perception of the environment, being based on photographs shots, but also limit the perception of the structural complexity of the real space. On the other hand VRML, even in the case when photos are textured on the surfaces, gives a somewhat cartoon effect.

Therefore, we can not conclude that QTVR is a more figurative language than VRML, in any occurrence, because it depends on the local context and the meaning that the designer wants to associate to the text. In this application, we made an effort to accurately evaluate case by case how to combine different parts of the virtual visit without inconsistencies.

4.1 Interactivity and web site architecture

We started this past season and it will become effective in the next one, to design a database to collect, in a structured way, all information that we want to publish, including multimedia documents. This fact will have deep influence in users interaction, that will become qualitatively different. If the web site is structured in a database, users may continue to consult it in the traditional way, through the links foreseen by the designer, but also will be able to query the database in order to create a their own final document, which may be the first and only time that will be generated. Same queries in time can generate different documents and also various users can formulate diverse queries. This of course is the case for all databases, but usually is not for web sites. In LaScalaWeb we at present provide an interface to the historical database of the theatre, therefore this form of interactivity is in some way already present; but will be fully exploited only when all information will be structured in a database.

Adopting a rough metaphor, the database can be seen as a collection of different boxes holding homogeneous data and a set of rules to combine them. The document has a temporary life: once it has been inspected, it implodes again into the database. To this respect we deal with digital way of life, that takes form at the time of its use. Following Hjelmslev [Hjelmslev 73], the database can be conceived as the system of all potential documents and each of them is the tangible result of one of the possible generation process. The designer control is weak on the document generation process, while it is strong on the retrieval system and on the interface design.

[1] In this context *text* indicates any object that can convey meaning, no matter which is the language used to produce it. Therefore a kind of text can be literal text, but also an image, a video clip or an applicative sample based on VRML or QTVR.

Acknowledgements

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INNE: a Neural Network Simulation Environment

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Abstract: This paper presents the Interactive Neural Network Environment INNE, a graphical environment to design, simulate and analyse the behaviour of neural networks. The aim of the application is to provide a rich and flexible tool for learning neural network models. Therefore the environment provides several different neural models and tools for visualizing the learning phase and the results of the computation. This last feature makes INNE rather different from other simulators and makes it suitable for students at their first approach to neural networks or to a specific model. Nevertheless the environment is general and robust and allows the design of neural networks to solve problems and to verify their performances. At present the models implemented are: Boltzmann machines and Hopfield networks, Back-error propagation networks, Hebbian networks, Simple competitive networks, Kohonen networks. The application has been developed in the CoLoS project.

1 Introduction

The application INNE (Interactive Neural Network Environment) is a graphical environment to design, simulate and analyse the behaviour of neural networks. It has been developed in the European project CoLoS (Conceptual Learning of Science) [CoLoS] [Härtel 94], which has involved several European Universities and research centers since 1988 when it started under the auspicies of Hewlett-Packard. His objective is to support concept learning and deeper understanding in the field of science and technology making optimal use of the didactical potential of modern communication technologies.

The aim of the application is to provide a rich and flexible tool for learning neural network modelling. This goal has influenced several design choices and in particular the emphasys that has been given on showing the dynamical processes that occur in the net during the learning phase and the computation. The neural models implemented are: Boltzmann machines and Hopfield networks [Ackley et al. 85], Back-error propagation networks [Rumelhart and McCelland 86], Hebbian networks [Oja 92], Simple competitive networks [Hertz et al. 91], Kohonen networks [Kohonen 88].

Given its didactical purposes, the application provides a number of pre-defined examples in order to teach the main concepts concerning a chosen algorithm while easing the process of gaining experience on the net architecture (i.e. acquiring the ability of defining the network structure and parameters). In fact, the ability of designing neural architectures to solve problems is acquired only by experience, since the demonstration of convergence is based on stochastic approximation techniques. On the other hand the cardinality of the training set is usually very limited and the choice of the parameters that regulate the network behaviour must be found heuristically in several trials. Furthermore it does not exist yet a general theory associating the number of learning steps to the approximation reached and this makes it difficult for beginners to start solving problems by adotping the neural paradigm.

In order to realise a range of examples easy to understand it has been necessary to enrich INNE with some auxiliary tools, for instance a generator of gaussian distributions and a generator of uniform distribution inside polygons. These tools are used to generate strong visual flavoured examples so that one can "see" what is going on during the computation.

Moreover to make examples more concrete and allow students to fully appreciate the implemented models, the environment provides a range of problems solved with neural networks with which students can experiment. For instance we illustrate the principal components analysis with the problem of image compression, the clustering analysis with the problem of image segmentation, the problem of topological mapping with an example of approximation of bi-dimensional figures.

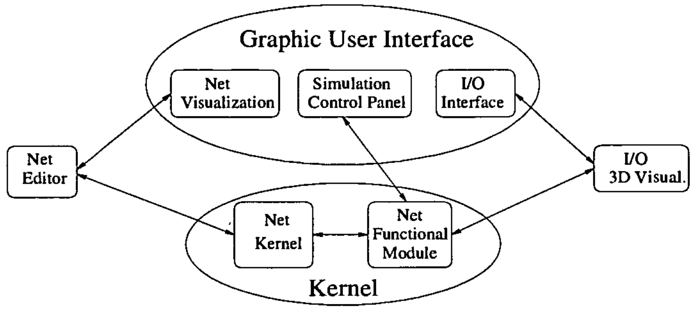

Figure 1: INNE architecture

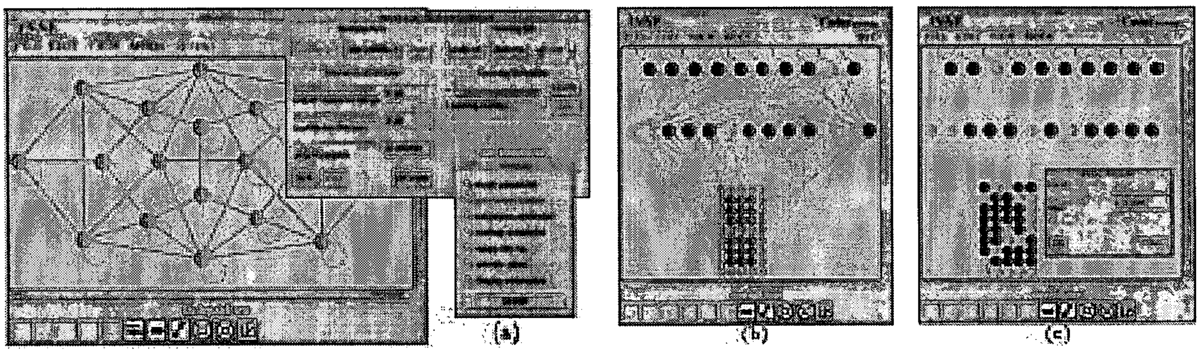

Figure 2: (a) The Boltzmann machine module. The Back-error propagation for digit classification: (b) accepting digit 8, (c)accepting digit 2 in presence of noise.

1.1 INNE architecture

The structure of the application is displayed in [Fig. 1] and consists of the Kernel module, the Net Editor, the 3D Visualization tool and the GUI module.

The GUI module includes the Net Visualization tool, a graphical window that interacts with the net editor and allows the definition of the network architecture and of its layout. The Net Editor provides tools for managing a subset of nodes and/or arcs as an object to ease the job and allowing the definition of large nets. Moreover, users attach a behaviour to the network they are editing through the GUI module acting on a Simulation Control Panel and choosing among one of the predefined models. The 3D Visualization module helps to understand the processes that occur during the learning phase and, in other cases, to visualize the results of the computation.
The Kernel module is subdivided into two parts: the former to manage the network with its nodes and arcs, the latter to compute the behaviour according to a model. While the interface is written using the X11-R5 libraries and Motif 1.2 the kernel is written in plain C language for portability reasons. The 3D Visualization module, also written adopting Motif libraries, is a tool implemented in the CoLoS project.

2 Simulation of Boltzmann machines

The first neural model available in INNE is the Boltzmann machine, a combinatoric optimization model implementing the probabilistic optimization algorithm called *simulated annealing* [Hertz et al. 91] and able to avoid local optimal solutions (i.e. networks that do not change dynamically their structure). In the module, a learning algorithm for classification problems is implemented as well, even though the back-error propagation learning algorithm is more efficient to this purpose. The Boltzmann machine can be used to solve combinatorial problems by approximation [Ackley et al. 85]; this can be shown by loading the network of [Fig. 2-a] that solve the *Indipendent set problem.* The objective is to find the greatest number of independent nodes not connected directly with each other on undirected graphs.

Users can choose between *deterministic* or *stochastic* behaviour and select the *sequential*, *random* or *full parallel* mode of updating the network and experiment the speed of reaching a stable state. The machine can be trapped into local optimal configurations. The experiment will show that the random parallelism mode can be very effective in the stochastic behaviour even though no convergence theorem

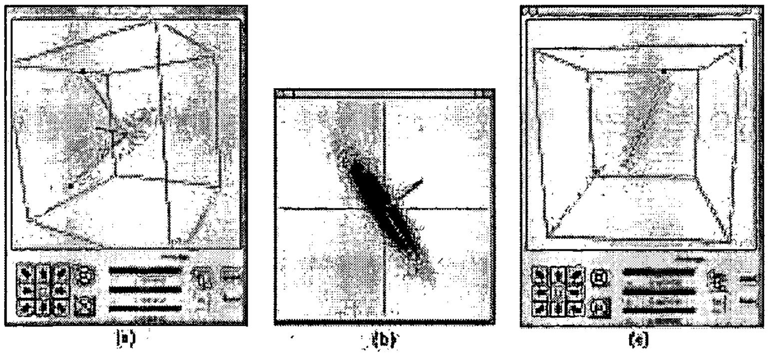

Figure 3: Visualizing the learning phase and the final configuration. (a) Finding the principal components with the Sanger rule in 3D space; (b) Finding the principal components with the Sanger rule in 2D space; (c) Finding the principal subspace with the Oja rule in 3D space.

has been proved so far. In the deterministic case the Boltzmann machine is a Hopfield model which offers the best computational time in the sequential mode as it reaches immediately a stable state choosen at random among local optimal configurations.

3 Simulation of Back-error propagation Algorithms

Back-error propagation is by far the most popular supervised learning method for multilayer neural networks [Rumelhart and McCelland 86]. Back propagation and its variants have been applied to a variety of problems, including pattern recognition, signal processing, image compression, speech recognition, nonlinear system modelling and control. The most appealing feature of back propagation is its adaptive nature, which allows complex processes to be modeled through learning from mesurements or examples, updating the arc weight connecting neurons.

In our simulation, this process is visualised and the arcs show different colours and thickness according to their weights. The method does not require specific mathematical models or expert knowledge to solve the problem. Our examples are simple problems often used for testing and benchmarking a network: typically, the training set contains all possible input patterns, so there is no question of generalization. For instance, the network in [Fig 2-b] recognizes the digits between 0 and 9. During the learning phase we can observe the error dropping and after training, we can test the network giving in input a hand written digit by setting on or off the input neurons displayed in a grid. The network in one step will try to recognise the digit even if some noise is present: setting the value of the output neurons between 0 and 1 according to the recognition probability of the digit [see Fig 2-c].

4 Simulation of Hebbian Algorithms

One of the neural models implemented in INNE is the Hebbian model to which we can apply the fundamental Hebbian, Oja and Sanger rules [Oja 92], [Sanger 89]. These three updating rules allow a different component analysis of the input data and we have added to the environment a number of tools to visualize the 2D and the 3D cases.

In order to produce meaningful examples of these networks, a graphical tool for generating and visualizing 2D and 3D gausssian distributions has been added to the environment. Every input neuron is connected to all output neurons, therefore their arcs define the vectors which can be represented in the input space. The coordinates of the points, randomly generated according to a distribution in the 2D or 3D space introduced by users, are given in input to the network. During the learning phase we can observe how the network analyses the gaussian distribution given in input. Adopting the Sanger rule [see Fig. 3-a] and [Fig. 3-b], the weight vectors of the output nodes individuate the direction of the principal components of the distribution in a 3D and 2D space. On the contrary adopting the Oja rule [see Fig. 3-c], the network only finds the principal subspace.

In [Fig. 3] we can see the input space and the vectors defined by the ouptput arc weights after a simulation of 10000 steps with $\eta_0 = 0.7$ and linear decay. During the learning phase we can observe how the vectors change their position in the space while the network tries to find the principal components of the distribution. At first (η is high) the swings are wide, while in the end there are only small swings.

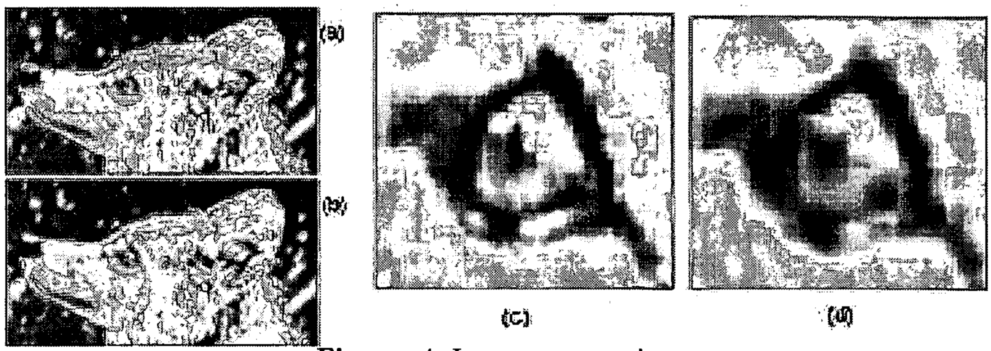

Figure 4: Image compression

4.1 The example of image compression

As an example of Hebbian algorithms, an application for image compression has been added to INNE. The proliferation of multi-media tools in computer communication networks has increased the demand for techniques to improve the efficiency of transmission and storage of image; therefore a large variety of algorithms for image compression has been realized. The basic idea behind a class of image compression algorithms is to exploit the fact that nearby pixels in images are often highly correlated. A given image is therefore divided into several blocks of pixels and each block, treated as a vector, is linearly transformed into a vector whose components are mutually uncorrelated. These components are then independently quantized for transmission or storage. The reconstruction of the original image is obtained by using the inverse linear transform operation on the quantized coefficient vector. The optimal transform in which the average mean-squared reconstruction error is minimized is called Principal Component Analysis (or Karhunen-Loéve transform).

For this example, INNE allows users to load images in the *ppm* (portable pixmap) format and after execution returns the compressed image: users can choose either the Oja rule or the Sanger rule for the compression. We can both compress and reconstruct the whole image by using the same neural network. The first choice to be taken concerns the neural network dimension that affects the size of the blocks into which the images are subdivided. In fact different sizes have been tested, but large networks, corresponding to large blocks, showed some difficulties in the training phase and the quality of the compressed image seemed to degrade according to the generalization property. Thus 8 x 8 blocks have been chosen and this is a standard size used in many different coding algorithms. Of course, the compressed image needs to be quantized before being transmitted or archived. [Fig. 4] presents an image compressed using a neural network that has 64 input neurons organized in a 8 x 8 matrix and 8 output neurons. The learning phase lasted 30000 learning steps, with $\eta = 0.3$, a decay function of η exponential with $\alpha = 0.3$ and the Sanger rule. After the training phase, the network output is quantized with 8 bits for the first and the second neuron, 6 bits for the 3rd and the 4th and 2 for the others. The decompressed image is shown in [Fig. 4-b], while [Fig. 4-c] and [Fig. 4-d] show a detail of the previous image, before and after compression. Here we can appreciate the faults caused by the block division.

5 Simulation of competitive networks

In unsupervised competitive neural models, single neurons compete for being the one to fire [Hertz et al. 91]. We implemented 2D and 3D displays of a multivariate gaussian distribution so as to allow to generate examples for this model easily. While defining a distribution in the input space, the input points, randomly generated according to the distributions, are fed into the network, which tries to find their centers.

The dimension of the input space is defined by the number of input neurons. The number of output neurons defines the number of clusters in which we desire to partitionate the input points. During the computation we can interactively modify the simulation parameters and affect the network behaviour in order to analyse it and improve its performance. For instance, we can choose to refine the learning algorithm, in case some output units (*dead units*) appeared to be stuck and never win.

In [Fig. 5-a] and [Fig. 5-b] we can visualize the behaviour of a net in the input space. The net has 3 input neurons, according to the 3D input space, fully connected to 7 output neurons. In the initial state, the 7 visible dots are randomly localized, their position being given by the weight of arcs connecting them to the 3 input nodes. After some training, the arc weights are modified so that the dots will locate

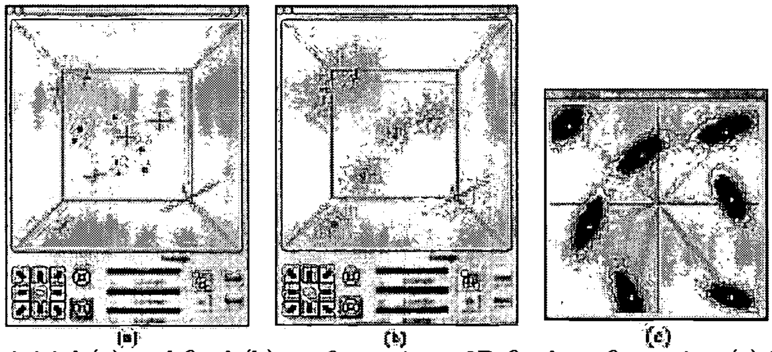

Figure 5: 3D initial (a) and final (b) configurations, 2D final configuration (c) in a competitive learning model

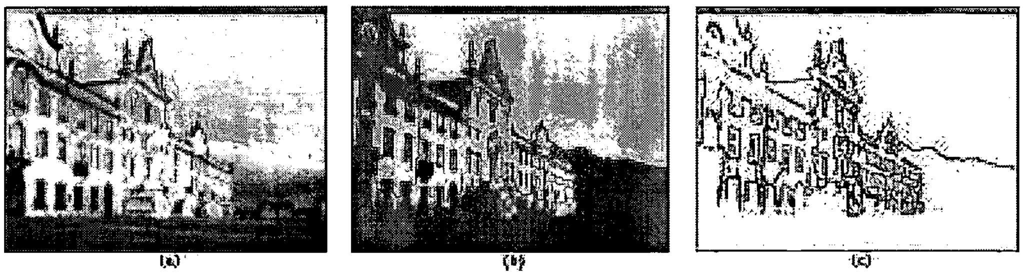

Figure 6: Original image (a), clustered image (b) and segmented image (c)

the clusters. In fact they are positioned at the center of the seven gaussian distribuitions in the final configurations. In [Fig. 5-c] we can see the same problem for the 2D case, run with the option called *increasing pattern method* which avoids the *dead units* and visualizes the route of the weight vectors from their initial position (0, 0) to the distribution centers. In these simulations we have used 50000 steps and a linear decay term of η from 0.5 to 0.

5.1 The example of colour clustering

Adopting this model of competitive learning, an application suitable to solve the problem of colour clustering has been added to the environment. Much work in computer vision still focuses on gray scale images even though these techniques cannot usually be applied to colour images. For example, the segmentation of a colour image is a more complicated problem than that of a gray scale image. Arbib [Arbib and Uchiyama 94] shows theoretically and experimentally that competitive learning converges to approximate the optimum solution. The net architecture will be affected by the characteristics of the image space and the number of input neurons has to be the same as the dimension of the colour space. In particular, we adopt the *Red/Green/Blue* space to visualize the colour distribution in the images. The number of output neurons depends on the number of the colour clusters into which we would like to subdivide the image colours. During the learning phase, the *Red/Green/Blue* values of random pixels of the input image are assigned as state to the input nodes and their positions in the colour space are visualized in a 3D visualization window together with the positions of the output neurons. This animation shows the learning process actually taking place in the network. When the training phase is over the original image is processed [see for instance Fig. 6-a]; the *Red/Green/Blue* coordinates of its pixels are fed into the network and their values are substituted by the colour of the corresponding cluster [see Fig. 6-b]. This new output image will present as many colours as the number of output neurons in the network. Moreover the application can use the output image to produce the segmented image by applying an algorithm to detect the borders in the colour regions, as shown in [Fig. 6-c]. Image 6-b is obtained by a network of 3 input neurons totally connected to only 4 output neurons.

6 Simulation of Kohonen's maps

Kohonen algorithms are unsupervised competitive algorithms [Kohonen 88]. These networks, also called Kohonen's maps, use the spatial organization of output neurons to determine the information in the input data. The network structure consists of a unique level where every input neuron is connected to

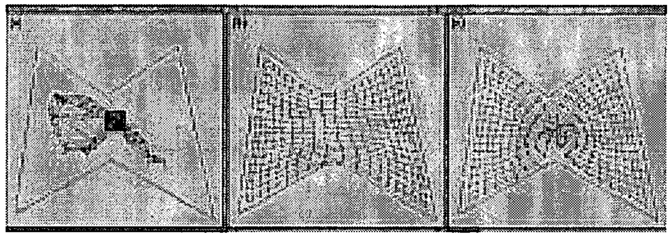

Figure 7: Net evolution. Initial (a) and final (b) configurations and error condition (c)

all output neurons, which are generally organized into a matrix of N x M dimension. INNE allows to approximate the input data generated by a uniform distribution inside 2D polygons. Through a graphical representation of the map, it is possible to observe the evolution of the simulations and how the map fits the input form. In this model we are not interested in the direction of w_i (as in Hebbian algorithms) but in their values, which define a position in the input space. Neurons that are next to each other in the network are shown as dots connected by lines and their positions in the input space are given by the arc weight w_i of the corresponding neuron.

For example, let us consider a neural network having 2 input neurons and a 10 x 10 matrix of output neurons. If we give in input a uniform distribution, in a polygon we can analyse the evolution of Kohonen maps tending to fit the input space. At the beginning of the simulation we initialize the net with small value random arc weights so that the neurons are shown all clustered in a small space of irregular shape as in [Fig. 7-a]. During the simulation we can observe how the reticule evolves towards more and more regular shapes [Fig. 7-b]. After the learning phase, if the number of learning steps was adequate, the map will give a good approximation of the input polygon. It is possible to observe that points on the borderline of the network are positioned at a certain distance from the border; in fact, every point represents a portion of the input space. This is divided into regions where neurons represent the centre of gravity. In the ordering phase of the weight vectors, we can have problems so that the network doesn't approximate the input space correctly. This event is illustrated in [Fig. 7-c]. When these problems occur, the time required for learning increases.

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Interactive Multimedia and Problem-Based Learning: Challenges for Instructional Design

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Abstract: Interactive multimedia (IMM) and problem-based learning (PBL) are both promoted in response to the current need to offer authentic and effective professional education. An emphasis on collaborative work in PBL contexts may have discouraged the application of IMM, more commonly designed for individual use. This paper describes a preliminary instructional design model for IMM using PBL principles and includes approaches to resolving the apparent tensions between the two methodologies. Application of this model to development of a CD-ROM for teacher education is described.

1. Introduction and Background

Traditional approaches to university education promote subject-based learning which encourages teachers to focus on covering material and students to adopt surface learning which fails to integrate knowledge [Margetson 1994]. New approaches encouraging both the integration of existing knowledge and the habits and skills fundamental to lifelong learning are needed. In addition, a need for periodic professional development and the desire of some to explore new careers, have contributed to demand for more flexible access to higher education. Coincidentally, new technologies promise to facilitate access to learning at times and places chosen by the learner.

Problem-based learning (PBL) developed in response to concerns that a subject based approach might not be the most effective preparation for future professionals [Boud 1985]. Since originating in North American medical schools, PBL has spread to many countries and a variety of fields including nursing, engineering, law and business [Boud and Feletti 1991]. Its characteristic focus on authentic problems as the starting point for learning has been credited with increasing the motivation of students and encouraging them to integrate knowledge from foundation disciplines. If it is true that PBL offers advantages for professional education and there is demonstrable demand for flexible access to such educational programs, then it seems logical to consider the use of interactive multi-media (IMM), as a means of making the benefits of PBL more widely available.

1.1 Instructional Design for PBL

The first step towards incorporating PBL principles into the instructional design and development of interactive multimedia resources is to identify the essential characteristics of PBL. Two commonly cited descriptions of PBL come from Boud (1985) and Bridges (1992). In outlining their views of PBL, these authors agree that the focus in a PBL process is on an authentic problem in a group setting where learning stems from collaborative analysis of the problem and is largely learner-directed. An alternative approach in which teacher education students engaged with a problem individually and prepared a written analysis of the problem in preparation for group interaction, has also been described [Gibson and Gibson, 1995]. Further, the collaboration of students in small groups has been an explicit assumption underlying the development of computer environments supporting PBL [Ronteltap and Eurelings 1997] [Koschmann et al. 1996]. Regardless of author however, each description of PBL incorporates reference to an authentic problem as the initial focus and assigns active, group-based roles to learners, at some stage of the process, for the purpose of determining solutions and synthesising knowledge.

Moreover, Heath [Heath 1997] recognises a trend in instructional design towards replacing traditional behaviourist approaches with constructivist orientations emphasising the use of emerging technologies. By incorporating interaction with an environment, cognitive conflict and negotiation of shared understanding, PBL provides an ideal vehicle for modelling such constructivist approaches [Savery and Duffy 1995].

1.2 Computer Support of PBL

A variety of examples of computer use in PBL programs can be found in the literature. A "Problem Solving Assistant", incorporating a problem-solving heuristic and research resources has been used to support teacher education students [Ritchie et al. 1995]. [Hart 1996] described a PBL architectural course using computer graphics systems. Computers have been linked to create a Collaborative Learning Laboratory [Koschmann et al. 1996] to support PBL meetings in medical education through access to resources and data exchange. Network technologies, including web pages, have supported collaborative PBL in a biotechnology program [Mackenzie et al. 1997], and a dual electronic environment which supports access to resources and preparation for subsequent group presentation in a collaborative environment has also been described [Ronteltap and Eurelings 1997].

Despite the emergence of computer use in professional courses incorporating PBL, [Hoffman and Ritchie 1997] found no published articles about integration of interactive multimedia in PBL. They suggested that multimedia might support PBL by producing key benefits in fidelity, representational richness, time and timeliness, individualisation, assessment, efficiency and increased power of agency.

2. Issues in the Design of IMM-PBL

2.1 Collaboration versus Individual Learning

Implementations of PBL typically include collaborative group work. Whether such collaboration is an essential component of PBL logically depends upon the role it plays in the overall experience of PBL. On the other hand, interactive multimedia is typically designed for individual use.

Exploring the value of PBL experiences for individual rather than collaborative use may be justified on two grounds. Firstly, professional practice is situated in a variety of contexts including collaborative teams, sole practice and competition. Successful professional practice frequently depends upon individual capacity to solve problems. Logically, educational experiences which develop that capacity should be valued. Secondly, individual PBL experiences may help to address the increasing interest in distance and flexible access to professional education and the increasingly successful integration of technology into higher education.

Studies of the cognitive and metacognitive processes of students during the initial problem analysis phase of PBL support the view that the role of group interactions in PBL is to facilitate activation and elaboration of students' existing knowledge and so encourage conceptual change through cognitive dissonance [De Grave et al. 1996]. If this is the function of group interaction in PBL, then, provided that an alternative mechanism with equivalent effect is introduced, it should be possible to design effective PBL for individual use.

2.2 Free Exploration versus Storylines and Simulated Reality

One of the characteristics of multimedia as an information source is ease of access. Users of multimedia expect to be able to explore the environment encountering a variety of stimuli. A key characteristic of PBL is its use of authentic problems. In real life, resources may sometimes be inaccessible, activities may be time dependent and decisions may be effectively irreversible. These conditions occur in the simulated reality of computer games.

Multimedia materials supporting individual PBL will include problem scenarios sharing some characteristics of computer games alongside collections of resources to be explored in the search for a solution. It seems likely that there will be tension between the genre of the computer game and that of the multimedia encyclopedia with the possibility of confusion for users. The efficacy of story for motivating progress through multimedia training and increasing transfer of content has been demonstrated [Bielenberg and Carpenter-Smith 1996]. Building a storyline around a problem may assist in drawing the user out of exploration mode, into and through the problem.

2.3 Tutors versus Scaffolding

Tutors in PBL groups do not act as informants but as facilitators who model higher order thinking and challenge the thinking of learners [Boud 1985]. The use of scaffolding approaches, such as breaking the larger problem into sub-problems [Savery and Duffy 1995] or including heuristic aids [Ritchie et al. 1995], may be appropriate alternatives for individual PBL using multimedia materials.

3. A Design Model for IMM-PBL

3.1 Scenario Development

[Fig. 1] outlines the process of developing a problem scenario for IMM-PBL. Although the model was refined in the process of developing an IMM-PBL package for teacher education, it is presented here in general form.

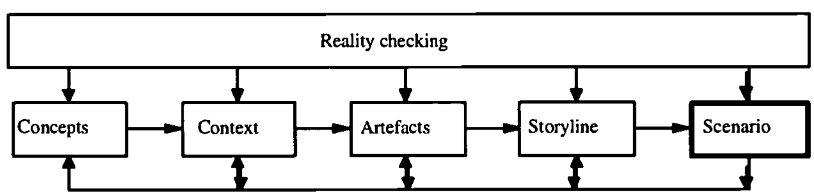

Figure 1: IMM-PBL scenario development

Development begins with identification of key concepts from the content domain [Savery and Duffy 1995] and a typical context in which the concepts might be used. A description of the context including aspects of the environment and the problem is developed. The problem is divided into a series of sub-problems to facilitate scaffolding by considering the types of artefacts, typically documents of various kinds, which might be produced in association with a stepwise solution to the problem situation. Finally, the scenario is completed by devising a storyline which describes the progress of the problem solver from initial encounter with the problem to final resolution and provides the motivation for the user. At each stage, effort is devoted to applying reality checks to ensure that the overall scenario, and each element of it, is plausible, and flows naturally according to user choice. The process tends to be iterative rather than linear and, as indicated in the lower portion of the figure, there is a feedback loop through which evaluations at each stage can influence subsequent revisions.

3.2 Scenario Structure

[Fig. 2] illustrates the structure of a typical problem scenario for IMM-PBL. Again the model has been generalised to highlight the principles of the instructional design.

In order to assist the learner through metacognitive scaffolding, the problem scenario is presented as a series of tasks embedded in a storyline related to a professional context. Each task results in preparation of some artefact relevant to the problem. The Activation Task is intended to situate the learner in the problem context and to begin the process of activating relevant prior knowledge. Elaboration Tasks provide opportunity for recall and reconfiguration of prior knowledge relevant to the specific problem and exploration of additional, context specific knowledge and 'experience' gained during problem solution. Consolidation Tasks emphasise relevant knowledge transfer, analysis, integration, synthesis and evaluation of selected, context specific knowledge and problem based 'experience'. Finally, the reflection task is designed to encourage learners to further integrate knowledge, 'experience' and artefacts gathered through the problem solving process into their cognitive structures as though products of real experience.

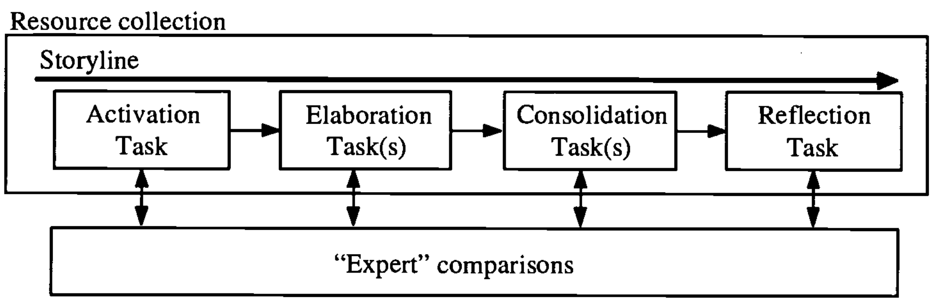

Figure 2: IMM-PBL scenario structure

After each task, users are able to compare their artefact with examples from a panel of experts. These interactions with experienced professionals replace the interactions with peers [De Grave et al. 1996] or with a facilitator [Savery and Duffy 1995]. Except when the storyline requires otherwise, users have access to a collection of resources relevant to the concepts encapsulated in the problems. Because PBL is intended to increase the capacity of learners to solve real problems [Boud 1985] and because identifying critical elements may be counter-productive [Savery and Duffy 1995], the selection of resources for inclusion in the package is gauged to require judgement in selection from what is provided and initiative in employing material from alternative sources.

4. Applying the IMM-PBL Instructional Design Model

The IMM-PBL instructional design model emerged during the development of a CD-ROM package to assist teachers with technology integration [Gibson and Albion, 1998]. The CD-ROM includes a collection of resources relevant to the use of technology in classroom teaching and a series of four problem scenarios based around the common theme of integrating technology into a variety of teaching contexts. Development of one problem scenario will be described as an example of how the design model may be applied.

4.1 Scenario Development

As it was desirable across the intended set of scenarios to represent different teaching circumstances in terms of school setting, pupil characteristics and resource availability, the overall context for the problems was developed around the situation of a teacher applying for a series of short term appointments. For this problem the specific context selected was a small rural school with multi-aged classrooms. The particular class to which the user would be assigned was about to be equipped with a new computer.

Concepts identified for inclusion within this scenario centred around planning and management issues associated with the integration of a single computer into a classroom, including the physical location of resources; planning for individual, small group and whole class work with computers; and behaviour management.

Artefacts identified as appropriate to this context included a brief statement about technology integration, a floorplan showing placement of furnishings and a powersource, notes about planning for technology use for discussion with other staff members and a summary of presentations from staff members in a staff meeting. Using these artefacts as a foundation, a simple storyline was sketched, and embellished with a non-reversible decision point (a chance to visit another classroom via video clips), a tour of the school with the Principal [voice over] and opportunities to interview other teachers (via video).

Checks on content validity, logic flow, professional plausibility and product feasibility were conducted at appropriate stages during the design and development process using a panel of experienced teachers, a cohort of pre-service teacher education students and professional colleagues from several international universities.

4.2 Scenario Structure

Since the overall context of the problem scenarios was devised around the search for temporary employment, the activation task in this problem comprised a brief response to a selection criterion relevant to the technology concepts embedded in the scenario. Planning the arrangement of classroom furnishings using a manipulative graphic floor plan afforded additional opportunity for elaboration of relevant knowledge through a concrete task and represented the elaboration task for this problem.

Work on consolidation tasks, presented as preparation for a staff discussion and supported by outlines provided in the software, required students to access other resources and to structure their own thoughts on the topic. Finally the reflection task offered an opportunity to reconsider the problem and to synthesise personal responses with the samples provided in the materials. Expert comparisons were provided in the form of sample solutions prepared by a panel of experienced teachers. These were made available to learners following completion of each task.

Resources provided on the CD-ROM included documents specific to the problem (school policies and plans), as well as a collection of more general material including video segments illustrating classroom computer use, relevant policy documents from education authorities and additional materials describing computer integration.

4.3 Navigation and Visual Format

Interactive packages of this type require a consistent format for visual display. Further, a means of navigation through the problem which provided intuitive control to the user was a necessity if the impact of the message was not to be subjugated to lower order issues of screen or movement control. In this package, an integral component of the teaching environment, the teacher's desk, provided a natural navigational tool for users. It was from this desk that all action and decision points, governing progress through the problem, originated.

4.4 Production and evaluation

The complexity of multimedia production typically requires that it be accomplished by a team with a variety of skills rather than through the efforts of one or two individuals. The production process for the package described in this paper has been outlined elsewhere [Gibson and Albion, 1997]. Integral to complicated processes of this type is the need for an evaluation strategy capable of supporting development. The formative evaluation of an early prototype of this package was carried out with a group of final year teacher education students. Reactions to the presentation and content of the first scenario have improved the useability of the final product. More extensive evaluations will be conducted with the final product. An area of particular interest in future evaluations will be the capacity of this CD-ROM based, interactive multimedia problem-based learning package to induce effects similar to those obtained with traditional approaches to PBL.

5. Conclusion

In combining the recognised strengths of problem based learning and interactive multimedia, issues related to the instructional design of such products became central to the development process. In describing some of these challenges to instructional design, the authors have recognised the difficulties inherent in attempting to translate a traditional, group based approach to learning, into a technology mediated, individual experience. Early indications from sample target group evaluations and analyses from professional colleagues in a variety of international contexts indicate that the effort has a credible foundation.

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The Impact of Multimedia Tutorial on Students' Learning Experience in Kuwait Higher Education

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Abstract: This paper presents the results of an experiment carried out on a random sample of 34 students from The College Of Commercial Studies, one of the colleges and training centres under the supervision of The Public Authority For Applied Education And Training (PAAET), Kuwait Higher Education. The experiment aimed at evaluating the impact of a Multimedia Tutorial Programme on students' learning experience. Two methods of information delivery were investigated: traditional lecturing method and multimedia method. The results show that students were motivated and satisfied with the multimedia approach compared to the traditional way. However, it is difficult to precisely evaluate students' retention of knowledge in this experiment.

The researchers suggests the need for further studies which might present different and various results depending on the type of learning materials, students' background, usability of the multimedia programme, and period of time undertaken in the experiment.

1.0 Introduction

Multimedia technology has now become a powerful tool for our educational experience [Ambron 1990] . It enables knowledge to be conveyed through a rich mixture of video, sound, music, graphics, still images and animation in a single electronic medium, providing the ability to link subjects in a non-linear format. Such technologies are not a threat, but rather, they present a good opportunity for education [Falk & Carlson 1992]. It is expected that this technology will not only improve educational productivity but also the way of learning itself. Implementing this technology will give the educators the chance to motivate the students, stimulate their interest, and encourage different and various ways of learning [Staley 1995].

Educators, all over the world, are challenged to re-energize the educational system to make education more exciting. Towards this goal, multimedia provides the right technology at the right time. Today, many people compare the multimedia revolution to the personal computer revolution of the 1980s. In fact, interactive multimedia is the sum of all these revolutions wrapped up into one revolution of communication that combines the audio-visual power of television, the publishing power of the press and the interactive power of the computer [Wills & Swart 1994].

The advancement of technology energized educators to integrate technology into the curriculum development process. Educators in the Ministry Of Higher Education in Kuwait in general, and in The Public Authority for Applied Education and Training (PAAET) in particular are looking into all issues related to the development of education. As multimedia is considered to be an essential element in educational technology, the researchers aim at, in this paper, evaluating the effectiveness of the use of multimedia learning materials on students' retention of knowledge, motivation, and satisfaction.

2.0 The Experiment

2.1 Subjects

Thirty four Kuwaiti students (first and second year female students) enrolled at the College of Commercial Studies PAAET, took part in the experiment. They were specialised in banking, insurance, accounting, secretarial and computer information systems. The primary objective of the study is to examine students' learning experience and retention of knowledge by using two types of learning environments: traditional presentation method and multimedia method. The students were divided into two groups as will be explained later in the procedure section 2.5.

2.2 Learning Materials

The learning materials used for this experiment introduce basic information about PAAET, a key figure in Higher Education in Kuwait. The content covers the basic organizational structure, functions, and activities of PAAET. Choosing such content, the researchers aimed at introducing general information to familiarise students with services, sectors, and facilities of their academic institutions.

The information was pulled out from the PAAET annual bulletin report [PAAET 1994/95]. It was prepared and organised to be introduced to students by two methods: traditional lecture method and multimedia method.

The organization of the traditional presentation was properly set, the content was prepared and transparencies were developed. On the other hand, the multimedia tutorial programme was designed and developed. Arabic language was the communication media in the two methods of delivery used in this experiment.

The multimedia tutorial programme was divided into two parts: part 1, covers the activities, functions, objectives and the training sector of PAAET. Part 2, covers both the applied education sector and the administration of PAAET. The same learning materials, as in the multimedia tutorial, were also prepared to be delivered in a traditional lecturing environment.

2.3 Multimedia Tutorial Design

The multimedia tutorial programme was developed using *Action 3.0*, one of the multimedia authoring packages from *Macromedia*. Traditional multimedia authoring steps were followed [Vaughan 1994]. Media elements such as graphics, images and sounds were captured and edited before putting all together. The multimedia authoring process took place, and aimed to create the presentation in order to communicate information as effectively as possible and to make the presentation memorable, to give the students a clear understanding of the learning materials.

Having scripted the presentation, it was helpful to draw a storyboard which basically amounts to the complete presentation. Drawing the storyboard gave an idea as to where to place animation, images and text. It also gave an idea about fonts, text style and size. In addition, It helped to adjust the general sequence of events in the presentation. The navigational structure of the multimedia tutorial is hierarchical. This structure allows the students to go through the presentation in a linear and a non-linear way. A guided chart was designed as shown in [Fig. 1] to give students an orientation and to let them know where they are in the programme. Students had some degree of control over the multimedia interactive tutorial.

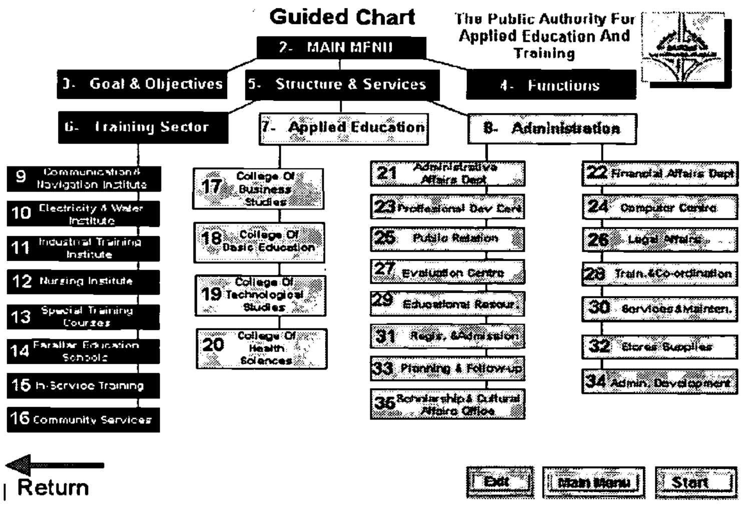

Figure 1. Guided Chart

Some of the design techniques were considered in the authoring stage of the multimedia tutoring programme:

* Some welcoming text and animated pictures were integrated at the beginning and the end of the presentation to accommodate students attention and motivation.
* Animation, pictures and graphics were used in various topics in order to illustrate and address topics.
* Human voice, music, and sound effects were adjusted with each screen to augment and emphasise some points and to enhance learning.

2.4 Method of Evaluation

Questionnaire approach was used to mainly evaluate students' learning experience, as well as the usability of the multimedia tutorial. The questionnaire was designed after preparing the learning materials and developing the multimedia tutorial programme. The questionnaire is divided into four sections. The first section is concerned with collecting students' personal data. The second section consists of two parts, each part consists of 15 multiple choice questions, these questions aimed at examining students' retention of knowledge on the topics introduced in the presentation (*both the traditional and the multimedia*).

The third section consists of 14 questions and aims at evaluating students' feedback and students' opinions on the two different methods of learning environments. The questionnaire uses a set of bipolar semantically anchored items (*preferring multimedia versus preferring traditional presentation*) with a scale of 0 to 5.

The fourth section consists of 8 questions, and aims at evaluating the interface, media, and usability of the multimedia tutorial programme.

2.5 Procedures

All of the 34 students were gathered in the lecturing room. They were told what they were going to do during the experiment. The students were equally divided into 2 groups, group A and group B. Each group had to go through the whole presentation which was divided into two parts, lecturing part and the multimedia one.

Group A attended the first part of the presentation in the lecturing room. This session covered activities, functions, objectives and the training sector of PAAET. It was delivered as traditional presentation. Group B, at the same time, attended the first part of the presentation in the multimedia lab using the multimedia tutorial programme. Students in the lab were able to navigate the programme and control the flow of the learning materials, the first part took about 30 minutes. Both groups were given the questionnaire and were told to fill in the first section and part 1 of the second section. Then, the questionnaires were collected from the students. After a short break, group A attended the second part of the presentation in the multimedia lab, they were able to navigate the programme and control the flow of the learning materials which covered the applied education sector and the administration of PAAET. Group B, at the same time, attended the second part of the presentation in the lecturing room which also covered the applied education sector and the administration. The second part took about 30 minutes.

At the end, students in both groups were given the questionnaires in order to fill in: part 2 of the second section; section three which is concerned with collecting information related to the students' learning experience; and section four which is concerned with collecting information related to the usability of the multimedia tutorial programme. Then, the Questionnaires were collected from the students.

3.0 Results

Based on the analysis of the collected data, the results are as follows:
1- The first section of the questionnaire, which is concerned with students' personal data, revealed that students were first and second year, business college, female students averaging a 2.5 grade point average (scale out of 4).

2- The second section examines students' retention of knowledge. Students answering the multiple choice questions related to the multimedia part of the presentation scored a total of 391 correct answers from 480 (81.5%), which is 2 points higher than the correct answers related to the traditional presentation in which students scored a total of 389 from 480 (81%) as shown in [Tab. 1].

	No. of Questions	Eliminated Questions	After Elimination	Correct Answers	Percentage %
Questions related to the Multimedia Part	510	30	480	391	81.5%
Questions related to the Traditional Part	510	30	480	389	81%

Table 1. Students' retention of knowledge- Multimedia method VS Traditional method

3- The third section, examines students' learning experience, and evaluates the multimedia tutorial programme as an open learning environment versus the traditional way of learning. The results are illustrated in [Tab. 2].

Questions	Totally Agree	Agree	Agree to a certain	Disagree	Totally disagree
MM is more useful compared with traditional Presentation	57.58%	33.33%	9.09%	0.00%	0.00%
The traditional presentation is more useful than the MM	15.15%	30.30%	45.45%	9.09%	0.00%
I am more enthusiastic in MM than Traditional	70.59%	23.53%	5.88%	0.00%	0.00%
I am more enthusiastic in traditional presentation than MM	15.63%	12.50%	34.38%	31.25%	6.25%
The flow of learning materials was more exiting in multimedia than traditional presentation	73.53%	17.65%	8.82%	0.00%	0.00%
The flow of learning materials was more exiting in traditional presentation than multimedia	2.94%	8.82%	32.35%	52.94%	2.94%
MM encourages me to explore information by my own	64.71%	23.53%	11.76%	0.00%	0.00%
control over the flow of content makes multimedia more useful than traditional presentation	70.59%	20.59%	8.82%	0.00%	0.00%
I am not intimidated to using multimedia	65.63%	18.75%	12.50%	0.00%	3.13%
I paid more attention to mm than the traditional	56.25%	34.38%	9.38%	0.00%	0.00%
I paid more attention to traditional presentation than MM	3.03%	15.15%	33.33%	45.45%	3.03%
I would rather learn by using multimedia programs than by traditional way of learning	65.63%	21.88%	6.25%	3.13%	3.13%

I would rather learn by traditional presentation	2.94%	2.94%	29.41%	55.88%	8.82%
I would like to integrate multimedia into our college	55.88%	20.59%	17.65%	5.88%	0.00%

Table 2. Students' Learning Experience - The Multimedia Approach Vs Traditional Approach

4- The fourth section examines the design and the usability of the multimedia tutorial. The results of the analysis are illustrated in [Tab. 3].

Questions	Totally Agree	Agree	Agree to a certain limit	Disagree	Totally disagree
Graphs and images were perfectly related to the MM prog.	65.63%	34.38%	0.00%	0.00%	0.00%
Colors and text were convenient.	48.48%	45.45%	6.06%	0.00%	0.00%
Controlling the program with navigation was good.	75.76%	15.15%	9.09%	0.00%	0.00%
It was easy to understand the structure of the MM program.	66.67%	27.27%	6.06%	0.00%	0.00%
The content was related and integrated in the MM	40.63%	59.38%	0.00%	0.00%	0.00%
sound was clear.	69.70%	24.24%	6.06%	0.00%	0.00%
The use of sounds in the program has enhanced attention.	42.42%	24.24%	24.24%	0.00%	9.09%
The multimedia tutorial was easy to use.	72.73%	12.12%	6.06%	6.06%	3.03%

Table 3. Usability of The Multimedia Tutorial Programme

4.0 Discussions

There are a number of interesting results in tables [1,2, and 3]. In [Tab. 1] it is obvious that there is a slight difference among students who answered correct questions related to the multimedia presentation which is 391 compared with those correct answers related to the traditional presentation part which is 389. This may give an indication that there is no significant difference between the two methods of learning in terms of retention of knowledge. For a very short experiment, however, it is difficult to measure students' retention of knowledge which could be affected by other factors such as type of information being presented, usability of the multimedia tutorial programme as well as the presentation skills of the lecturer.

Students were interested, motivated, and excited by learning through multimedia. The results presented in [Tab. 2] support these propositions. The physical act of clicking a mouse to control the flow of the presentation seems to have a strong attractiveness to students. Their ability to explore and to find information by their own pace seems to give them the chance to put them in the driver's seat. It seemed that multimedia session had transformed students from passive recipients of information to active participants in their own learning. It was notable that the advantages of multimedia are its ability to re-energize students and stimulate new excitement which led to a general agreement among students that multimedia will be beneficial if integrated into their college curriculum.

Students were asked some major questions related to the interface of the multimedia tutorial programme such as, the degree of interactivity, ease of use, integration of media, integration of content and colours. The results are shown in [Tab. 3], indicate that the tutorial was easy to use and control. Moreover, the integration of media and content was effective. In addition, text and colours were convenient. Although 9% of the students were not totally happy with the multimedia sound, 72.7% agree that sound had aroused their attention to the learning materials.

It is very important to consider designing a good interface for any multimedia educational programme in order to get the best out of it. Mckerlie and Preece have supported that and indicated that good integration of media in an effective and creative way, taking users' constraints, excitement and support into account will give the best result. They advised designers to exploit creative talent and experiment with new ideas and ways of thinking [Mckerlie & Preece 1993].

5.0 Recommendations

The researchers make the following recommendations to decision-makers in Kuwait Higher Education in general and PAAET in particular with respect to this study:

1- Integrate technology into its curriculum development process and establish a curriculum development centre.
2- Encourage teaching staff to gain basic understanding of the use of computers and multimedia applications.
3- Establish a Multimedia Unit in each college, institute and training centre.
4- Integrate the Multimedia Unit with the Curriculum Development Centre.
5- Provide an Internet access to students as international networks are being opened up and contain information and media that can be selected and navigated from large numbers of computer systems.
6- Encourage researchers and staff members to contribute to the development of this technology to maximise the use of this type of teaching tool.

6.0 Future Directions

Ropa suggests that within the multimedia learning programme, metaphors, graphics, colours, symbols, and icons should reflect a feeling of the country where the programme is going to be used [Ropa 1991]. In this study, although the interface of the multimedia tutorial programme is developed in Arabic, the researchers did not consider other cultural issues when designing the programme for the Kuwaiti students. As culture has an impact on the multimedia user interface design, it is essential to understand the nature of the target culture.

Future design, development, and evaluation of multimedia learning programmes need to incorporate considerations of cultural issues, not only in language and terms, but also in every aspect of the interface such as: metaphors, mental model, navigation, graphics, look, feel, and taste of the programme.

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A Distributed Classroom

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Abstract: In this paper we report on the design and development of a 'Distributed Classroom' involving two secondary schools in Palermo. In particular, we describe the features of the developed learning environment, and focus on the structure of the communication process which has been implemented in order to make the learning process extremely efficient.

The primary goal of this study is to experiment with and evaluate a cooperative learning environment based on telematic tools and to define new methodologies that allow for an effective integration of technologies into curricular activities.

1. Introduction

Rapid developments in interactive communication technologies are quickly leading towards very deep social transformations behind the Information Society.

In this context, the educational system is challenged to play an essential role in promoting and controlling these transformations: only schools can effectively lead the way- through specific curricula and by adopting technology for teaching/learning processes - towards a full transition to the Information Society. The educational system must promote and sustain the innovative vision of the Information Society, by introducing - as early as possible in the child's scholastic life - pedagogical activities based on the new interactive communication tools.

The general aim of the reported experience is to make students and teachers, involved in the project, aware of the real potentialities offered by new technology in education, by leading them trough a real experience of distributed classroom.

2. The New Classroom

The primary goal of this study is to experiment with and evaluate a cooperative learning environment based on telematic tools, by introducing a specific kind of communication technology in curricular activities of classes in the Italian secondary schools; in addition we have evaluated the changes due to this introduction. To reach this aim we have designed a 'Distributed Classroom' that allows groups of students to communicate with one or more other remote groups, according to these main characteristics:

- class sessions involve both synchronous and asynchronous communication by using one or a combination of several technologies such as computer conferencing, electronic mail, etc.
- all students can research, study, review and exchange the learning material in a cooperative way.
- during class sessions students can discuss, clarify concepts and be engaged in problem-solving and group activities and other learning exercises.

To create the on-line learning environment we have adopted the Bulletin Board System (BBS) technology, with graphic interface. Communication and file exchange occur through the tools available on the BBS system: e-mail, newsgroups, shared file areas, chatting rooms.

The students (aged between 12 and 13) of four classes from two secondary schools, subdivided into groups according to sociometric criteria, are encouraged to experiment with telematic communication and then with the different communication paradigms, thus creating a concrete experience of a Virtual Class.

The groups have concentrated on the study of two historical houses in different geographical areas where they come from which are part of the National heritage.

Moreover, the groups are led through different interaction schemes, which have been designed to stimulate different cooperation strategies and to favour communication within and between groups.

3. Description of Communication Process

The design of the communication model has been central to our work and, at the same time, very useful. A communication model is an essential tool for understanding the organization and relationships between the different stages of a planned communication process.

Firstly, it was important to get models which would be both precise and flexible.

Secondly, the models had to exhibit a very high degree of communicability and comprehensibility, since they had to be understood by people with different pre-skills, competencies and experiences: students, teachers and trainers.

Finally, these models should be able to guide all the people involved in the communication process (teachers and trainers) in the discussion of the organizational problems, didactic programming and evaluation.

In particular, both the teachers and the trainers examined the following problems: hypothesis about the on-line learning process; hypothesis about the modifications which occur, in the students and in the teachers, involved in the on-line communication experience; how to improve the exchange of didactic material and ideas related to a specific subject; the needs for tools, strategies and evaluation methods, suggestions about the scheduling of the activities, and so forth.

In conclusion, the model defining phase has produced many very interesting ideas for each actor in the communication process.

The first step of this process is based on presentation of students, using a telematic identity card or "home page", created according to their fantasy. This allows each student to get to know on-line companions and enables them to understand and use telematic tools.

Once the groups had acquired the necessary skills they were helped to learn and cooperate telematically using a second communication model as follows.

The group communication process was organized according to the plan shown in [Fig. 1].

Remote groups are paired so that two corresponding groups gather information about the same subject; the first group of the pair deals with the general aspects of the subject, while the corresponding remote group analyses a specific case regarding the subject.

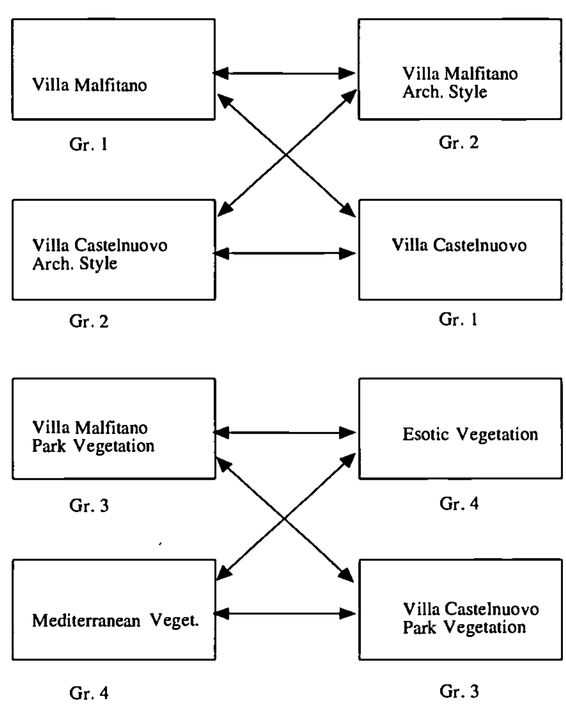

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Figure 1: Organization of interaction between remote groups

In the first stage, the bi-directional communication, between pairs of remote groups, takes place regarding common subject in a horizontal way, from general aspects to specific aspects and vice versa. In this way, the material is collected gradually by the remote groups and is then integrated and elaborated cooperatively in order to carry out a thorough study of the scientific and architectonic aspects of the chosen houses.

When the group had completed its part of the research, using BBS, it communicated to the remote group.

In this case, cooperative learning is achieved by means of certain expedients such as: the exchange of results with other groups, by means of telematic forum in order to stimulate comparison; communication, by e-mail, of the partial results of the research to the teachers. In the same way, using e-mail, teachers answer giving them adequate feedback.

Beside the horizontal interaction between remote groups, as described above, during the second stage, diagonal interaction was used. This helped to produce more effective cooperation between the groups which had studied the subject from a general point of view and those which had considered specific aspects of the subject. The meta-cognitive aim of this kind of interaction is to find analogies and differences in order to integrate all the information.

These interactions are indicated by the diagonal lines in [Fig.1].

As hypothesized, the cooperative learning is stimulated by the comparison between the information obtained and, then, by the identification of common features of the material (e.g. an architect who designed several buildings in the different areas of the city).

Finally, using a third model, we have stimulated 'free discussions', by means of telematic forums, of topics examined by pairs of remote groups. The purpose of this is to give all the groups an overall view of the work and so allow each student to cooperate "with and between" groups.

Moreover in this experience it is necessary to underline the role of teachers and trainers. This consisted in the supervision and continuos assessment of the level of learning and participation between the individual groups, where necessary modifying the assignment of tasks or the communication flow between groups.

The communication in the described models, was synchronous or asynchronous as the work required.

4. Lesson Learned

This experience has led us to make the following considerations about how much technology affects the teaching/learning process:

-the use of the computer in the interaction between the actors in the communication process allows students to improve logic-cognitive skills which come from writing and reading textual documents;

-because of the modification of the setting, the members join together, exchange information, establish the rules, plan the activities, organize themselves, in other words, the group cooperates in order to reach a common result;

-in specific situations, the telematic tools simplify the management of the group processes, such as the activities of observation and feedback which are necessary to evaluate the group as a whole and the contributions of each member; in addition, telematic tools encourage a self-evaluation process;

-from a socio-affective point of view, the use of telematics aids the network of relationships among peers; this is due to the fact that telematics provide new and diversified study situations. These situations are based on play aspects and on the cooperative value which are intrinsic in the use of Telematics;

-stimuli and motivation to learn are increased by the appeal which is typical of a new tool and of an innovative communication mode.

Besides the didactic potentialities of Telematics, some drawbacks which might arise during the Distributed Classroom experience must be taken carefully into account. We report those which have arisen: the impact with something new and the resistance to going outside the boundaries of one's own class; the difficulty in organizing the activities of the groups in a synergetic way; the unfamiliarity of interacting in an indirect way; the difficulty of learning about the new technologies and their didactic potentialities.

As mentioned before these possible drawbacks have been carefully taken into account at the project design stage as well as during the whole experience, by performing a constant evaluation process.

5. Conclusions

In this paper we have reported on an experience of a distributed classroom, and we have focused on the design of the structure of the communication process and interaction.

Among the several activities, we have guided students and teachers towards new creative learning and teaching strategies.

The developed environment has proved very efficient in enabling students and teachers to realize the real potentialities of the computer mediated communication, thus going beyond the simple use of new attractive tools.

This experience is the starting point of a wider project that seeks to enhance the potentiality of telematics as a tool to improve the sharing of experiences among different situations and participants, the interdisciplinarity, the development of socio-cognitive skills and, last but not least, the recovery of school motivation in pupils with particular educational needs.

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Education of Engineering Students within a Multimedia / Hypermedia Environment — a Review

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Abstract: Universities are facing a challenge like enterprises did during the last few years. With less and less costs, the product (in this case education) should become better and better if the University will hold its its rank in the information society of tomorrow. This goal implies that teaching must become very dynamic and link direktly to research results in technology related subjects.

About three years ago Darmstadt University of Technology started to realise these ideas for the education of all mechanical engineers. This article summarizes activities of the Department of Computer Integrated Design in distributed lectures, lectures on demand, hypermedia information environments and multimedia tutoring systems. The main focus was thereby the efficient use of new technologies to improve education within the restrictions of limited resources, rather than the proof of technical realisation. Therefore feedback and evaluation had been an important part of the projects.

1. Distributed Lectures

Lectures are traditionally the kernel of university education. This traditional form implies that everybody who wants to attend has to be in the lecture room at lecture time. If the target group for the lecture is distributed over a larger area, attending the lecture can often be timeconsuming or even impossible because of other dates. Attending a lecture course at other Universities (e.g. in special topics) is not possible at all. The situation gets even more difficult if the idea of life long learning is taken into account. Therefore the possibility to distribute normal lectures online through a LAN/WAN was evaluated.

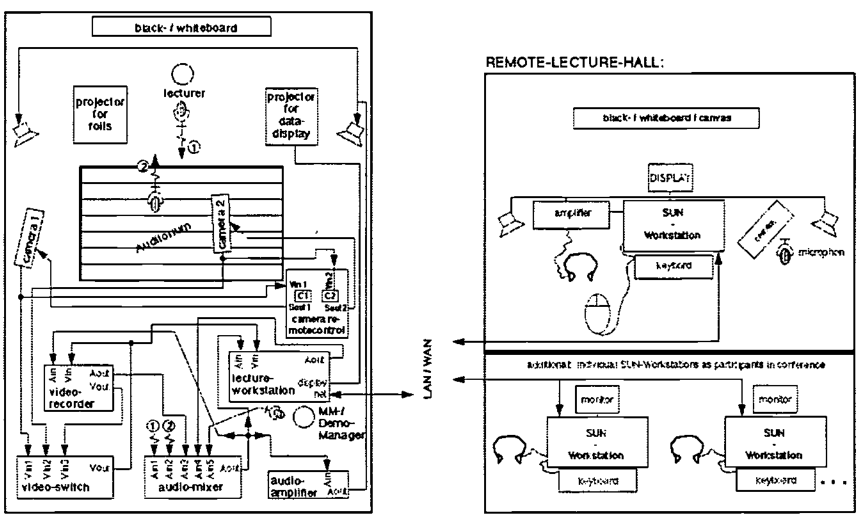

Figure 1: Multimedia lecture-/ and remote-lecture-room and individual workstations

The equipment used is shown in [Fig. 1]. Two cameras and several microphones are used to capture the lecturer, the used media like slides or writing on the black- or whiteboard and the audience. The media-manager chooses the video-signal and mixes the audio-channel that is actually transferred through the net. Both cameras are equipped with remote-control heads. Videos shown in the lecture are directly sent to the remote coumputers. Requests from remote participants are handled by the media manager and can be posed online by means of audio-amplification with the video signal shown on the canvas of the data display. The workstations used in [Fig. 1] are SUN workstations, as the conferencing tool ShowMe was used.

Practice has shown that the quality of primary sound and secondary video are crucial for the acceptance of distributed lectures by the remote participants who have been spoiled by expensive TV and cinema productions. Therefore a guaranteed high bandwith e. g. through ATM (Asynchronus Transfer Mode) and the professional skills of at least two media managers (in order to handle requests) in a specially equipped multimedia lecture room is necessary. (In a normal lecture room, the light conditions are normally very poor for taking video especially if overhead projectors are used.) The technical equipment needed to achieve a high quality transmission is considerably extensive and far from plug and play techniques. Consequently distributed lectures can only be considered as an efficient teaching method if the professional equipment and the professional skills of the operators are used full time or at least every day.

Universities should be encouraged to start cooperative efforts with the idea to reduce the quantity of lectures in each location to be able to improve the remaining lectures to a very high quality. These lectures would then be distributed to other locations and related to the qualitiy of the lecture a demand from the remote locations would arise.

2. Lecture on Demand

In the previous chapter, it is shown how lectures can be attended from different locations with the possibility of interaction. In this chapter the possibility to repeat a lecture or to attend a lecture later is dicussed. In addition to the distribution in terms of location from the previous chapter, a distribution in terms of time is now enabled naturally encompassing the loss of the possibility of direct interaction with the lecturer. This is called ´lecture on demand´ because it shall enable the students to get any of the available lectures throughout the whole year (most lectures are only once a year) from almost every location 24 hours a day.

Therefore the digitized lectures should be accessible from almost every computer in the internet with normal multimedia ability. The materials must be provided completely in standardized formats to ensure platform independece for at least a few years. Digitizing and processing of lecture material must be done using moderate manpower within a day or two, for each 90 minute lecture such that the material offered is always up to date. By attending a lecture on demand the user must get all the information that was provided within the original lecture.

The first goal can be reached by means of the WWW (World Wide Web) in combination with Java applets and source files in independent formats (such as ASCII, GIF, JPEG, SunAudio, etc.) with moderate file sizes. By analyzing lectures based on slides and blackboard writings it becomes evident that nearly all the information is contained in the combination of slides and the sound of the lecturer. Therefore these two media must be supplied in a very high quality. The video picture itself merely helps to get to know the lecturer and to give the impression of participation (which can be quite important) and not to miss important details.

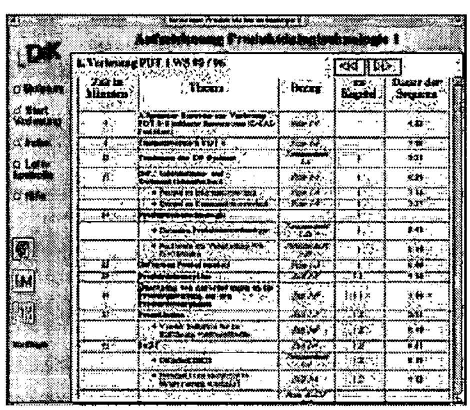

Figure 2: Overview of a lecture structured into sequences

For recording lectures, the arrangement in [Fig. 1] is simplified. One camera records the lecturer himself. The other camera is used to record the slides and the blackboard. This camera also records the sound of the lecturer via the wireless microphone such that synchronic information is available for the digitizing later on. Both cameras are remote controlled, questions from the audience are recorded with separate microphones.

The first step in processing the material is to divide up the lecture into thematical sequences (e. g. each slide shown and explained can be described as a unit). Later on these sequences can be accessed directly or found by a search engine. Therefore the sequences are described within a few words. The relation to the slides and the lenghts of the units are also documented [Fig. 2].

Lecture slides made with a graphic program can easily be provided as a GIF or JPEG picture without any loss of information. Handwriting on slides or on the blackboard can by the use of the video-recording easily be redesigned in a graphic program and also prsented as GIF or JPEG.

The quality of sound is very important. The biggest loss normally happens right at the beginning of the process chain due to unappropriate microphones or bad recording conditions. That can easily lead to a very low signal to noise ratio. For this reason wireless microphones and high quality recievers without any sound dropouts are essential. An audio mixer is needed to adjust signal strength for the recorder. The signal must be digitized at a high quality (e. g. 16 bit, 22 kHz). Such high quality sound files can then be converted to compressed files with lower border frequency such as μlaw. This reduces the file size by a factor of almost 4 which is important for the loading time of the lecture later on. Expierence shows that the loss of quality in this step is moderate if it has been high enough initially.

The video signal itself contains the greatest amount of data but the least amount of information in this case. For reasonable response times, this amount of data must be compressed drastically. Tests of the acceptance of different presentation forms led to a method where the video-stream (25 frames per second with PAL) is split into a set of individual, high quality, compressed pictures (JPEG) taken at a constant interval (e. g. 1 sec) instead of reducing the picture quality while keeping a high frame rate. An interval of about 1 sec. leads to a high acceptance because the response times for watching the sequence are moderate, the quality of the pictures is so high that details can be seen and the user does not get the impression of a flickering film that is running too slow.

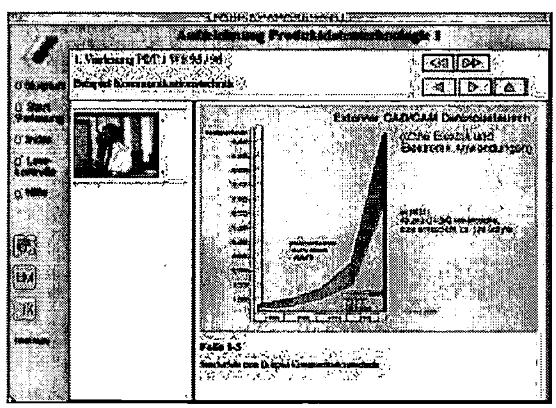

Figure 3: Sequence of a lecture played in the WWW-Browser by a Java applet

With the method described above 12 lectures (each 90 minutes long) of the course PDT 1 (Product Data Technology) have been recorded and digitized [Anderl and Vogel et al.1996] . With the method described above the entire course has a size of less than 700 MB. For access to the lectures on demand by the WWW a navigation and orientation structure similar to the one described in chapter 3 was designed. The lecture on demand can be used on any machine in the internet where a browser with full Java ability (including the performance of sound) is available. The Java applet loads one sequence at a time (slides, soundfile and video pictures) and plays it with the synchronic information given in the applet-call.

3. Hypermedial Information Environment

At the University of Darmstadt mechanical engineers get an integrated engineering education in design during their basic studies in the first and second year. This is divided into three parts. A detailed description of this education based on Product Data Technology is given in [Anderl and Vogel 1997] . All material for the CAD-course (the first of the three parts) is provided by means of the WWW. This material includes manuals for the CAD- and the PDM-Systems (Computer Aided Design- and Product Data Management-System), exercises, lecture sheets, additional information and examinations.

For an efficient use of this material an information environment had to be designed, which allows a simple navigation in conjunction with an unambiguous orientation. The actual content is separated from the means of orientation and navigation. A structure was developed to describe any of the different branches within Information-System. This allows the realisation of an automatic creation of navigation and orientation for each branch by special tools. This method leads to an Information-System that is easy to maintain. The Information-System is enriched by local search engines and manually created index pages.

The practical use in different courses showed that even though all material was directly available at each work place there is still a great demand for printouts. Normal printouts of the manuals, exercises, etc. from the WWW do not support efficient work. They are just loose pages without header or footer, without a table of contents or page numbers. These printouts cannot be used in a sensible way for personal annotations or for studying somewhere else other than in front of a computer.

Therefore it was necessary to develop and implement a method that allows the conversion of a structured HTML document into a well laid out paper document that achieves the quality of a document created originally with a text processing application.

The result shown in [Fig. 4] was achieved by parsing the HTML manual to TEX using its defined structures and deriving postscript files afterwards. In practice this method has proved to be very efficient for the documents used within the CAD-course which are primarily designed for the use in HTML and secondarily for use in the form of printouts. Changes in these manuals and exercises are done easily and are available for everybody instantly.

It is obvious that only such semantic constructs can be parsed successfully from HTML to TEX which have an equivalent there. E. g. a table containing pictures, often used to arrange pictures on the screen of the browser, cannot be expressed in TEX. Workarounds in the parsing algorithm will never be generally satisfactory. Therefore the best way in such cases is to declare that such semantic constructs must not be used in the HTML sources which may undergo conversion into a postscript file. This results in the declaration of a HTML subset as a kind of styleguide.

On the other hand there are semantic constructs in TEX like the caption of a picture (which is linked to the rule that picture and caption always have to be on the same page) that don't have an equivalent in HTML. For some constructs semantic rules where established within the HTML styleguide that would allow the parser to recognise an artificial HTML caption if it was there or leave it out (after a picture) if not.

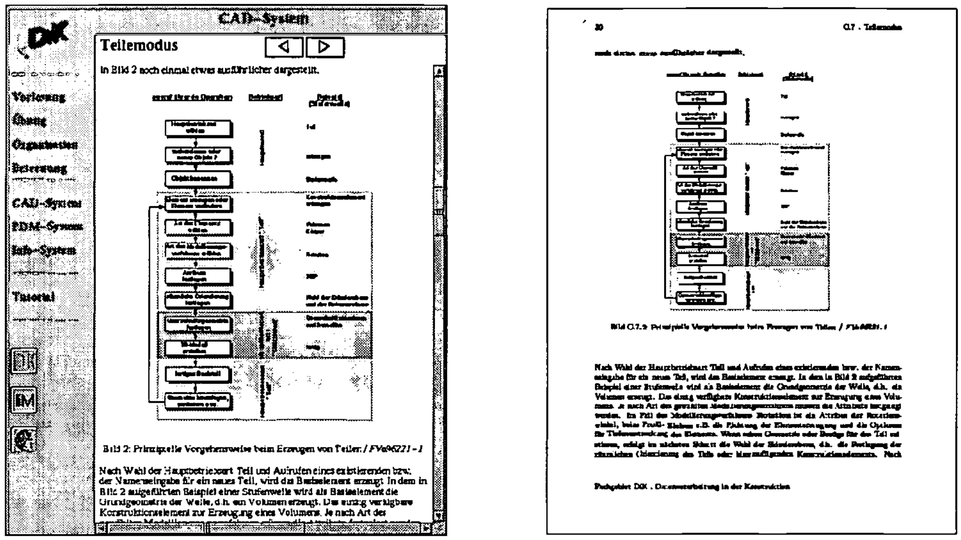

Figure 4: Manual in HTML with orientation and navigation structure and the derived printed manual page

For documents which contain a considerable number of mathematical equations and which are primarily designed for use as a printout and only secondarily for the in HTML the opposite approach should be preferred. The quality of the source format will always be better than that off the derived one. Hence in this case it is suggested to start with TEX, define which subset may be used and derive the HTML as a secondary form of presentation.

Important for both ways of working is that the source files contain the structure of the document separate from any layout description. The layout itself is generated by algorithms within the browser or the LaTex code. Documents that are designed within modern textprocessing systems (e. g. Microsoft Word) are not based on this idea and the file formats of these systems are far away from a fixed standard (even taking RTF (Rich Text Format) into account). Therefore there was no significant effort made to derive these formats from HTML or vice versa.

4. Multimedia Tutoring System

The experience in lectures and courses concerning CAD- and PDM-Systems has clearly shown that demonstrations how to use the various functionalities of these systems are essential for participants who want to comprehend the usage. The techniques of lecture on demand and hypermedial manuals as they are discussed above both are not able to store and reproduce the full information given in such a demonstrations. The ´lecture on demand´ cannot provide the required picture resolution (e. g. 1024 x 768 pixels) which is clearly above normal video resolution. In the hypermedia manuals such demonstrations could only be transfered to long passages with a few sentences of text in between batches of sequential pictures. Such documents are normally quite tiring to work with, the reader has to switch continuously between description and the pictures themselves to understand all the steps of the process being explained. In the original demonstration the viewer had the possibility to watch the screen and to listen to the explanation at the same time. Within the multimedia tutoring system this possibility is given on demand for a set of demonstrations (tutorials) [Anderl and Vogel et al.1997] .

Each tutorial is divided into sequences of moderate length (e. g. 2 - 5 min.). The digitized sequence consists of a number of high resolution pictures, soundfiles, the text that is spoken in written form and information about the synchronisation. This material is accessed through the WWW by a platform independent Java applet running on the client of the user [Fig. 5]. This Java client offers a wide variety of control possibilities. The sequence can be stopped, rewound, viewed in single steps - even scrolling through the sequence (e. g. to find one special action) is possible. In cases where no sound is wanted, the spoken text appears in a separate window in written form instead.

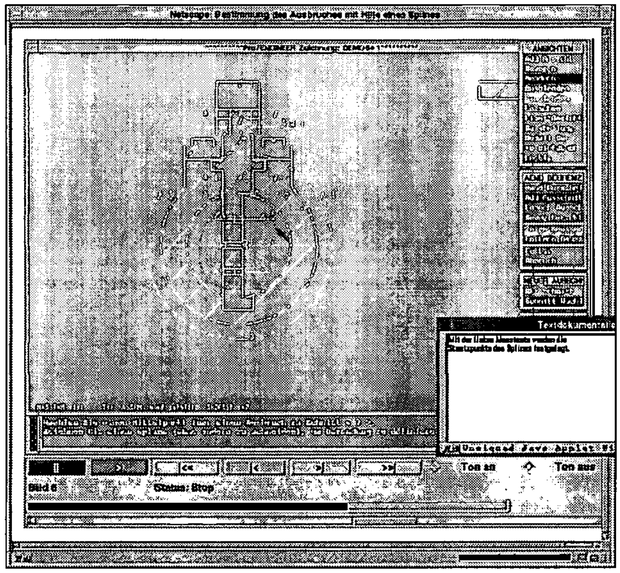

Figure 5: Java-player running a demonstration of how to use the CAD-Software for the derivation of drawings

This technique was frequently used with a high acceptance during the CAD course in 1997 although the performance of Java was still rather poor under the operation systems used at this time. The multimedia tutoring system enabled the students to repeat what they had seen in the lecture right at that time when they where putting it into practise - especially when they got stuck with one or other functionality of the CAD-system. Questions that were posed during the course by email could often been answerd quickly with a link to related sequences.

5. Conclusions

In this article it was shown, how modern multimedia and hypermedia techniques could already be used to improve university teaching. Benefits could be achieved in the amount and the quality of the available teaching material, in the efficiency of the distribution of this material and in some cases in the efficency of teaching large numbers of students. Generally speaking multimedia and hypermedia techniques enable the creation of higher quality course material which should lead to courses of higher quality themselves. But improving the quality of any course will always be time consuming wether multimedia and hypermedia techniques are used or not. Luckily these techniques allow now an instant distribution of all material to a large number of students somewhere in the WWW. If this advantage is exploited through teaching cooperations the resources gained by reducing the actual redundancies in creating course material can be used to improve the material and the courses themselves.

To reach this goal the university must avoid the main mistake many enterprises did in the past: Not the reduction of costs but the improvment of quality and of innovation should be the primary motive power of all structural changes. If the universities make use of the chances that are inherent in multimedia and hypermedia they will be perfectly prepared for the challenges of tomorrow in the educational sector.

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Maintaining Link Integrity to External Web Sites in a Hyperwave-based Learning Environment

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Abstract: Teaching in an Internet-based learning environment provides unique challenges. Of particular interest is the question of maintaining link integrity. Although several modern hypermedia systems can guarantee that links within their systems boundaries are maintained, it is more difficult to ensure that links to external Web servers remain intact. The system we have developed maintains consistency to external Web sites for all essential documents (as specified by the courseware authors). It also notifies the link authors when remote documents have been altered or deleted.

1. Introduction

Internet-based learning environments are an important development worldwide. Unfortunately broken links pose a considerable problem for system administrators, teachers, and students alike. For example, it is most frustrating to discover in the middle of a lecture that a link, which was valid when a lecture was prepared, has disappeared – maybe just one hour later (as we have experienced more than once). Students also experience additional stress when they discover, just before an exam, the disappearance of material they have briefly skimmed at the beginning of a semester.

1.1 Our Virtual Learning Centre

We have aimed to create an interactive distributed learning environment, using a combination of new course material and lecture material available from previous years [Lennon & Maurer, 1994]. Since there is a wide range of hardware that has to be supported, we have relied on common Web browsers that support Java applets. Successful features of our project include:

- The inclusion of all lecture material, tutorial notes, assignment descriptions, student projects and assignment marks (in some cases answers for the whole class), as well as past test and exam papers, with their model answers.
- Additional lecture material consisting of PowerPoint slides are stored in Hyperwave, sequentially linked, and tables of contents generated as the course proceeds.
- The ability for students and lecturers to annotate material and restrict access to the annotations through Hyperwave's group access rights.

1.2 A Proliferation of Files

Experience has shown that students expect annotated lecture notes, tutorial notes, assignment information and a whole raft of extra information. They also expect that anything on the screen should have a reasonably high pictorial content, which creates a further proliferation of files since every graphic, however small, has to reside in a separate file. The number of files for one course can easily exceed 200. Since the number of courses given in one semester at the University of Auckland is currently just under 3000 we can estimate that if all courses were given electronically we should be planning for over 600,000 files.

1.3 A Proliferation of Broken Links

The next question to be considered is how many links may be involved in a database of 600,000 files. This is more difficult to answer since authors vary widely in the number of links that they include in any document. Taking our own site as an example, we estimate over one million. This means that someone may have to try to maintain the integrity of over a million links in the database.

Also to be considered is the problemof how an administrator of one server knows when a document on another Web site has been moved or removed. In the current climate, the answer is that they will rarely know.

Hyperwave [Andrews et al., 1995] [Maurer, 1996], which was developed to address these problems, has been used for the management of all electronic material in our Internet-based learning environment.

1.4 Further Motivation For Our Work

It is becoming increasingly popular for publishing agencies to produce related Web sites for their publications. Many books now refer not only to their publisher's sites, but to other related Web sites. Unfortunately, a book which has perhaps spent over six months in production and contains links within it to various Web sites, may well be out of date the day it is finally distributed. An ideal example of this problem would be The Internet Yellow Pages [Harley Halm & Rick Stout, 1994] published in 1994. This book is entirely dedicated to listings of newsgroups, FTP sites and Web pages, many of which are now well out of date. Following an arbitrary URL from this book will likely result in the infamous "404: file not found" error from the host site, because the original document referred to has been either renamed or deleted.

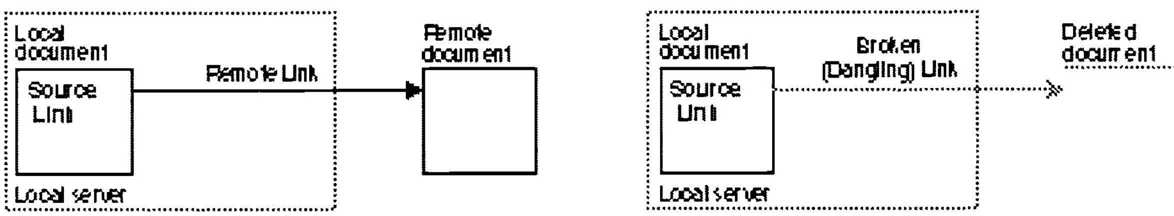

Figure 1: The dangling link problem across server boundaries.

Online guides and lists of links also suffer from this problem to a lesser extent. It is, of course, much easier to alter a Web page to reflect a change in a URL than to reprint an entire book. Changes to a Web site still require manual alteration of the document in question, but more importantly, someone must be available first to notice that a particular link is now out of date.

What is needed is a method of specifying links in relatively stable Web documents and printed material in a manner which allows automatic notification of broken links and provides a simple method of correcting or re-directing these links.

Before moving on to the problem of links to documents stored in external Web servers, we first highlight a few key built-in features of Hyperwave.

2. A Brief Summary of Key Features of the Hyperwave System

Hyperwave (originally called Hyper-G) is an advanced hypermedia document management system developed at the Institute for Computer Science and Computer Supported New Media (IICM) in Graz, Austria. The principal architects are Prof. Hermann Maurer and Frank Kappe [Kappe et al., 1993].

Hyperwave was developed to store high-volume hypermedia resources, which can be spread over multiple servers [Kappe, 1995]. The long-term maintenance and development of databases becomes crucial when databases grow beyond a certain size. To expedite management, particularly of links, a more structured approach needs to be pursued right from the beginning [Flohr, 1995] [Maurer et al., 1994].

Hyperwave follows a more sophisticated concept than most available Web server systems. The project's aims are [Andrews et al., 1994]:

- System access using hyperlinks, hierarchical browsing, and searching.
- Reducing fragmentation of document collections over multiple systems and servers.
- Support for multi-lingual documents.
- User identification and access control.
- Integration of existing Internet information systems.
- Automatic enforcement of document consistency.

Hyperwave offers a self-contained working and navigation environment, and relies on the Internet as its base communication medium. TCP/IP port 418 has been reserved by the Internet community for communication to Hyperwave servers.

The core of a Hyperwave server is formed by a set of object-oriented databases. It supports customary database features such as the assigning of attributes to objects, indexing, and searching. The server also maintains a hierarchy of user and group information. The following attributes can be assigned to any document:

- Read and write permissions for both groups and individuals.
- Extra search keywords.
- Titles in different languages.
- Display properties.
- Custom attributes.
- Direct debit, from the user's account, of the cost of viewing a document.
- Setting of a time period during which the document is visible to the public.

Since attributes are not stored within the objects (as in most Web servers), but in a separate database, they can be efficiently extracted and manipulated. In addition, objects can be locked to ensure they are not updated concurrently.

2.1 Local and Remote Link Maintenance

There exist utilities which can augment Web server functionality and ensure that all links at a site are pointing to the correct documents, or discard links which no longer point to existing documents. These utilities generally only ensure that all 'on site' links are kept up-to-date.

Hyperwave also addresses this problem on a 'site' basis. The details of a link within a document stored in a Hyperwave server are kept separate from the actual document itself. The server is always aware of exactly which document a particular link refers to and, more importantly, which documents make use of the link.

When a document is moved on a Hyperwave server, all links referring to that document are automatically updated. Similarly, when a document is deleted, all links referring to it are 'deactivated'. As soon as the document referred to is restored or a new one created, the link becomes active once more. This automatic maintenance of local links also works across multiple Hyperwave servers.

A full description of Hyperwave, including all technical details, can be found in [Maurer, 1996].

However, Hyperwave does not check that links pointing out of documents in Hyperwave to documents on remote Web servers remain intact. This issue is the topic of the rest of this paper.

3. Remote Link De-referencing

It is not practical to expect everyone in the world to start using a Hyperwave server to ensure the integrity of links world-wide. We propose the use of special link and document caches, implemented using Hyperwave, which could be used to de-reference links on a local server and protect static documents from changes on the Web at large.

Hyperwave allows links to remote sites to be loaded as entities in their own right. When a user accesses a link in a local document, instead of connecting directly to the remote document it simply connects to the local remote link object. The remote link object automatically refers to the remote document and this redirection is virtually transparent to the user.

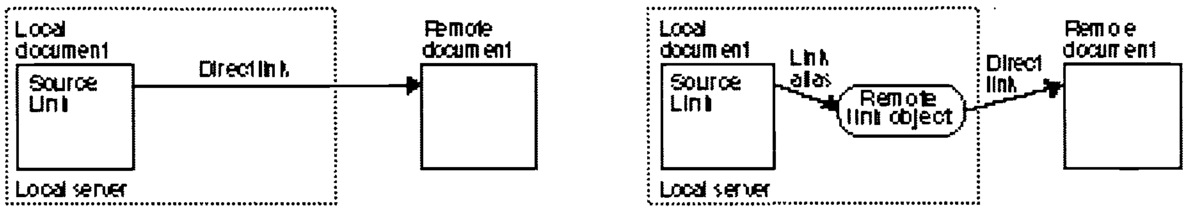

Figure 2: De-referencing a link using a remote link object.

By using and maintaining the remote link objects, several features can be implemented:

- An automatic, regularly executed program can be used to check the integrity of all the remote link objects.
- The author of the link can be automatically notified via email if the remote document has been changed or deleted.
- The author of a link can update the destination of a link object without needing to directly alter any of the documents using the link.
- If the site containing the remote document is unavailable or temporarily off-line, the author can be notified.
- The text of remote documents can be cached and used when the originals become unavailable for any reason.
- A number of different documents can make use of the same remote link object.

In practice, a user will click on a link in a document, which will refer to a remote link object. This object will either re-direct the user to the remote document, or provide the cached document and explain that the actual remote document is unavailable for whatever reason.

3.1 External Link Maintenance

Setting up remote link objects and referencing them is a relatively simple exercise using Hyperwave. The main problem to be overcome is detecting when a remote document no longer exists (or is no longer valid) and what to do when this happens. It is fairly straightforward to detect when a document has been deleted from a Web site, simply by periodically attempting to download the document. Some parameters are required to determine how 'periodically' the links should be checked and to indicate how long a document must be missing or unobtainable before it is deemed to have been deleted (or simply too unreliable to use).

Another complicating factor is that the content of a document may change to the point where it is no longer relevant in its original context. The current relevance of a document must ultimately lie in the hands of the author who decided to use the link in the first place. It would therefore be sensible for the link cache to report to the author that a remote document has been altered.

The HTTP protocol used by Web servers allows document information to be retrieved without actually downloading the entire document [http://www.hmu.com/web_links/http2]. The remote document's modification time/date is ideal for noting changes in a remote document. This modification time can then be added to the remote link object as an attribute for future reference.

3.2 Remote Document Caching

When a remote document has been removed or renamed, and the link author informed, it would be advantageous to be able to supply a strictly temporary version of the document until the author alters the link's destination, or the original remote document becomes available once again.

After creating the original remote link object, and checking the existence of the remote document, the text part of the document will be cached (ignoring images and other embedded items). The remote link object can then use the cached document in the event that the remote document becomes unavailable. When supplied with the temporary cached document, the viewer is warned that the document they are seeing is not the original, and a URL_ to the original remote document is supplied should they wish to check it themselves.

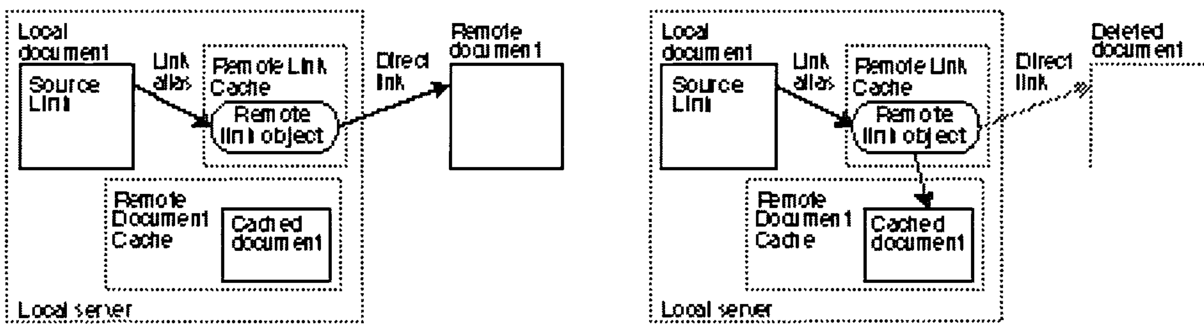

Figure 3: Supplying the original remote document or the locally cached version.

4. Implementation

We have implemented a prototype link cache, working as described above, using Hyperwave running on a UNIX system. Two separate programs run periodically, cache_setup and cache_maintain. Cache_setup creates new remote link objects from existing links, and cache_maintain maintains the remote link and remote document caches.

When a user on the Hyperwave system decides that they want the external links in a document to be maintained, they add a custom attribute "CacheURLs" to the document. This flags the document to have all external links de-referenced by the cache_setup program, which runs as a CRON job once a day. The user also has the ability to run cache_setup immediately if they wish, via an HTML form/CGI.

Once it executes, cache_setup processes each document on the server with a new CacheURL attribute. It removes all URLs linking off the local site (with the exception of those accessing CGIs) and creates remote link objects in the Remote Link Cache (RLC). Each user on the system has their own unique RLC and remote links, so that changes made by one user to their remote objects in the RLC do not affect the links used by others. The HTML of the source document is altered to use the links in the RLC (refer figure 2). As each remote link is created, a text-only version of the remote document is downloaded and stored in the Remote Document Cache (RDC). There is only one system-wide RDC.

The CacheURL attribute is altered to indicate a successful load and an attribute is added to the remote link object, indicating the last modification time (and date) of the remote document. Finally, the user is emailed the results of the load, stating which links were successfully loaded and reporting any problems.

The cache_maintain program also runs as a CRON job but on a more frequent basis. Under normal circumstances (ie. when there are currently no broken links) it will attempt to verify all links in the RLC every six hours. If there are links which have been previously found broken and are using temporary text-only documents from the RDC, then cache_maintain will check these links once an hour until they are either corrected or deemed deleted.

Upon execution, cache_maintain checks each remote link in the various RLCs. First it attempts to get the last modification time of the remote document referenced and compares this to the modification time attribute of the remote link object. If these time stamps are identical then no further action is required for this link, otherwise the remote document must have been changed and the owner of the remote link is informed via email.

In the case of a deleted remote document, or a non-responding site, the remote link object will be re-directed to the temporary cached version of the document. The link owner is then informed of this action. Links that are still not resolved after a week are deemed to be lost and the link owners are emailed once again, with the advice that they should remove the link permanently.

5. Future Work

The system we have implemented as described above is certainly not complete, nor as user friendly as it could be, but it performs its core functions admirably. Users are usually informed of changes in the status of their links within a day of a link breaking. Unfortunately, at this stage some knowledge of the underlying Hyperwave system is required to change the destination of the remote link objects.

The actual work involved in creating the raw functionality was quite simple compared to the complications encountered in making the system as convenient and transparent to the user as possible. Other than improving the user interface, most of the future work required will be determining the optimum periods for checking links (both working and broken).

6. Conclusion

The system we have developed on top of Hyperwave lets teachers designate that particular documents should have all links to external Web sites de-referenced to point to the local server's link and document caches. This enables teachers to simply set one attribute on each of the documents they deem to be important and the system will de-reference all links to external Web sites contained within that document. We believe that this facility will significantly improve the reliability of electronic courseware and thus reduce levels of stress for teachers and students alike.

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A Typology for Distance Education - Tool for Strategic Planning

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Abstract: The prevalence of the Internet and the Web in higher education has been transforming higher educational institutions in various degrees. There are a wide variety of terms indicating such phenomenon ranging from web-based instruction and online courses to cyber degrees and virtual universities. Those terms are often used without clear definition. In this paper, six different categories of higher educational institutions in cyberspace: online course catalog/clearing house, university brokerage, virtual university consortium, virtual university, online campus, and unaccredited online campus, are discussed to provide a big picture of current trends in distance education. Then, three elements of online courses are discussed in order to give some framework in designing online courses. Lastly, the future trend of higher educational institutions is also discussed.

1. Introduction

As the Internet and Web technologies are becoming the popular vehicle of instructional delivery, we have begun to see the plethora of words referring to such mode of instructional delivery (e.g., web-based instruction/course/distance education, Internet courses/university, online instruction/course/campus /university, cyber class/course/school/university, virtual classroom/campus/university, etc.). Though these terms share some common concepts; some instructional components delivered through computer networks and some degree of time and distance independence, a precise nuance of each term differs, reflecting the diversity of such offerings.

First of all, the spectrum of these terms ranges from a traditional classroom-based course, which uses the Internet/Web to supplement classroom activities. Such a course may use the Internet/Web to deliver class materials such as syllabi, homework assignments, lecture notes, exams, and Q&A sessions. At the other end of the spectrum is a degree-granting program offered completely through online activities without requiring students to physically attend any classes. All of the terms listed above fall in somewhere between the two ends of the spectrum.

Traditionally educational systems in most countries had required in-class instruction by teachers and in-class attendance by students. When distance learning programs started to appear in the early 20th century under the more commonly known name at that time, correspondence courses, their major purpose was to serve the population who could not afford to have higher education otherwise, such as geographically remote students. The primary communication mode between an instructor and students was regular mail.

In the early 1970s, as television became the common household media, some distance learning programs which started to utilize this telecommunications media. However, television is an expensive medium for production and distribution and in order to recoup such cost, those distance learning programs, which utilized television for instructional delivery, followed the model of mass education utilizing satellite broadcasting or cable television. In such a model, instructional delivery tended to be one-way (i.e., from an instructor to students) and interactivity between the instructor and students or among the students was limited.

In 1980s, the prevalence of VTR made it possible to utilize asynchronous mode of instructional delivery via television, which provided students with flexibility in time in addition to place. But, the model of instruction still tended to be unidirectional, leaving few opportunities for a student to interact with the instructor or other students.

Today's sophisticated interactive communications technologies allow distance educators and learners to go beyond this transmission model of instructional delivery, allowing a high degree of interactivity between a teacher and students and among students at a reasonable cost. The interactivity is defined in the educational context as "..a process whereby students are systematically encouraged to be active participants in their own learning. It is achieved by teaching approaches that engage students in the construction of knowledge."[Center for Interactive Learning, 94]. In the context of the use of information technology in education, there are two kinds of interactivity: interactivity between a student and the material as seen in computer-based training (CBT) and interactivity among people including instructors and students as seen in computer conferencing. The latter form of interactivity is the culmination of the new mode of teaching and learning. The benefits of having more interactions in effective learning have been discussed and attested in various educational communities. As culminated by the Kenneth Bruffee's writing on peer interaction in the classroom, constructivist theorists argue that people construct their knowledge through social interaction with others.

Based on this theory of social construction of knowledge, effective distance learning programs should facilitate social interaction among students and between instructor and students. With today's technologies such as the Internet and various computer network applications, it has become easier to implement interactivity into a distance learning program. Electronic mail facilitates personal interaction between an instructor and a student and computer conferencing facilitates class-wide interaction among students without being constrained by time and distance.

With the prevalence of today's Web technology, there is a danger that the old transmission model of one-way instructional delivery will be repeated, ignoring the importance of students' interaction and leaving students autonomous and isolated. An instructor can utilize the Web to place his/her course materials for students' retrieval, but still the Web may be a primitive media for creating an interactive learning environment. In that sense, the term, web-based instruction/courses/distance education, may not be the right term yet for this emerging model of distance education delivery.

Apart from the Web, there are a number of collaborative technologies or so-called groupware, which support various degrees of interactivity. Some of them are proprietary, but the current overall trend of such technological development is the more integration with the Web. Taking advantage of the wealth of information available on the Web, such a collaborative technology is becoming a great vehicle for effective instructional delivery. However, the mere use of a collaborative technology in distance education programs may not guarantee that it will facilitate learning. Its effective incorporation into a distance learning course requires careful design and the instructor's time and efforts. The role of an instructor in this model will be more of a facilitator of learning than a presenter of a fixed body of information.

In this study authors conducted an extensive survey of current distance education programs in a variety of universities with emphasis on those with some online/Internet/Web components built in, to develop a taxonomy of current distance learning systems and to identify important dimensions that need to be considered in designing a distance learning system. The long history of distance learning programs reflects a variety of modes of distance learning programs. Still a number of programs rely on the communications mediums of one-way presentation. On the other hand, the number of distance learning programs which take advantage of more interactive communication mediums, namely computer networks and the Web is increasing dramatically. This study examined such recent phenomena and categorizes those newly emerged distance learning programs in order to provide a clear picture of higher education in cyberspace. (The listing of institutions under the following categories and matrix of technologies used by each institution can be found at http://ritdl.rit.edu/Research/higher-education.htm.)

2. Taxonomy of Higher Education Institutions in Cyberspace

Buzzwords such as virtual university, virtual college, virtual campus, online campus, electronic university, and electronic campus are being used without putting much thought, and a variety of online degrees are being offered by unaccredited institutions (see "Is the Internet Becoming a Bonanza for Diploma Mills?" *Chronicle of Higher Education*, December 19, 1997). Though the idea of providing anytime/anywhere learning environment is notable and many reputable institutions offer such alternative learning programs with quality, for a prospective student such diversity of distance learning programs is rather confusing.

After closely examining more than 80 online distance learning programs, the author came up with six different categories: online course catalogs/clearing houses, university brokerages, virtual university consortia, virtual universities, online campuses, unaccredited online campuses.

2.1. Online Course Catalogs/Clearing Houses

Online course catalogs or clearing houses catalog online and distance education courses offered by universities and colleges and create searchable database to make such information readily available to public. They are solely information sources and they don't offer any courses or degrees themselves though some of them call themselves as "university", "academy", or "campus".

2.2. University Brokerages

University brokerages are those institutions which do not have any faculty members of their own and do not offer any courses but do award degrees to those students who have taken required number of credits from specified universities and colleges. This seems to be the emerging trend of distance learning programs as two such organizations, Regent College and Western Governors University, are newly formed and have been attracting a great deal of media attention. They are mainly comprised of universities and colleges in a specific region and aim to provide students with flexibility and mobility to take courses from different institutions in the region. This form of degree offering may become popular in future once policies and academic support systems have been worked out in a wider scale.

2.3. Virtual University Consortia

Virtual university consortia are similar to university brokerages in the sense that those are the associations of multiple universities/colleges. The difference between university brokerages and virtual university consortia is that the former offer degrees of their own while the latter do not. For example, SUNY Learning Network is a good example of virtual university consortia as it is an association of eight colleges, and students can take courses from any of the eight colleges. However, the degrees are awarded only by either one of two existing colleges: SUNY Empire State College or SUNY New Paltz.

2.4. Virtual Universities

Virtual universities are identical to universities and colleges in the traditional sense as they have their own faculty members, they offer courses to their students, they provide students services, and they award degrees. The only difference between traditional universities/colleges and virtual universities is that in virtual universities students don't have to commute to the campus and physically attend classes to earn a degree. There are universities of this type catering to masses as the distance learning format allows them to expand their markets regardless of their geographical location and reach as many students as possible. An example of this type of universities is University of Phoenix. The university is a for-profit organization and claims itself to be one of the nation's largest private accredited institutions for business and management.

There is the other type of virtual universities, which can be called "niche universities". The ability to reach millions of people beyond geographical limitations allows educational institutions of a special kind to exist. Examples are: The American College of Prehospital Medicine, California College for Health Sciences, and ISIM University. This kind of virtual universities are more likely to increase in the future as the competition among different universities/colleges become fiercer and universities/colleges struggle to find a way to survive.

In addition to such distinction in terms of audiences they serve, there are two types of virtual universities in terms of their course format. Many virtual universities that rooted in traditional correspondence schools do not have classes; in other words, they provide no support mechanisms for students to communicate or collaborate with fellow students to ask questions or to discuss issues. The students have to study on their own in somewhat isolated environments with a little guidance from an instructor or a tutor. Though those institutions can be also called "virtual universities", as they do not have physical campuses but have faculty members, offer courses, and award degrees, those institutions should be distinguished from the other kind of virtual universities; virtual institutions that emulate traditional universities in providing class-based learning environment. The former type has an advantage; it offers true asynchronous learning experience as it usually allows open entry (meaning a student can register and start a course any time he/she wants) and it allows self-paced learning. However, without the opportunities to interact with other students, the learning experience it can provide may be somewhat limited.

2.5. Online Campuses

Online campuses are online version of traditional universities/colleges campuses. It means that those institutions in this category are universities/colleges which exist in physical campuses and have been offering courses and degrees to on-campus students. As the recent popularity of the Internet, many of such universities and colleges have started to move some portion of the courses or some part of their degree programs online. There is a wide variety of such offering, ranging from universities and colleges which utilize the Web as supplement to on-campus course offering to those offer complete certificate, associate, bachelor's master's and doctor's degree programs online. In offering those degree programs online, inevitably the institutions have to create not only the courses online but also a learning environment for students to register for classes, pay tuition, order books, seek academic advising, and search for resources.

2.6. Unaccredited Online Campuses

As mentioned previously, there are unaccredited institutions that offer courses and degrees online. As long as those institutions are clear in their goals that they don't intend to offer degrees in a traditional sense but to offer training and workshops for career development, this type of online campuses become a good supplement to higher education. However, some institutions (most notoriously Columbia State University) are not clear about their accreditation and offer degrees that may not be recognized by other institutions and organizations. Due to the ease of setting up a virtual campus in comparison to a traditional physical campus, these kind of unaccredited online campuses may proliferate. Prospective students must be wary of such "diploma mills" and should thoroughly examine the mission of the institution before enrolling and paying their tuition.

3. Elements of Online Courses

Virtual universities and online campuses usually have a nice Web interface to some or all of the following components of a university or a college: course catalog, registration, academic calendar, library, financial aid, student advising, career counseling, bookstore, and user support.

At a micro level, the components of a virtual university and an online campus are individual courses. The use of the Web and computer networks in the courses has potential to be advantageous in four ways. First, the nature of its platform independence and easy sharing of data enable collaboration among distant peers. With the computer conferencing tools, students in disparate places and in disparate times can attend virtual classrooms where thoughtful ideas and comments may be exchanged and heated discussions may be held. Second, the hypertext links allow integrating disparate sources of educational materials and disparate formats of information into one place. Connecting ideas and presenting information in different formats are easier and students will have easier access to the wealth of information. Third, the updating the information is easier on the Web and not like print-based or computer-based training materials, the information on the Web can be constantly updated and adjusted as the class progresses. Lastly, the Web, especially the next generation of HTML called XML (eXtensible Markup Language) will provide the potential to dynamically customize the content of the course materials according to the skill and knowledge level of the student. The courseware tailored to an individual learning style will make the learning experience more efficient and effective.

Each course consists of three parts: course material presentation/distribution, communication between an instructor and students or among students, and assessment of students' coursework. In distance learning, different technologies can be used for each course component.

3.1. Course Material Presentation/Distribution

The most common approach to online course is putting syllabus that will serve as the navigational tool for the content of the course. The course syllabus page usually contains the links to the lecture materials presented in the HTML format or PowerPoint format, and links to other resources. Many sites require a student to log in with his/her user ID and password so that the course materials are not available to those who have not registered for the course. Some colleges and universities provide a template for the course web page so that all the online courses in the institution have a consistent look, which may be less confusing to students.

The most technologically advanced course material presentation and distribution would be the Stanford Online project, which digitized and compressed the videos developed for Stanford Instructional Television Network (SITN) courses using VXtreme streaming video technology and then stored them on a video server, making those classes available to company-sponsored students as well as campus students in an on-demand, video-streaming environment Though it would be nice to utilize desktop videos for course material presentation and distribution, currently this is limited to a corporate environment or on-campus environment where students have access to high-speed lines directly. Another advanced course material presentation example can be found at USC ITV Distance Learning Online. It uses the RealVideo steaming video technology with the synchronized slide presentation in another frame of the web browser window.

3.2. Communication

Communication should occur between an instructor and students and among students. It can be one-to-one and can be one-to-many, and can be synchronous (i.e., real-time) or asynchronous. The authors strongly believe that one of the major advantages of online courses is the facilitation of interaction between an instructor and students and the high level of student involvement in their learning. As this component of online course is rather intangible compared with the presentation aspect of online courses, it is often overlooked or underestimated in implementation of online courses. The key to a successful online course is the creation of virtual microculture [Aoki, 95]. Virtual microculture is a unique group dynamics, which arises as a result of frequent interaction and collaboration toward a common goal.

There are a number of tools which are designed to facilitate interaction and collaboration in an online course [Aoki, 98]. But tools are just tools; tools themselves do not create a successful online learning experience for students, but instructors who utilize those tools to moderate, direct, and facilitate online discussions. Those tools enable more thoughtful discourse, as interaction is not bounded by time.

3.3 Assessment

There is always a suspicion among educators who are just starting to put their courses online, that in online courses an instructor cannot tell the person who is taking the exam or quiz is actually the person who claims to be. In traditional distance learning programs proctored exams have been widely used as the method of assessment as in proctored exams the authentication is rather easily done by checking the student's picture I.D. Online quizzing seems to be gaining its popularity recently because of the availability of tools, which make the creation and administration of such quizzes relatively easy. However, only few courses actually utilize such online quizzing systems as a primary means of assessing a student. Instead, most online quizzing systems are used for students to self-test their learning.

The concept of competency-based assessment of learning has been implemented in some virtual universities, including Western Governor's University. The concept tried to assess an individual's skills and knowledge instead of clock hours spent in courses. The concept is noble as most learning may actually occur outside of formal educational settings. However, it is still uncertain to what extent such competency can be standardized and measured across a variety of disciplines in such a rapidly changing world. As the major focus of the Western Governor's University's mission is to develop such assessment tools, we will see how they develop the assessment tools.

4. Conclusion

As the Gutenberg's printing press made education more accessible to masses centuries ago, computers and the Internet has the potential of transforming public education into the learning opportunities for everyone at anytime in anyplace. We have started to see some of such a trend in higher education in a fairly subtle way, but still the transformation has not been realized to its full potential yet. As Jack Crawford mentioned in his article [Crawford, 95], "for the most part all we have really done is used the new technology to 'speed up' the old way of doing things rather than to reform it." This is an easy trap that many institutions may fall in as it is much easier to use technology to extend what they have been doing than fundamentally transforming the nature of institutions. The beauty of the global Internet is that it enables people to participate in professional dialogue regardless of their location, gender, social status, and national origin. Abundant resources, which were not accessible to public before, are now available on the Internet. In a way, microcomputers and the Internet can put more education into the hand of students; in other words, it can make education more student-centered. A student can now be more in charge of what, when, and where he/she learns. Along the line, higher education institutions will no longer be the center of power and control of dispensing information and knowledge, but service organizations that cater to students' needs for guidance and leadership. The higher education institutions that will thrive in the next century may not necessarily be the ones who have adopted the most advanced technologies, but the ones who have made the shift in the role of educational institutions to enable truly student-centered learning.

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Understanding and Critiquing the Electronic Text

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Abstract: This paper is an overview of our work in establishing ways in which to critique and creatively utilise the full potentials of the new electronic deliveries for education. It examines how sets of criteria can be established to ensure that each element of any interactive multimedia (IMM) presentation works both within its own terms and within the new electronic medium. In doing so it argues that while we can draw upon extant criteria for effective print, video, and sound materials, new insights are needed into how they might be applied in order to understand more fully their combination in an interactive environment. This paper considers how extant criteria can be taken be taken beyond their original application to develop new criteria appropriate to the understanding and utilisation of IMM and its modes of discourse. These new criteria recognise that effective IMM is greater than the sum of its parts and that success in its own terms is measured by the degree to which its parts combine to work together in a richer interactive environment. Without such criteria we have no benchmarks for discussion, understanding, critiquing and application of the new electronic deliveries.

1. Introduction

In our work in presenting Masterclasses in Writing, and in developing curriculum and teaching undergraduate classes for Media, electronic textuality has confronted us with challenges and possibilities. These include the development and application of the new media in practice and also an understanding of its place within a theoretical and critical framework.

We teach from a tripartite system of print (course outlines), and electronic texts (CD ROM, *Oz21: Australia's Cultural Dreaming*, [Arnold, Green and Vigo: 1998] and World Wide Web sites.) Our understanding of the intersection between theory and practice has led us to develop criteria for writing and critiquing cybertexts. This paper addresses some of the ideas behind our work and opens up the establishment of criteria for interactivity, three dimensionality and virtuality.

Clearly a new medium develops its own criteria, but there are clues embedded in our understandings of print, typography, television, film, literature, genre (and so on) upon which we can build or which we can challenge. We have placed this within a theoretical understandings provided by postmodernism.

Print has given power to authorship, authority and hence to authoritative structures like schools and universities. In simple terms, the knowledge industry began to construct itself as keepers who allowed incomers to succeed only after several hurdles had been overcome. Knowledge was something rarified, something out of the ordinary, something denied the common person and the popular culture. It was stored away and given certification in a way that storytelling, entertainment and general information were not. It underpins 'high' culture'. The Academy which allows academics to join only after they have completed doctorates is an example of this.

Film and television have been largely locked out of this dominant knowledge paradigm. They are part of 'low', or 'popular', culture which is only being acknowledged as worthy of study in this late 20th century period. They have taken the privacy of print and made it more open, more common, if you like. Perhaps they have returned the power of the personal that was once evidenced in the oral historian, the poet, the jongleur. Defenders of the knowledge-keeping paradigm have seen the input of film and, in particular, television, as a part of the 'dumbing-down' of society.

Like Neil Postman, the American critic of the low standards of 'popular culture', particularly television, they see the "openness" of the text as having an inevitable correlation of 'amusing ourselves to death':

> 'In [Amusing Ourselves to Death] I argued that American public discourse has been changed by the electronic media from serious exposition into a form of entertainment, and I concurred in the view of Aldous Huxley that in the future people might well be controlled by inflicting pleasure on them rather than pain.' [Postman:1992:51]

This fear arises from the introduction of mass media like television into people's homes. It reinforces the idea that, broadly speaking, information as knowledge is seen to reside in the authoritative textuality of print. In this context, electronic textuality is most challenging. Available as it is to a single person locked in virtual contact with unknown intimates, it invites interactivity and offers multimedia including virtuality and three dimensionality within a global discourse. The electronic text provides us with singular challenges to produce a common understanding of how to discuss or critique it.

This paper discusses how, at the same time as they are being applied and built upon, many of the criteria that we have established for print are being altered by electronic deliveries. Take, for example, the language used on email or in chatrooms: it is very much that of speech, a discourse which has been pre-empted by print since the renaissance. Yet it is speech in writing, at least for the moment, for already we have 'see-you-see me' style programs. So the discourse has no real grammatical or stylistic structure, spelling is irrelevant, upper case is rude shouting. Yet it isn't speech moderated by the directness of body language, gesture, and eye contact. It is a new form of oracy: it is virtual speech.

The formalities that have long been established in print in even personal letter writing but certainly in business discourse, are not embedded in email or chatrooms. Graffiti, despised by print textuality as destructive, has a place on graffiti boards on the internet or as invited comments on web sites. Interestingly, the greatest formality of print: ownership or authorship, is not central to electronic discourse, much of which may even be undertaken by people whose 'true' identity is not revealed, indeed, is concealed behind entirely self-constructed personalities. These 'personas' may participate in the sense of being 'lost' in a story that is common to the involvement of readers of fiction. Yet their involvement is obviously more writerly than that. In this way, they provide an excellent example of Jacques Derrida's 'readerly-writer'. This is the bringing to life of a text through the actions of the reader, not the author as owner and authority. That is, there is no authorised version.

The private persona and the public global textuality of internet discourse is more than a coming together of print, speech, and visuals. Interactivity, virtuality, three dimensionality and immediacy add a component that doesn't exist in the complex production worlds of print, film and television. Yet the criteria that we have developed for each of those singly and all of them together is a very useful starting point for a consideration of the elements of critiquing electronic discourse.

Neil Postman would challenge this idea that nothing comes from nowhere and thus that past cultural textual constructions underpin new electronic textualities:

> "...when a powerful new medium like television enters a culture, the result is not the old culture *plus* the new medium, but a new culture altogether." [Postman, 1992:66]

2. Print as a taxonomic text

Clearly, the web relies upon an understanding of textuality which is prepared to give up the dominance of one authoritative reading. The idea of a web is of interconnected sites which have gaps and interstices. A web both contains and allows movement of discourse. The gaps can be seen as having importance in themselves.

The greatest difference between print and electronic discourse is the empowerment of the reader through interactivity. That is, the reader and the writer are as one. The binary oppositions which underpin questions of authority are no longer necessary. The main player is the person using/making electronic texts. Unlike the print book, a cybertext thus far eludes capture by established genre criteria.

Flowing from its title and author, the content of a book places it firmly within an established genre system. This system has the binary opposition of fact and fiction which has been challenged by postmodernist thinkers such as Gregory Ulmer:

> "To approach knowledge from the side of not knowing what it is, from the side of one who is learning, not that of the one who already knows is a mystory. What is the experience of knowing, of coming to or arriving at an understanding, characterized as following a path or criss-crossing a field, if not a narrative experience, the experience of following a narrative?" [Ulmer, 1989:106]

and Gayatari Spivak:

> "... human textuality can be seen not only *as* world and self, *as* the representation of a world in terms of a self at play with other selves and generating this representation, but also *in* the world and self, all implicated in 'intertextuality'...such a concept of textuality does not mean a reduction of the world to linguistic texts, books, or a tradition composed of books, criticism in the narrow sense, and teaching." [Spivak, 1988:78 her emphases]

Nevertheless, it remains a dominant mode of authorising print texts. It is heavily embedded in as well as acting to underpin taxonomic systems themselves. Electronic deliveries, such as the web, as we shall see, resist such genre and taxonomic systematisation and show themselves to be most able to be understood when these are open to deconstructive readings by individual players making individual constructions of meaning and discourse.

Genre acts to provide the reader with an authoritative placement and guide to what is being read. So we know that literature claiming to be fiction is not about the factual world *per se* although it acts to reveal the interactions between people in virtual re-enactments of the real word itself. We understand that poetry presents itself on the page in a certain way and is most important in the relationship between the intellect and the emotions with the musicality of language itself. Drama in its many forms in television, the theatre and film is shown to be a way in which we can come to understand ourselves through the externalisation of acting-out story-telling. Scientific and academic writing present themselves in a specific genre based on methodologies which are established and agreed upon as important or part of the established 'rules'. This is the epistemological certainty of the academy and of science.

This sortive principle of genre has led to the major binary opposites of 'fact' and 'fiction'. Such a binary opposition inevitably leads to the valuing of one form of discourse over another, and so fact has become a more considered and important text than fiction. In this context it is instructive to consider where the law and the church reside in such a value/genre system.

3. Possibilities in electronic discourse

If we argue that this binary opposition leads to constriction rather than knowledge, as we do, then we open up the possibilities of new ways of connecting human stories. Gregory Ulmer has coined the term 'mystory' for this:

> "... the mystory does not repeat, is not reproduced, in that no two are alike. Their recognisability as a kind derives from the relationship among three levels of invention juxtaposed in the process of conducting research. Mystory itself is more a relay than a model, produced not for its own sake but as the trace of convergence of living and artificial memories." [Ulmer, 1989:171]

Once all textuality is seen as a construction, then we are no longer constricted by genre itself. The tidy criteria that this brings to our reading/writing is disrupted. As such criteria find themselves under challenge as new textualities of electronic delivery evolve, new ways of thinking about textuality are imminent and necessary. Our response to what Caputo calls the 'the post-paradigmatic diaspora' is one of understanding new dimensions of textuality and new possibilities of discourse. [Caputo, 1987]

These new ways do not fit in to the taxonomic and point-of-focus way of thinking that dominated western culture throughout the Enlightenment and which still provide benchmarks for critical thinking and cultural analysis. In discussing Lyotard, Norris says that he sees the current period as:

> "...an epoch that must witness the final irrevocable demise of all 'enlightenment' ideas and values. Historical developments have made it impossible to believe any longer in those great 'meta-narratives' of progress, freedom. And a universal truth at the end of all inquiry which once sustained the thinking of philosophers from Kant to Hegel, Marx d their successors. In the absence of such totaling narratives we must now fall back on a humbler, more pragmatic, or context-specific kind of storytelling, one that lays no claim to ultimate truth but enables us to make at least provisional sense of ourselves and our historical predicament." [Norris, 1988:77]

Clearly, in the proposition that nothing comes from nowhere, working against previous cultural constructions is as important as building upon them.

The new millenium will see not only a communications era but also a breakdown of categories and boundaries in how we think about information and knowledge. This dispersal of certainties presents challenges for those of us who critique and problematise those occurrences which are commonly perceived and accepted as most 'natural' or 'normal' in our society.

The most pressing of these challenges is the creation of a set of criteria by which we can evaluate new electronic textualities and which can provide the basis for critical interchanges about them. There is, of course, a point of paradox here. In trying to establish guidelines and critical vocabulary, we appear to be participating in the very taxonomic methodologies and epistemological certainties which we are claiming can be displaced by the new textualities with their open-ended potential for multiple navigational 'readings'.

We are proposing an alternative reading: rather than solving the paradox, we propose to determine the fruitful possibilities that might occur from working within its apparent contradictions. The recognition of evaluative criteria that we have brought to texts of differing genres in the past will enable us to build upon their strengths for flexible critical frameworks by which we address electronic deliveries. They will enable us to think and talk about cybertexts as well as to construct and participate in them.

4. Fact and fiction: binary opposites

One example of this process of criteria development is the bringing together of the ways we evaluate 'fact' and 'fiction'. Interactive multimedia relies upon an altered understanding of both of these oppositions so that they can be seen as one. There has been a great deal of thinking done in this are. Both Lyotard and Ulmer have something useful to say, and feminist theory in its many different attributes also confronts this unnecessary dichotomy. According to Lyotard:

"The complicity between political phallocracy and philosophical meta-language is made here: the activity men reserve for themselves arbitrarily as *fact* is posited legally as the *right* to decide meaning...If 'reality' lies, it follows that men in all their claims to construct meaning, to speak the Truth, are themselves only a minority in a *patchwork* where it becomes impossible to establish and validly determine any major order...we Westerners must re-work our space-time and all our logic on the basis of non-centralism, non-finality, non-truth." [Lyotard, 1989:120. His emphases]

Feminist Rosemary Tong suggests:

"Whether women can, by breaking silence, by speaking and writing history overcome binary opposition, phallocentrism and logocentrism I do not know. All I do know is that we humans could do with a new conceptual start. In our desire to achieve unity, we have excluded, ostracized and alienated so-called abnormal, deviant and marginal people...as I see it, attention to difference is precisely what will help women achieve unity." [Tong, 1989, 223 - 237]

FACT:	FICTION:
• Based on research which documents the procedures followed • Sets a highly specific and clearly defined field of contention • Has a clear methodology which specifies and follows accepted guidelines and epistemologies • Is usually written in the passive tense to indicate authorial disengagement • Is not usually written in the first person so that the personality of the writer is disguised • Sets numerical and statistical statements as objective and personal storytelling as subjective • Is often supported by diagrammatic representations, graphs and spreadsheets • Claims to have stated reality with any reference to data well documented • Situates itself within a framework of academic or critical thought which is unambiguous in its "voice" or context • Is often published by scholarly publishers or arms of publishing houses • Is categorised as fact in bookshops and libraries • Replicable	• Claims to be an imaginative construction and is recognised as such by the reader • May have instructional intention but this is disguised as entertainment • Creates characters who live only on the page and within the covers of the book • Is an exercise of the imagination and clearly indicates the writer's engagement • Provides an escape from the real world into another space • Is intended for relaxation and pleasure with use of "objective" text relegated to dramatic device • Is categorised in libraries and bookshelves as non-academic, non-real • Contains constructed dialogue which is not a record of real speech • Written in a variety of tenses depending upon the 'voice' that is being 'read": authorial, point-of-view of character/s; commentary by character/s; dialogue • Has no methodology or epistemology stated or sited unless used as dramatic device • Is categorised as fiction in bookshops and libraries • Singular (non-replicable)

Table 1: Fact and fiction: binary opposites

Much postmodernist and feminist thought has acted to enquire into the disinterestedness claimed by 'fact' and to propose that it occurs in an environment which is really a certain kind of storytelling. If we drop the binary labels of fact and fiction and accept the idea that they are all constructions: all a form of storytelling, then we can apply the criteria we have developed to critique both fact and fiction to the new electronic textualities. We can fruitfully follow Spivak's idea that 'the world actually writes itself with the many-leveled, unfixable intricacy and openness of a work of fiction' [Spivak, 1989:95]

In doing so we can move beyond the past implied by the 'postmodernist' label into the electronic future and explore where postmodernist deconstruction might lead us in the IMMaterial world.

5. Conclusion

This paper has conveyed something of the critical, practical, creative and theoretical journey we have made in creating, using and understanding interactive multimedia. It indicates the rich field to be mined when we understand and critique the new electronic text of interactive multimedia and develop its particularities in such areas as: Characterisation; The creation and Manipulation of images; Interactivity; Argument; Connectivity; Discourse; Dialogue; Representations of reality; audio-visuals print graphics online; Audio-visuals; Design concepts; and The plot, the story, scenarios.

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Internet-R@dio

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Abstract: The „Valckenburgschule Ulm" is a vocational school with the profiles nutrition, social management, health and nursing care. There are about 1260 pupils and over 110 teachers. Since June 1996 it is possible to connect to the Internet from 55 workstations via proxy server, router and ISDN. Internet-R@dio teams are designing short radio programs based on teaching units, which are also interesting for the public.They are using online services and especially the Internet for their investigations. The Internet is also delivering acoustic information that could be cut into the programs.The young radio journalists are editing their material in a fully digital environment. The short programs are transmitted by „Radio Free FM", a noncommercial radio station in the area of Ulm. In any case the programs are not lost, they are preserved as texts, pictures and sounds on a web server. The audio files can be heard worldwide over Internet. Other schools, radio stations and interested people can use the programs for lessons or information.

1. The Basic Idea

Valckenburgschule Ulm has repeatedly produced and broadcasted programmes with various topics with the help of the non-commercial station *Radio Free FM.* As a vocational school the Valckenburgschule has different sections like dietetics, agriculture, health and care. Therefore as an example the subject "dietetics in combination with ecology" was introduced in a programme together with a discussion between the pupils from the dietetics section of the school and farmers of the region.

A fundamental disadvantage of the medium radio is, that on one frequency you can only obtain one bit of information at a certain place and time. The question is therefore, how these programmes can be made available in an acoustic form to other schools, groups, radio stations and stations run by citizens.

The solution is Internet Radio! The internet has the possibility to offer or retrieve acoustic information (speech, music, and sounds) besides the worldwide exchange of texts, images, and programmes. As a consequence two disadvantages of radio transmission do not apply, which are the binding to a certain time and the local limitation as audibility is concerned. The key word is "Audio on demand".

Moreover one can use the permanently rising number of existing audiofiles (e.g. internet-talk-radio) both to enrich classroom teaching and to produce specific programmes. This simultaneously means that the listeners of stations like *Radio Free FM* can obtain information from the internet, although they themselves do not have access to these on-line services. Of course these on-line services should be used as an aid as programming is concerned. E-mail and news can additionally be included to ask experts or persons involved in something or to let them state their opinion.

The project "Internet R@dio" therefore decisively enriches teaching and it enlarges the opportunities of non-commercial broadcasting by using the internet and vice versa.

2. The Aims of the Project

Integrating of: Teaching - internet - radio broadcasting.

Inter-disciplinary debate about topics that are both relevant for teaching and public interest.

Creating both transparency and public interest for subjects within the local community.

Usage of the medium "on-line services" in classroom so that pupils can work out certain topics.

Research via on-line services to prepare radio programmes.

Retrieving audio information from the internet and integrating it into one`s own programmes.

Digital production of programmes together with *Radio Free FM* about topics derived from school and topics of general interest.

Putting these programmes and interviews in a compressed acoustic form in the internet, so that other schools, educational institutions, and radio stations can retrieve them.

Working out newsflashes in texts and images about existing programmes, so that schools and educational institutions can retrieve them.

3. The Technical Requirements

Pentium PC running with windows, additionally a large and quick hard disk;
ISDN-connection, ISDN-card or network card and router;
Internet Access and clients for www, Archie, FTP, e-mail, news, IRC;
Right to write on a www-server;
Portable and stationary DAT-recorder with optical I/O and microphone;
CD-player with optical I/O;
Digital audio interface with optical I/O;
Active speakers;
Editing software;
Software to compress audio data;
Different audio player;
Web-publishing-tools.

4. The Form of Organization

As the Valckenburgschule in Ulm has only one digital editing station and digital audio tape it is not possible to do the complete production of a programme related to the school subjects with a whole class. It is, however, desirable that the research is done in certain subjects or in data processing.

Especially interested pupils, after having had a discussion with the class and the teacher, then form a project group, to deal with the results of the research in order to get a high-quality programme.

5. Necessary Skills to take part in such a Project

It cannot be expected that all pupils have the same amount of skills and knowledge at the beginning of such a project. The work for such a programme is based on the division of labour, as it is done in broadcasting as well. It is very important, though, that the pupils can follow each single step concerning the production, even if they do not master these steps.

These steps are:

Secure handling of on-line services;
Professional handling of recorder and microphone;
Writing texts for broadcasting;
Good intonation and being able to give the gist of a text;
Handling of the editing place;
Realizing the crucial and irrelevant contents of statements and interviews;
Feeling for rhythm of speech concerning editing;
Being able to produce HTML-pages with a suitable programme;
Handling of a scanner and image editor;

6. Execution of a Project

6.1 Planning

At the beginning the topic of the project, suggested by pupils or teachers, has to be checked out concerning the following criteria:

Relevance as the curriculum is concerned;
Public interest;
Suitability as a radio programme;
The topic must be intelligible to everybody within 10 minutes;
Suitability to use it in a classroom.

One of the suggested topics was "genetically altered food".

The first criterion "relevance as the curriculum is concerned" is given, as the topic "novel food" is included in the subject "dietetics in combination with ecology" at "Ernährungswissenschaftlichem Gymnasium" (Grammar school with profile dietetics). Moreover there are links to other curricula in biology, politics, social studies and other subjects (Topics: genetic engineering, consumer protection, European law, law). And in general there is public interest.

It is soemhow more difficult when one looks at "suitability as a radio programme". First a rough concept has to be worked out with the pupils. That means one has to think about vital aspects of the topic, which aspects can be put in an acoustic form and which aspects cannot. It is also desirable to have an interesting or emotionally attractive starter for the programme. With regard to the existing case the group used a short newspaper article, which said that Switzerland would withdraw 500 tons of chocolate from the market, because the chocolate contained genetically altered soya. This chocolate was falsely declared. With the help of this article one could easily limit the project to "genetically altered soya beans".

In most cases a limitation on one special aspect of a topic is no problem and very often desirable. Especially when you think about using it in class: First of all it is very difficult for pupils to listen for a longer period and secondly the programme should help to discuss the topic more intensively in class (e.g. questions asked by the teacher:“Which aspects were covered?“, “Which other aspects are additionally important“?, “What correlations exist?“ etc. ...)

Whether the final two criteria can be a fulfilled can only be said after the production of the programme. They must be regarded as a guide line while the project is in progress.

6.2 Research

Once the topic is fixed and limited the necessary research has to be done, first of all with the help of the www-service in the internet. In the existing case the following search strategy was suitable (in Alta Vista Advanced Search): “Genmanipulation“ (gene manipulation) and “Sojabohne“ (soya bean) and “Deutschland“ (Germany). It is advisalbe to write a short summary about the data that were found, especially in view of a later presentation.

The planning of the programme can now be specified with the help of the data. A list of the facts and statements collected beforehand shows the focus the programme covers: Pros and cons of genetically altered food, consumer rights, pros and cons of food-labelling.

6.3 Interviews and Statements

It is vital for a good broadcast that the persons affected, experts and perhaps also politicians get a chance to speak. A survey carried out in the streets can support acousticly statistic data that were found. At first glance this seems to be fairly easy, there are, however, traps as the interviewing technique is concerned: So yes-no questions should be avoided as in extreme cases you get very short responses to a reporter’s flood of words. Questions beginning with who, what, why, where etc. are more suitable. Even here you have to be careful, if you want to avoid unnecessary difficulties while editing. The answers to the question “Why do you do your own yoghurt?“ all began with “Because I can ...“ and this blocks the possibility to replace the question by a presentation. Moreover it is important to ask the interviewee to answer in complete sentences. As an example one could mention: “I am against the manipulation of genes in food, because ...“. Once you have informed the interviewee you get the answers in the expected form. In general it is better to ask for the willingness to take part in an interview, when the recorder is turned off. This avoids unpleasant situations.

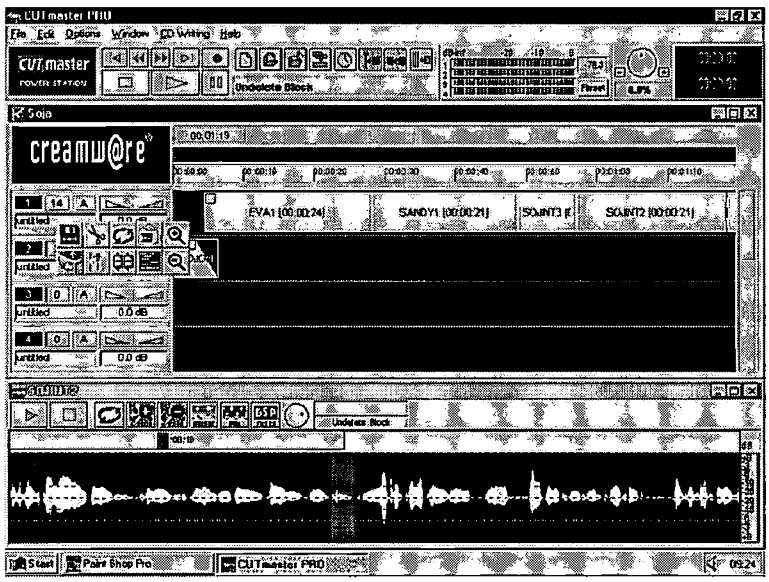
To get an expert`s view requires a lot of preliminary work. The first barrier one has to clear is to establish the necessary contacts. E-mail is certainly one way, as it is embedded anyway in working with on-line services. In our case telephoning was finally easier and more reliable, although the costs were considerably higher. The greatest difficulty was, of course, to find an expert who was in favour of gene manipulation concerning food. Instead of interviewing the experts they were asked to present their point of view within 90 seconds, so that it was generally intelligible. Of course they were informed about the structure of the programme.

6.4 Retrieval of Audio Documents from the Internet

It was a surprise for the pupils that the opinion of a politician (here: Minister Rüttgers) about gene manipulated food labelling was in the internet as an audiofile. Although the sound quality was not very good - due to the Sun-audio-format being out of date - it was still used because the minister mentioned his opinion very briefly and detailed. Unfortunately audiofiles that are useful are rare in the internet. There are only various audiofiles to topics that are related to space (“The spacedoor“).

6.5 Editing of the Interviews and Statements

One listens to all the interviews and statements, once they have been recorded, and then they are transferred from the DAT - recorder via the digital audio-interface-card to the hard disk. The single takes are edited with a suitable programme. The handling of the editing software is very easy, when you only use simple operations like, editing, adjusting the volume, arranging the takes, and simple fadings (e.g. with CUTmaster PRO). One does not need more for the production of a programme consisting only of words. It is to emphasize that each cut and editing can be reversed any time, as the actual audiofile is not dealt with. All the information about cuts etc. is stored in separate files. As the work was done with unexperienced pupils this proofed to be a decisive advantage in comparison with the common analogue technique where the editing was done mechanically on a tape recorder.



Picture 1: Screenshot of the audio editing program

6.6 Wrting and Working on the Presentation

The writing of the own presentation for the programme is the next step once the interviews and statements have been edited. Writing in this context does not only mean to summarize facts and to write connections to the next paragraph, writing for broadcasting has ist own rules: The sentences must be short, they should not contain foreign words, and facts and figures should be as clear as possible. Example:Instead of " ... 52 % of the interviewees were of the opinion that ..." one can easily say " ... more than half thought ...". To speak the texts on the radio requires some practice and various repetitions. Even texts the pupils have written themselves turned out to be more diffcult than expected.

6.7 Completion of the Programme and Broadcasting

Once the texts are edited the single paragraphs are put together in a reasonable way. The editing software makes it possible to arrange the takes with the help of the mouse. Adjusting the volume and if necessary the fadings complete the production. Sometimes there have to be further cuts and rearrangements in order to achieve a good programme. Finally the programme is transferred from the hard disk to the DAT and is ready to go on air.

6.8 Compressing of Audiofiles to place them in the Internet

Next to the broadcasting in the local station the main aim of the project is to supply audiofiles for the internet. Besides the production of HTML-pages, in which the audiofiles are embedded, this requires the compression of the programme with suitable software, because one minute of a monophone sound requires about 5 Mbyte storage space, when it is in CD-quality.

The most common procedure in the internet is "real audio". The audiofile can be compressed in such a form that real time broadcasting is possible. The higher the transmission rate the better the sound quality. The necessary software which is the encoder and the player can be taken from the internet.

With both slow lines and PCs there is also the possiblity to load the audiofile completely and then to decode and listen to it. As teaching is concerned this procedure is not advisable as it consumes too much time. This should only be done if you want to reuse it (e.g. in own programmes or to transfer it on a cassette for using it in rooms without PCs).

6.9 Forming of HTML Pages for Teaching

The audiofiles will be embedded in HTML-pages. Pictures of interview partners also excite interest. Especially in view of using it in classroom it is important to offer the texts presented. So it is possible not to listen to the whole programme, but to read the text and only follow the statements and interviews.

Eventually one can arrange the links going along with the topic as far as they are considered relevant for teaching.

The end of the single project is the transfer of the complete pages and audiofiles with the help of FTP to the web server.

7. Usage in teaching

Schools which want to use the finished programme in class need at least a PC and a sound card. Additionally they need a player for both "real audio" and "MPEG Layer 3". The necessary links can be found on the internet pages of "project Internet-R@dio".

If one has only a PC with sound card available the programme can be transferred via the outlet of the sound card to a cassette recorder. You should use high quality (MPEG at best) so that the programme can be heard in class. The text can be printed, if necessary, and supported by information from the link pages.

Of course it is better when all PCs in the classroom have access to the internet, a sound card, and headphones. A local proxy server is useful, if you want to listen to the audiofiles in high quality, otherwise there will be bottlenecks and therefore interferences as the transmission is concerned. If the teacher does not have this possibility he should do an intermediate storage and copy the audiofiles in a folder to which all the pupils have access.

If one can do without a supreme sound quality there should not be any problems using both an ISDN connection to the internet and "Real Audio 14.4", even if there is a simultaneous retrieval from different work stations.

8. Digital Audio Broadcasting - DAB

Radio Free FM takes part in a DAB pilot scheme with a 24-hour licence. DAB offers besides the mobile reception in CD quality, which is free from interferences, also the possiblity to transfer data services. Among other things pages can be retrieved virtually interactive. The page description language is HTML (with some limitations). So it is possible for programmes connected with educational radio to transfer additional information, key sentences, hints for literature, simple graphs or pictures. It is intended to integrate new possibilities of DAB into the project "Internet-R@dio".

Images of Proteins on Multimedia: Creation of a Language for Expressing Biological Concepts

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Abstract The electronic media is becoming the main media involved in the transfer of scientific knowledge. Several databanks collecting sequences of genomes and tridimensional structures of proteins have already been created and organised. Researchers from laboratories around the world are providing these databanks as well as, are demanding for more scientific information related to their research projects. It is tempting to offer all the scientific information which is already stocked in databanks, to the students, since now, many universities have access to these databanks. However, we must analyse if, the scientific results collected in these databanks are directly understable by students or any users who have not the basic knowledge necessary to correctly handle all the information provided by research laboratories. Also, it is important to reorganise scientific data for the unspecialists. In this perspective, I propose the elaboration of a scenario for presenting data concerning the protein study and the beginning of a specific language for expressing some biological concepts.

Introduction

The human genome project is one of the biggest research project [Chadwick 1994] that mobilises a lot of research laboratories around the world. Several genomes of various organisms have been sequenced [Fleichmann et al. 1995, Bult et al. 1996, Hudson et al. 199,5 Wilson et al. 1994, Dujon et al. 1994, Tomb et al. 1997] and a comparative analysis of the genes sequence, allows us to deduce the evolution of some enzymatic function. In the future, we expect to be able to predict the tridimensional structure of any protein, directly from their primary amino acid sequence deduced from the gene sequence.

From the genome project, the drug design project is now evolving, including researchers from biology, biochemistry, chemistry and bioinformatics fields, who will design and synthesise new drugs that are inhibitors for enzymes or in contrast better substrates for deficient enzymes. Thus, from the genome project towards the drug design project, the future seems very exciting and the field of biosensors [note] is now emerging.

In this perspective, we need to prepare students to be able to handle all the information already collected, in the huge databanks accessible on the internet. Also, in order to prepare these students who will be the future users of the scientific information, we are collecting now, several research laboratories have joined a team for realising a CD-ROM, concerning the protein study, protein structure and the drug design, to be used at university and in industry [Assairi 1995]. The development of this project stimulates the idea to create a specific language for expressing biological concepts when presenting images obtained from scientific instruments.

Description of the Project

The CD-ROM concerning the study of the enzymes involved in DNA metabolism [Assairi 1995] is composed of two kinds of documentary spaces: the main documentary spaces and the satellite rubrics "[**Fig. 1**]". The main documentary spaces concern proteins, nucleic acids, methods, instruments, biological role of the enzymes analysed, relationship between science and society, glossary, bibliography. These documentary spaces are connected altogether and several chapters located within one documentary space, are connected to a unique platform forming an arborescence "[**Fig. 2**]". On the other hand, the satellite rubrics provide the basic knowledge which is required to correctly understand the scientific information delivered on the main documentary spaces.

Proteins

DNA, RNA
Carbohydrates

Bibliography

Techniques, Methods

Glossary

Instruments

Biological Role

Science and Society

S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S...

Figure 1: Navigation inside the CD-ROM.
The main documentary spaces and S1 to S...satellite rubrics are interconnected altogether.

Enzymes

//

XTP Recognition Motifs

*Consensus amino acid sequence
A/GXXGXGKT
*Evolution of the consensus amino acid sequence
*Analysis of the topography of the XTP recognition site
***covalent [enzyme-ATP] complex
***determination of amino acids involved in the recognition of the XTP
***design of a XTP recognition site

Drug Design
Synthesis of new inhibitors specific to the XTP binding site

*Topography of the XTP binding site of the enzymes
*Analysis of inhibition of the enzymes by products
*Chemical modifications of the known inhibitors
*Synthesis of products

Organic synthesis of Peptides

Synthesis of Peptidomimetics

Figure 2: Common arborescence.
The main space concerning the enzymes is connected to several satellite rubrics such as protein motifs, drug design, drug synthesis and organic chemistry.

The interactivity will be organised by presenting questions with their specific answers to the users, in order to control the understanding of the given information "**[Fig. 3]**". The level of interactivity will be tested with the students themselves, all along the realisation of the CD-ROM.

Protein Sequence
utilities
*__amino acid function__
*aliphatic
*acidic
*basic
*aromatic
*__structure__
*alpha helix
*beta sheet
*__enzymatic function__
*amino acids involved
*proteolysis domain
*__interaction__
*with DNA
*with protein
*with nucleotides

I

II

Q

II

I

Question | Answer | Return

Figure 3: Interactivity.
Upper I and II icon: fast and slow backward, lower I or II icon: fast and slow forward; Q: question for testing the understanding concerning the information presented on the computer screen.

Several research laboratories as well as teachers from universities, are involved in this project. Several european languages as well as chinese will be used and an english glossary will be established since the english is the main language used by the science community.
Thus, from research laboratories, scientific results will be treated for delivery towards universities and industry. Also all researchers will be involved in this diffusion of scientific results in such a way that the results will be understable by other users than researchers themselves.

Images Are the Main Source of Information Used on Multimedia

The CD-ROM which is presented in this article, deals with the structure of protein and the drug design. Also, images of proteins will be the main mode of expression for transferring scientific information.
Crystallographic pictures will be presented to the users and software for molecule modelling will be installed on the CD-ROM, for giving the opportunity, to the users, to exercice themselves [Sybyl].
However, the main objective is to teach the user, to be able to deduce judicious structures for the drug design and furthermore for the drug synthesis. Also, it is important that the user correctly understands the images of proteins which are presented on the computer screen. Indeed, the user has to discover by himself what is the most important on the structure for the function of the enzyme. However, he does not know enough basic knowledge, to correctly deduce the right conclusions by himself. In this case, a very high level of scientific information will lead to a complete misunderstanding.
Although it is important to prepare student by using a high level material (scientific results obtained directly from research laboratories), it is important to think about the way, these high level of scientific results, are delivered to the users. When the images are stocked in the databanks and delivered on the internet, any user can access to unmodified images provided by research laboratories and delivered by scientific instruments. But on the CD-ROM, where images can be reorganised, it is possible to elaborate a judicious scenario with modified images.

Scenario for Presenting Images of Proteins

The main objective is to teach the user's eye giving thus, the ability to deduce upon the structure of the active site of a peculiar enzyme, the best potent inhibitors of activity or on the contrary, a better substrate for some deficient enzyme.
In this perspective, a scenario has been elaborated [Assairi 1996]. It is composed of several sequences of images connected altogether "[**Fig. 4**]". Thus, a sequence of several views of a specific protein will be

organised in a unique way. Of course, the organisation of the views, to be shown must be decided by the experts on the proteins analysed because they know what details which are figuring on the image, should lead to a misinterpretation. A second sequence of images showing several views of an homologous protein to the first protein, presented will be connected to the first sequence. Again, this sequence of images will be visited in a unique way. Then several other sequences organised as above and showing other related proteins or non related proteins but sharing some biochemical properties will be connected to the previous sequences of images.

protein B protein B protein B protein B	protein A protein A protein A protein A
protein C proteinC protein C protein C	protein D protein D protein D protein D

Figure 4: Scenario for presenting the crystallographic images.
Several views of the same protein A are connected forming a unique sequence, several unique sequences concerning the proteins A, B, C and D are connected altogether.

Collection of Signs Used for Expressing Biological Concepts

Several concepts like *duration* of a biological mechanism, *efficiency* of an enzyme, reversibility of a chemical reaction and so on, are usually expressed when using the *text information*, but they are not mentioned when using the *image information*. These biological concepts are necessary for understanding the image of protein which is presented on the computer screen and for correctly deducing important features in order to set up the bases of new hypotheses. What is important, is to replace the picture of the protein shown on the computer screen within its biological context.

Concepts

active molecule
efficiency
inactive molecule
phosphorylated or unphosphorylated
methylated or unmethylated
acethylated or unacetylated
glycosylated or unglycosylated
intermediate of the biochemical reaction
reversibility

Signs

P or **uP**
M or **uM**
A or **uA**
Gly or **uGly**

Figure 5: First signs proposed.

Also, it is necessary to mention, at the attention of the user, whether the image presented corresponds to either the active or the inactive form of the enzyme, by using specific signs able to express some biological concepts "[**Fig. 5**]" and I propose that these signs will surround the images forming thus, a specific language "[**Fig. 6**]". This collection of signs will be increased following the advances of science and the need for expressing new biological concepts. The signs will be furthermore uniformised by the experts working in the protein field, for clarification and elaboration of a more structured language.

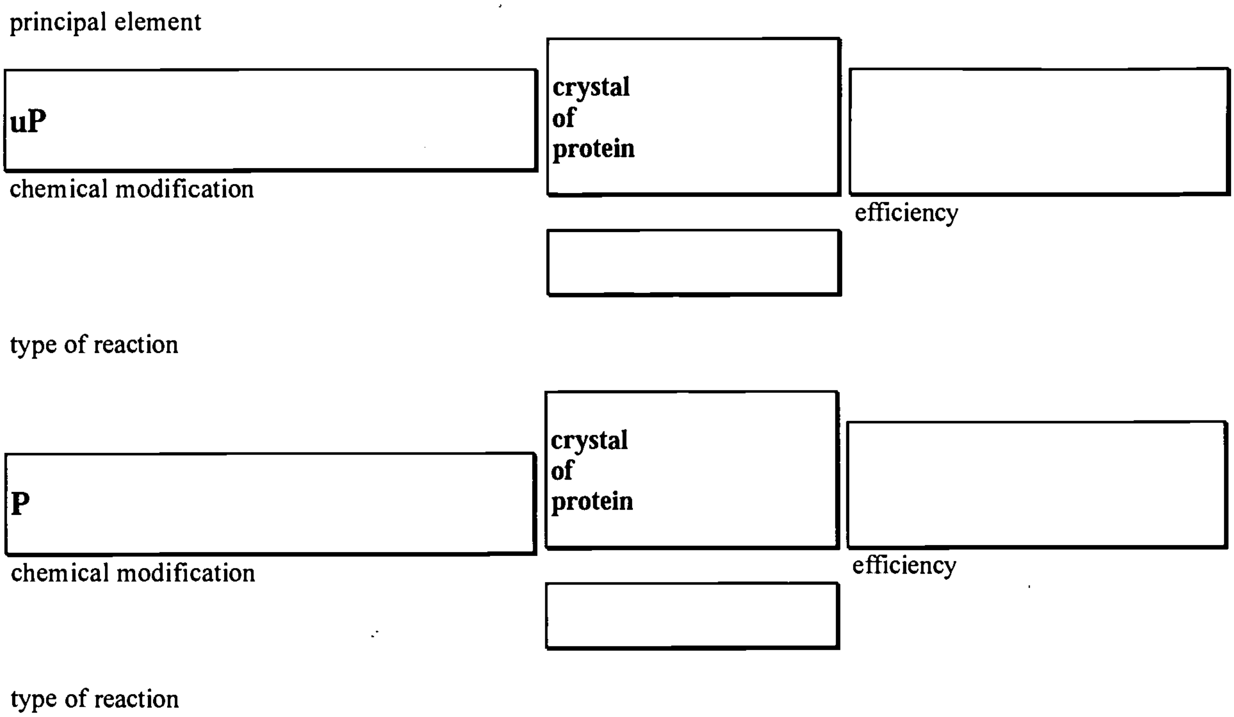

Figure 6: Crystallographic pictures surrounded by specific signs.
The unphosphorylated protein uP is inefficient although the phosphorylated protein P is efficient, the protein shown here catalyses a reversible reaction.

Conclusion

The use of new technologies is increasing for education and the transfer of knowledge. But the contents delivered by these new technologies need to be presented in such a way that the information will be correctly understood by any users.
A specific language is being created in order to present a very high quality of specific results to users like students and to allow them to be ready to handle the huge amount of scientific information collected in databanks from research laboratories. This language includes the creation of specific signs to be used for surrounding the pictures of proteins indicating their physiological state (active or inactive form).

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note: Biosensor: molecule which specifically recognises either biological receptors, proteins or other biological components and is able to be detected by an instrument.

CD-ROM: Enzymes Involved in Metabolism of DNA and Carbohydrates

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The Human genome project is mobilising a lot of research laboratories and several genomes from different organisms have been already sequenced. A lot of protein structures have been resolved, opening the field of research concerning the drug design. Students must be ready to handle all the information already stocked in databanks. The new technologies are offering opportunities to learn with efficiency and very often, the universities are already connected to the internet. In this context, several research laboratories have joined a team and have proposed a CD-ROM concerning the study of proteins, with the idea to stimulate the research field concerning the drug design.
The CD-ROM entitled "Enzymes involved in metabolism of DNA and carbohydrates" is organised in two different types of documentary spaces. The main documentary spaces concern proteins, nucleic acids, methods, instruments, biological role, science and society, glossary and bibliography and several satellite rubrics are connected altogether.

Generalized Replay of Multi-Streamed Authored Documents*

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Abstract: We report about a new open multimedia document type which can be replayed by a generalized kind of multi-stream presentation. The considered documents combine an arbitrary number of time-based media streams altogether fulfilling the prescribed requirements. We introduce the Random-Access Property as well as the Master-Slave Synchronization of media streams. The aim is a general model for an application which is able to replay any instance of the defined document type. We present a prototype and discuss our expiriences with the integration of these documents in multimedia learning and teaching environments.

1 Multi-Streamed Documents - Generation and Replay

The simultaneous presentation of several time-based data streams causes many problems. This ranges from the physical transmission of distributed streams via well-known communication channels, through exhausted system resources while decoding and replaying continuous media like audio and video, to the synchronization of the streams and their access at arbitrary given points.
The data streams discussed in this paper and if belonging to the same document presented on the same machine. The documents we consider are built of several (at least one) heterogeneous streams. Furthermore it makes no sense to present these streams simultaneously if there is no content-related correlation between them. In most cases these documents have been generated during some kind of *live* presentation, demonstration or session, where different types of media have been used in parallel, i.e. media which can be recorded online in an analog or digital way including all time-related information necessary to replay them in the same way as presented.

To give an idea of these documents, we can consider **sessions on a computer**, for example some kind of advanced training, where the instructor of the course explains the features and the handling of some new applications (e.g. a word processing tool) to the participants. In this case the voice of the instructor - this produces the first stream - and his actions performed on the desktop - this produces the second stream - are recorded. *Lotus ScreenCam* [10] is a suitable tool for such a task. During the replay the two streams are presented synchronuously in a convincing way. As far as Unix is concerned, there are some interesting experiments in recording and replaying X-Sessions [6, 7]. Drawbacks are: This kind of replay as well as the generation itself is restricted to certain window systems and platforms (e.g. ScreenCam: PC/Windows). The recording at the low level of a window system leads to huge data amounts necessary to store the documents exceeding those produced by the audio.
Another example are **MBone Sessions** [5], teleconferences where usually the voice of the different participants, their video and their whiteboard actions - each producing one data stream - are multicasted over the Internet. These streams generated at various locations can be recorded from the network with a tool called *MBone VCR* [8]. The playback is done by re-multicasting the recorded streams. But similar to ScreenCam it is not easy to navigate inside these documents, to find and to jump to the interesting sections of such recordings. Re-multicasting does not solve the problem of recording telelectures or teledemonstrations at the presentation site to generate products for local synchronized replay and offline use.
This leads directly to the last example called **Authoring On the Fly** [3, 4]. In this scenario the online lectures are multicasted and recorded at the same time on the presentation machine. The lecturer uses the well-known whiteboard *wb* from the MBone Toolset [5] or the enhanced *AOFwb* [2] especially developed for this task. Audio, that

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means the voice of the lecturer, animations running on the presentation machine and (in some special occasions) video are the additional media employed in this environment. The resulting documents meet exactly our requirements discussed in detail later on. They are always a concrete example for all those general documents and media streams considered in the following sections.
In the next section we introduce data streams and some of their characteristics as far as they are interesting to fulfill our idea of a generalized simultaneous presentation of several streams. We define what we call the *Random-Access* capability and a *Master-Slave Synchronization* of media data streams. It results in the composition of these streams to a type of multimedia document. In section three we present a general model for an application which is able to replay arbitrary instances of this document type. Finally we report about our realized prototype and the experiments we made with it during the last months.

2 Data Streams - Synchronization and Random-Access

The connection-oriented transmission of a sequence of data packets from a source component to a destination component is globally called a *Data Flow* or a **Data Stream** [11] . It is guaranteed that the packets are received in correct order. Examples are the writing to a file, the reading from an audio device, FTP or Pipes on a Unix system. All data streams considered here must be locally available and completely stored on the filesystem of the presentation machine. Thus they have to be transmitted from same kind of storage media (hard disk, CDROM, DVD, etc.) to the memory handled by the presenting application like the replay of a Quicktime movie by a common tool.

2.1 Time Dependency

Data streams containing some kind of time-related information can be called **Time-based Data Streams**. This could be any arbitrary kind of relation between a time line and the data in the stream without any rules how this should be interpreted during a presentation. It could be a function in its mathematical unterstanding from the considered space of time to the index set of the packets in the stream. A good example for this time dependency are **Media Streams** generated by same media input like audio or video devices. But also applications like whiteboards or the direct mouse and keyboard actions (desktop session recording) could be considered as input devices. All of them generate a data stream including time-related information which makes it possible to replay the streams correctly with regard to time.

To be more precise we consider a strongly monotonous increasing sequence of time stamps $(t_i)_i$ as part of the stream which divide the stream into data blocks $(b_i)_i$ called **Presentation Elements** (PE). The information in the presentation element b_i describes what should be presented during the time interval $[t_i, t_{i+1}]$ (Fig. 1). These streams are called **Synchronizable Streams**.

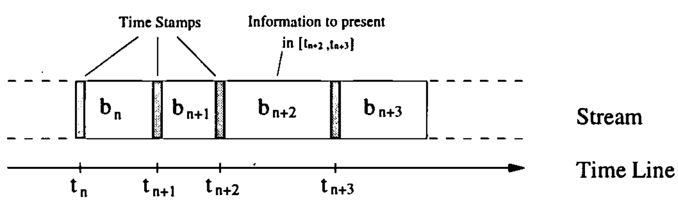

Figure 1: Time stamps and presentation elements in a data stream

Examples for PEs are single video or audio frames as well as the drawing commands for graphical elements (line, circle, text, etc.) of a whiteboard action stream. In uncompressed continuous media streams (audio/video) the sequence of time stamps is implicitly given by the frame rate and the frame size (and sometimes the number of channels). With regard to these two values it is easy to determine the sequence of time stamps and the corresponding mapping to the byte positions in the stream. But also captured desktop events (e.g. mouse clicks, keyboard input) timestamped automatically at the generation time or later on by the receiving event handler are examples for PEs in a synchronizable stream.
There is no restriction in the number of elements presented in parallel during the same time interval. This is not a problem for strongly regular media streams where each PE has the same size and parallel PEs start a the same point of time (e.g. stereo audio stream). With regard to all other cases it is necessary to allow the PEs the overlapping of

several consecutive time stamps (Fig. 2). To avoid flickering (i.e. tiny gaps in the visual or audiovisual presentation of elements) the presenting application has to ensure that PEs which overlapp a timestamp do not disappear at that point of time (e.g. usage of double buffering and clipping mechanisms during graphical output).

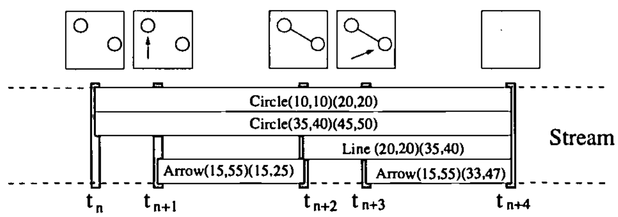

Figure 2: PEs overlapping several time stamps

ID	Object (PE)
15	Circle(10,10)(20,20)
16	Circle(35,40)(45,50)
17	Arrow(15,55)(15,25)
18	Line (20,20)(35,40)
19	Arrow(15,55)(33,47)

Object List

Time Stamp	Nr. of Objects	Object IDs
45500	2	15 16
46350	3	15 16 17
50670	3	15 16 18
51480	4	15 16 19 18
54020	0	

Event Queue

Figure 3: Approach - Event Queue and Object List

A suitable solution to realize discrete synchronizable media streams is the combination of **Object Lists** and **Event Queues**. An Object List is a numbered list including all PEs used in the considered media stream. An Event Queue is a strongly monotonous increasing list of time stamps where each entry points to a list of object identifiers. These ids corresponds to the objects (PEs) presented in parallel during this period of time (Fig. 3).
Indeed there is no restriction to the kind of objects used in these lists. This can be drawing commands as well as application control commands (e.g execute the specified animation, browse the specified HTML-page). The recording tools within *Authoring on the fly* [3, 4] generate streams of this kind to describe the whiteboard actions performed by the lecturer.

2.2 Random Accessibility

In order to facilitate the navigation and content-based orientation within a media stream we suggest a kind of *visible scrolling*, i.e. the simultaneous display of all included visual data while scrolling forward or backward along the time line. It depends on the scrolling speed and the resolution of the scroll bar how many of the PEs become visible to the user. This makes it very easy to get a quick overview of the presented contents and to locate the parts in the stream which the user wants to focus upon.
In order to enable the visible scrolling we need to provide access at any arbitrary point of time, i.e. the random accessibility of media streams. We call a media stream **random-accessible** if it is nearly free of history. This means that it should be possible to determine all corresponding PEs for any given point of time s_0 without rescanning larger earlier parts of the stream. To fulfill the given time constraints during the replay it must be possible to the to find the highest time stamp below s_0 with the following PEs in a period of time which must be under a given threshold τ. This value τ is influenced by factors as human perception (e.g. the human eye is usually not able to distinguish between more than 25 video frames/sec).
Examples for random-accessible streams are continuous media streams like uncompressed audio and video where it is easy to compute the requested frame and file position out of the frame rate and frame size. But even compressed continuous media like MPEG can be considered as random-accessible, if the distance between independent frames (e.g. I-frames in MPEG) is small enough to fit within the threshold τ. In order to decode the requested frame (e.g. P-frame or B-frame in MPEG) we mostly need only the frames between the surrounding independent frames. With some preprocessing effort (to find the byte position of the frames) and some additional amount of memory (to store the positions) it can be possible to access the requested frames directly. Streams realized through object lists and event queues as mentioned above are random-accessible by their definition. These streams do not have any history. Each entry contains the complete list of object identifiers which could be presented independently from any other event occuring before the specified point of time.
The property of random-access combined with the control of a presentation from outside the application enable the external indexing of a media stream. Hyperlinks for example (out of HTML-Pages or PDF-documents) can reference to points inside the stream. It is possible to generate an interactive index, a contents overview or combine it with corresponding articles or other related work. This way random-access facilitates the integration of media streams into multimedia learning and teaching environments or other CBT-products.

2.3 Master-Slave Synchronization

We are now in the position to define what kind of documents we consider for our approach of replay. **Documents** are a combination of several synchronizable random-accessible media streams. At least one stream must be a so called **Master Stream** and all other ones are **Slave Streams**. Master Streams are uncompressed and continuous, usually audio or video as well as combined audio/video. As introduced in the previous section all streams in a document are usually related with regard to their contents and are presented simultaneously. In order to synchronize them we use a **Master-Slave Synchronization** where the Master Stream is used instead of a global clock to synchronize the Slave Streams. The idea is to divide the Master Stream into small equal-sized blocks and to use their time stamps as points for synchronization. These start points are also time stamps of the Master Stream. Everytime when of one the blocks in the Master Stream is completely replayed we look up the corresponding time stamps in all Slave Streams to find out which sets of PEs have to be presented in parallel at the current point of time. This is possible because all Slave Streams are sychronizable and random-accessible. The real-time replay of the whole document is now given if the Master Stream is replayed synchronously to the global clock. This is usually the case with audio and sometimes it may be possible with video.
An interesting aspect in Master-Slave Synchronization is the block size in the Master Stream. If we assume, that all Slave Streams present only visual information and no audiovisual information the block size is small enough if the frequence is roughly equal to 25 time stamps/sec. But even an audio stream with the a frame rate as low as 8000 samples/sec and probably the most continuous media streams have a granularity which is fine enough for every human visual perception.

3 A General Application Model

In the following we want to describe a general model of an application that is able to replay arbitrary instances of the document type defined in section 2.3. As a realization of this application model we want to present our prototype and its integration into multimedia environments.

3.1 The Model

The application is divided into several independent *presentation modules*, one for each media stream in the considered document. All these modules are individual applications running on the presentation machine. Each module is able to read and to present its assigned stream individually. Usually the modules are developed for a certain type of media stream and cannot present other stream types. There are two connection-oriented simplex communication channels between the *Synchronizer* - the module presenting the Master Stream - and every other module (*Helper*) (Fig. 2).

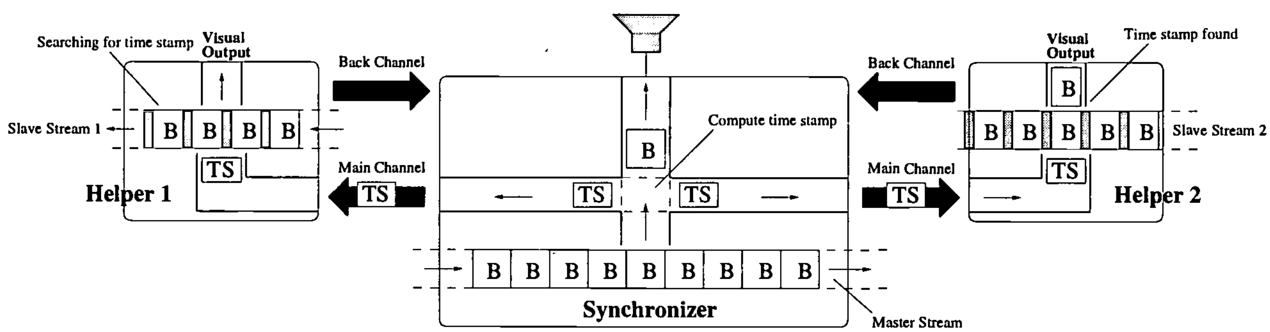

Figure 2: Simplified application workflow

The main channel in direction to the Helper is used to control the Helper and to realize the Master-Slave Synchronization. The Synchronizer is presenting the blocks of the Master Stream one after another. Everytime when one block has been presented completely (e.g. an audio block has been replayed) the corresponding time stamp is sent to each of the Helpers through the main channel. The Helper is queueing the time stamps while always processing the most recent one. Earlier time stamps are ignored. Processing a time stamp means presenting the concerned set of PEs as fast as possible. Control sequences sent through both kinds of channels are either *events* (e.g. Presentation has started, Presentation has stopped, User is scrolling, Helper exits abnormally) or *requests* (e.g. Helper: exit, Synchronizer: jump to time stamp). These control sequences are also queued on both sides and processed immediately.

There are several reasons to choose a distributed application model in contrast to a monolithic structure: Monolithic programs are difficult to develop and especially difficult to maintain. Strong dependencies between different modules increase the probability for unexpected errors. The main advantage is apparently the ease of extension: It is straightforward to add new Helpers to the application. The specification of the simple communication protocol is everything the helpers must provide, no other details of the modules especially of the Synchronizer has to be known. At the initialization stage the Synchronizer reads the document description, calls the helpers corresponding to the streams specified in the description and opens the communication channels. The call of the Helpers is identical for all of them.

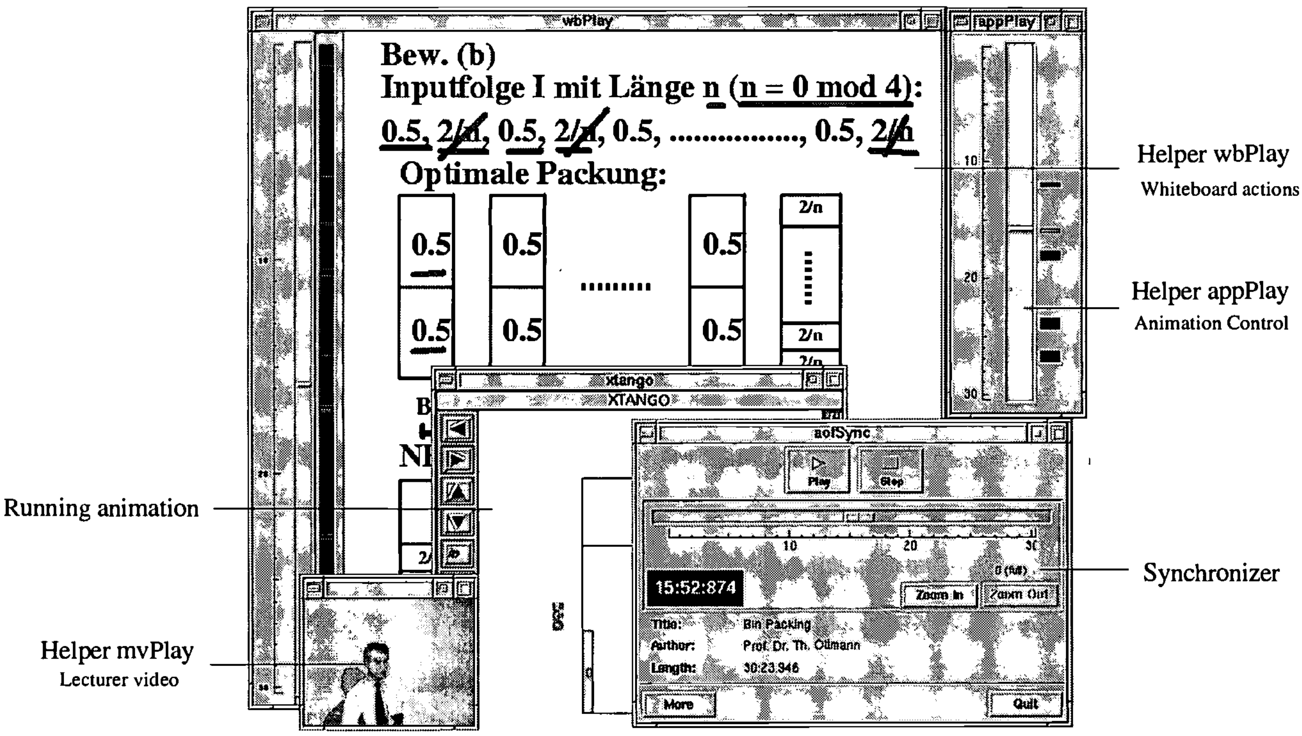

Figure 3: Screenshot of the prototype replaying a lecture on Bin Packing

3.2 The Prototype

The existing prototype is actually implemented on different unix-based platforms. The communication channels are realized through FIFOs (named pipes). The Master Stream in this prototype is always an audio stream. We have implemented three different helpers so far. One Helper is replaying the whiteboard action stream generated by the AOF recording environment [3, 4]. Helper two is presenting a stream including start- and stop commands for external applications. In most cases these applications are animations integrated into a lecture. The third helper ist a movie player replaying an arbitrary Motion JPEG video. We tested the application with several documents generated by the AOF recording environment where always the first helper is used, in most cases the second helper and sometimes the third helper (for the lecturer video) is used, depending on the considered document.

Additional features are:

- Visible scrolling is enabled.
- Control from outside: It is easy to force the application to jump to specified time stamps (e.g. via HTML-Browsers through certain hyperlinks). Thus every kind of indexing of the document is possible.
- Control via Helpers: The user can jump to start points of animations or to slide changes on the whiteboard replay.

- It is possible to add new media streams by specifying the corresponding files and the replaying helper in the document description.
- The application can be used as simple audio player (documents without slave streams).

This application is used in a new kind of multimedia book [9] just published in fall 1997 as well as in a our local learning and teaching environment where every member and every student of the department can access and replay the documents on every workstation. We provide demo packages including one document and the replaying applications for different platforms on our web-server [1].

4 Conclusion

We presented a model and its realization of an application replaying locally arbitrary instances of a general stream document type while the synchronization of streams is always guaranteed. The considered documents are a combination of several time-based synchronizable random-accessible media streams. Indeed there is no restriction neither to number of streams in the document nor to the kind of included media streams, if the specified requirements are fulfilled. For synchronization purpose we divide the streams within one document into Master Streams and Slave Streams and use one of the Master Streams to synchronize the other ones.

The defined document type covers a wide range of multimedia documents which can be replayed in this way as a high-quality presentation. It is straightforward to integrate the documents into multimedia educational environments. A central argument is the Random-Accessibility which enables the indexing of the document and the linkage with arbitrary document collections. Interactive content overviews with active links to the corresponding positions in the documents are possible as well as the combination with other content-related material (e.g articles, books, references, simulations). The availability of the replaying application for the platform PC/Windows which we are just developing together with the already available Unix versions ensures a wide area of application.

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Collaborative Meaning-Making in Computer Conferences: A Sociocultural Perspective

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Abstract: The goal of this paper is to propose a perspective on how the sociocultural approach, and in particular Cole and Engeström's model of activity, can inform the design and introduction of computer conferencing in the context of university education. It is argued that computer-conferencing systems should be seen by educators as new mediational means that become formative components of new activity systems. Conceptualizing and modeling these activity systems as complex sets of learning objects and objectives, rules, roles and tools, rather than a narrow focus on the technical aspects, is therefore the actual challenge facing the educational community.

1. Theoretical Framework

The sociocultural approach to human psychology, most notably to thinking and learning, is taking shape in the dialogue among conceptual models and research agendas related to the theoretical heritage of Vygotsky, Leont'ev and Bakhtin, to cultural psychology [Cole 1990], situated cognition [Lave & Wenger 1991] and distributed cognition. In a recent volume, Wertschand his co-authors summarized the central tenet of this approach as follows: "The goal of a sociocultural approach is to explicate the relationships between human mental functioning, on the one hand, and the cultural, institutional, and historical situations in which this functioning occurs, on the other" [Wertsch et al. 1995]. The main unit of analysis of sociocultural research is recognized to be human action. Although different exponents constitute this unit in different ways [Engeström & Cole 1997], they all seem to agree that, as an analytic category, action holds the potential of transcending the false antinomies between mind and environment, individual and society [Wertsch 1991].

Another central building block of sociocultural research is the notion of "mediating artifact" [Cole & Engeström 1993], "mediational means" [Wertsch 1991], or " cultural tools" [Wertsch 1995]. Mediational means provide the link between the concrete actions carried out by individuals or groups and the surrounding social and cultural environment. The importance of mediational means is derived from the work of Vygotsky and his followers who laid an emphasis on the formative role of tools (both material and symbolic, or "psychological" in Vygotsky's terms) on human action and thought.

Following Vygotsky's tradition, and building on Leont'ev's "activity theory" in particular, Engeström [Engeström 1987] and later Cole and Engeström [Cole & Engeström 1993] have proposed a model of human activity as a systemic formation taking into account its tool-mediated nature, its object-orientedness and its rootedness in community practice. This latter aspect makes the model applicable not only to analyzing individual behaviour, but also to activities performed by collective actors such as groups and communities.

According to Cole and Engeström's model, the central components of an activity system [Fig. 1] include the individual actor (subject), the community in which this actor is constituted and the object of activity representing its motive. The relations between subject and community are mediated by the artifacts (tools, mediational means) applied to the activity on one hand, and by this community's rules of action and interaction, on the other. The relationship between community and object of activity is specified through an elaborated division of labour - "the continuously negotiated distribution of tasks, powers and responsibilities among the participants of the activity system" [Cole & Engeström 1993]

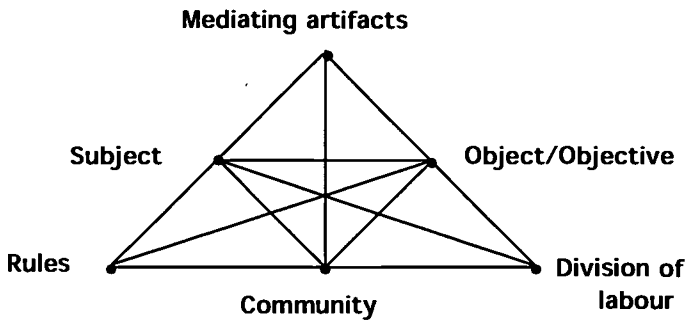

Figure 1: Cole and Engeström's activity system model [Cole & Engeström 1993]

The goal of this paper is to propose a perspective on how the sociocultural approach, and in particular Cole and Engeström's model of activity, can inform the design and introduction of computer conferencing in the context of university education. It is argued that computer-conferencing systems should be seen by educators as new mediational means that become formative components of new activity systems. Conceptualizing and modeling these activity systems as complex sets of learning objects and objectives, rules, roles and tools, rather than a narrow focus on the technical aspects, is therefore the actual challenge facing the educational community.

2. Background

This paper draws on in-depth discourse analysis of computer conferences carried out within the framework of post-secondary level courses in the fields of the social and human sciences using Virtual-U. Virtual-U (VU) is a web-based asynchronous learning environment including a computer-conferencing feature called Virtual Groups (VGroups). It was developed at Simon Fraser University, BC as one of the beacon technologies of the Canadian TeleLearning Network of Centres of Excellence.

The conference transcripts were analyzed with a view to their thematic structure, and the functional characteristics of the "speech acts" performed by participants. Proceeding in a bottom-up fashion, that is working from the empirical material towards generalizing concepts, two sets of categories corresponding respectively to the observed two main types of discursive action: "acts of meaning-making" and "interactive moves" were devised. Acts of meaning-making are speech acts aiming at interpretation of the subject matter thus making it personally meaningful to the speaker and the group. Interactive moves are speech acts in which the goal is to establish relationships between and among participants in their capacity as thinkers, group members and persons. Each utterance found in the conference transcript was classified according to the kind of meaning-constructive and/or interactive function it performed. For a detailed discussion of the coding scheme see [Bakardjieva & Harasim 1997].

The analysis described above focused on the level of actions. Actions, according to Leont'ev's model of the general structure of activity [Leont'ev 1981], are the basic components of various human activities that translate them into reality. Taken by themselves, without a reference to the activity they constitute, actions are hard to make sense of. Why the process that unfolds in front of our eyes takes the shape it does? What would be the optimal set of actions that educators would like to see performed by students in online conferences with a view to their instructional goals? Such questions posed by practitioners incorporating online conferencing in their university teaching cannot be answered by analyses restricted at the level of action. That is where we need the concept of activity and activity system in order to provide a systemic framework for the guidance of pedagogic intervention.

3. Computer Conferencing as Activity System

Computer conferences as a specific type of software and an associated chain of operations can become a part of different activity systems in the context of university education. Therefore, to make any general claims about the pedagogical uses or effects of computer conferencing would be misleading. Leont'ev maintained that the main feature that distinguishes one activity from another is its object: "After all, it is precisely an activity's object that gives it a specific direction. ... an activity's object is its real motive" [Leont'ev 1981]. Computer conferencing, when viewed as an activity is thus defined by its object. This object could be community-building and socialization, mutual help with technical or other problems, exchanging information on topics of shared interest, etc. Most typically however, the object of computer conferences representing components of university courses (taught fully online or mixed-mode) is the subject matter of the course and more specifically students' need to achieve deep understanding of the subject area. The following discussion will deal with this particular activity although, admittedly, it is not the only one that can be identified in relation to computer conferencing in the context of post-secondary education.

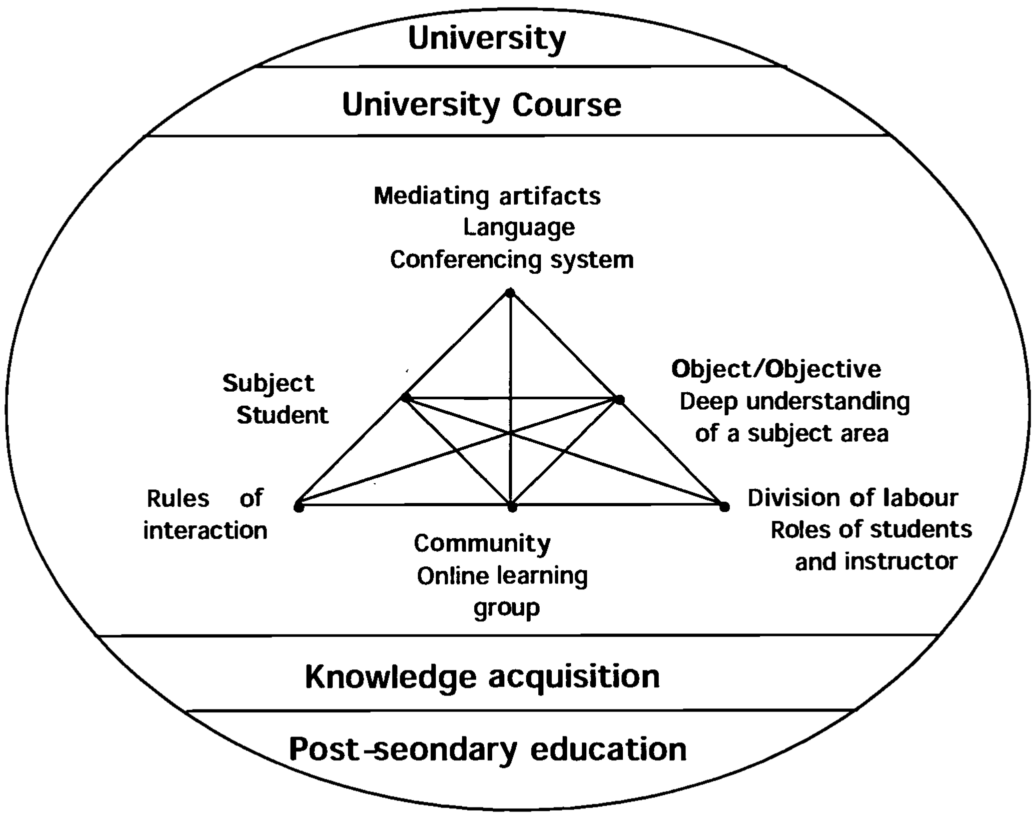

Figure 2: Educational computer conferencing as an activity system.

Figure 2 represents educational computer conferencing oriented towards deep understanding of a subject area employing the general model of activity system proposed by Cole and Engeström [Cole & Engeström 1993]. In this concrete activity system, the main components are the individual learner (student), the online learning group and the object/objective of the activity as a whole. The activity is mediated by two central mediational artifacts (or more generally, means) - language and a computer conferencing system comprised of the respective technical hardware and software. The relation between the student and the learning community is mediated by a set of rules specifying what is appropriate and recommended to do in this particular setting. The relation of the community (learning group including the instructor) to the object/objective is mediated by a set of roles constituting the structure of power and responsibility of individual members vis-à-vis the activity's object. This activity system as a whole is situated in the larger context of the particular university course and in the institutional setting of the university. These two higher level activity systems can be characterized respectively by their objects - knowledge acquisition/construction and post-secondary education.

The character of the mediational means and the object of computer conferencing as an activity system determine the general nature of actions that will translate this activity into reality, to paraphrase Leont'ev's formulation. These will be discursive actions and interactions, communicative manipulation of symbols and meanings, implemented through operations related to the conferencing interface and the computer input and output devices. The specific content of these actions and interactions however, cannot be foreseen or deducted solely from the character of the mediational means and object alone. It is also largely dependent on the content of the rules and social roles making up the whole of the activity system.

At this point, attention should be drawn to the fact that unlike other educational activities such as classroom discussions, seminars, laboratory experiments, etc., computer conferencing is a newly emergent activity system with which participants have little or no prior knowledge and experience. This means that no clear and widely accepted cultural conventions specify the action and interaction rules and roles of participants. Both instructors and students engaged in computer conferencing perform a sort of cultural experimentation with this activity bringing to bear elements belonging to other settings and eclectically combining them in a new practice. Given the institutional context and the object of the activity, what could be the cultural resources that will be drawn upon in this process of experimentation? The following are some of the factors that can be expected to influence the character of the rules and roles defining computer conferencing as far as its development represents a naturally unfolding cultural process:

Rules of action and interaction:
- University culture
- Youth culture
- Discipline culture
- Internet culture
- Medium related de-individuation

Roles played by students and instructors:
- Division of labour in the university
- University standards
- Participants' levels of competence
- Principles of evaluation

4. Creating the Activity System: A Tentative Guide

If, on the other hand, a particular instance of educational computer conferencing is to be designed reflectively as an activity system, pedagogic decisions have to be made regarding the concrete content of its various components. General institutional arrangements such as semester duration, course enrollment, instructors' work hours, nature of course material, evaluation standards and expectations, as well as pedagogical objectives have to be translated to the level of computer conferencing.

(1) *Conference object:* Conferences typically focus on either a particular discussion topic or a particular activity (socialization, research, help, etc.) Arrangements have to be made to ensure that all participants have access to the object of the conference, for example sources of information dealing with the topic of discussion.

(2) *Conference objective (or direction of transformation of conference object):* The character of the conference objective, affects the self-organization of the group, the interactions among members and the degree of closure the discussion reaches. Depending on whether any particular end product is expected, and whether it is a collective or individual responsibility, different patterns of group dynamics and meaning-making activity are observed.

(3) *Time frame:* Corresponds to object and objective. Ensures completion of object transformation, for example meaning construction and understanding.

(4) *Number and character of participants (community size and structure):* Ensures reasonable "air-time" and thus reasonable degree of involvement of participants. Determines the pre-existing cognitive and cultural resources of the community.

(5) *Participation format (rules of action and interaction):* Specifies quantity and timing of participation as well as what kinds of actions and interactions are desirable and appropriate. Reduces performance anxiety. Provides students with support in terms of goal-formation.

(6) *Roles students play:* Assigning defined roles to students ensures coordination of actions vis-à-vis activity's objective. Relations of power and responsibility become clearly recognizable. Undesirable effects could be subversion or withdrawal.

(7) *Leadership (moderation):* Ensures interaction management and control over the meaning-making processes.

(8) *Instructor's role:* Refers to how the instructor will participate in the conference, if at all: leader, coach, consultant, regular participant.

(9) *Grading:* Specifying grading criteria, i.e. how quality of participation is going to be judged, gives students an important direction for goal-formation and action.

5. Implications for Design: Responsive Mediational Means

5.1. Language

A number of linguists have argued that different "areas of human activity" [Bakhtin 1986] or "situation types" [Halliday 1978] evoke specific variations of linguistic forms. Bakhtin has introduced the notion of "speech genres". Speech genres are typical forms of utterance which "correspond to typical situations of speech communication, typical themes and, consequently, also to particular contacts between the meaning of words and actual concrete reality under certain typical circumstances [Ibid.]." Halliday [Halliday 1978], for his part, has spoken about different linguistic "registers".

A close correspondence between the determinants of a speech situation as characterized by Bakhtin and Halliday and the defining parameters of "activity systems" as described by Leont'ev and Cole and Engeström can be observed. Therefore, it follows that with the evolution of activity systems involving language as a mediational means, typical speech genres corresponding to the structure of the activity system take shape. Subsequently, participants in this activity system are guided in their discursive performance (as to what is necessary and appropriate to "do with words") by the speech genre, thus reproducing the activity in the socially prescribed way.

Indeed, the discourse analysis of computer conferences described earlier in this paper shows indications of the spontaneous emergence of a characteristic mode of discursive performance related to the activity of collaborative meaning-making in electronic educational environments. I would like to call this form of speaking *the online-learning genre*. This hypothetical speech genre seems to take an intermediate place between the "learned" discourse of the academic field (which students typically try to imitate when writing papers) and a laid-back peer discussion of issues of common interest (which would normally take place after classes or in the cafeteria).

The online-learning genre represents a mixture of scholarly propositions and argumentation on one hand and peer-interactional forms involving gestures of sharing, self-disclosure, solidarity-seeking and building, on the other. In conference entries stating their positions on problems identified in the subject matter under consideration, students also support their classmates or talk about the group interaction, or give out personal information or personal feelings. In this way the social risk of stating a position regarding matters in which students perceive themselves as novices is managed by establishing a human relationship with the peer audience.

Thus, the online learning genre can be conceptualized as a discursive "tool" specifically suited to the activity of gaining deep understanding of a subject area while working in a collaborative online group. One important question to be considered by educators employing computer conferencing, then, is what steps can be taken to further develop the online-learning genre in pedagogically desired directions on one hand, and through what means students can be taught to recognize and practice it, on the other. This last skill may prove to be as necessary to the successful participation in educational computer conferences as the mastery of the technical aspects of the conferencing system.

5.2. Conferencing System

Technological mediational means are usually developed with one set of practical purposes in mind, and later, carried over into different spheres of activity with or without sufficiently careful adaptation. Computer conferencing emerged in response to the need of groups of scientists and decision-makers to exchange information and comments at a distance. It was modeled after the format of electronic mail which presupposed an initiation-reply sequence of communicative exchange. Branching into different threads was the innovative conference feature which allowed structuring of group conversations according to topic. These two features characterize most contemporary conferencing systems including VGroups - the one our study was based on.

The conference interface as it appears in VGroups includes two central action prompts: The choice between "New Message" or "In Reply To" options offered to participants allows them to either initiate a new topic or follow up on others' contributions. The "Subject" field calls for a succinct specification of the point of the exchange. Contributions, then, can be represented on the conference overview screen as a branching tree-like structure.

With a view to the actual character of the mediated activity, two main problems can be found with this interface. First, the tree-like structure is in no way homologous to the network of interrelated meanings woven in the process of the group pursuit of understanding of the area. Secondly, the type of entry classification feature (limited to initiation or reply) reveals almost no information about the rules of action and interaction and the various participants' roles in the activity system. As a result, in the actual use of the conferencing system by students, as shown by the discourse analysis, both prompts are perceived as formal, get twisted and subverted and do not serve well the coordination of the process.

There is no easy solution to the problem of how a conference interface could be designed to inform, enable and coordinate the complex activity under consideration and represent its outcome in an adequate way. One possible approach could be the iterative introduction of various new features into the conferencing interface and their testing in the practice of online learning groups. The danger related to this approach is that given the potential of cultural tools to shape action [see Wertsch et al. 1995] educators may end up with an activity system centered on its mediating artifact rather than on its object and objective, that is a practice of educational computer conferencing structured to accommodate its mediating technology. Another way to go is to design conferencing systems on the basis of detailed models of the educational activities they are supposed to mediate. Such models would include all three hierarchical levels of the structure of activity. That means they will rest both on theoretical construction of the activity system with a view to its object/objective and main actors' relations, and on empirical studies of the actions and operations fleshing this system out.

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Virtual Classrooms in Traditional Universities: Changing Teaching Cultures Through Telematics

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Abstract: The integration of new telematics-based teaching methods in traditional universities will be an important challenge for academic institutions in the future. Telematics is the tool that can definitely change many of the methods normally used to deliver lectures. It makes the organisation of curricula and the delivery of courses more flexible. This paper deals with the evaluation of the implementation of two experiences, a web-based module that combines regular face-to-face interactions, and an international debate. The experiences are part of the project REM (Réseau d'Enseignment Multimedia), funded by the European Union (Telematics Applications Program). In this project, eleven Higher Education institutions collaborate producing course materials and teaching resources with the aim of offering international courses in virtual classroom environments. We conclude with some recommendations for future developments, especially for those situations in which participants share the same virtual classrooms.

1. Introduction

This paper describes two experiences in which traditional face-to-face and Web-based teaching methods were combined at the University of Barcelona as part of a regular course in Environmental Education for student teachers. Both experiences belong to a two-year project funded by the European Union and included in the Telematics Applications Program. This supports projects in different areas, aiming to research, develop and demonstrate innovative applications of telematics environments; one of these areas is Education and Training.

The first experience took place at the University of Barcelona with no external participants. During the first semester of the academic year 1996-97, we delivered a Web-based module in Environmental Education to a group of pre-service teachers attending the regular course at the same time. The design of the module interface included both tutor-student and pier-pier communication areas, allowing a full telematics-based delivery system.

The second experience was carried out in collaboration with the University of Bangor-Wales, the University of Illes Balears and Nottingham Trent University. Thirty-five lecturers and pre-service students took part. It involved an on-line debate about the role of teachers in environmental education. In both cases the students were assessed.

The results of the evaluation of both experiences are intended to pave the way for overcoming many problems we identified during the activities and at the end of them. This will serve to design models of collaboration and course delivery in international settings during the third year of the project.

2. Background

Over the last years, a lot of attention has been paid to studying the possibilities of using Internet as a vehicle for distance education. The communication between the actors of the teaching and learning process is an added value to the varied learning environments created around telematics support tools. Moreover, the emergent web-based learning systems allow us to envisage a very changeable panorama in course delivery.

New virtual learning environments make it possible for a course to be delivered fully through the network, thus opening the possibility of a virtual classroom. New institutions are blossoming around this powerful idea, including new distance universities generally based on Web interfaces.

How are traditional Higher Education institutions facing this new panorama? What cultural and organisational changes will these institutions face in the future? How do teachers and students take advantage of the possibility of participating in international courses using Internet? Before having a clear answer to these questions, we need to validate experiences in which all the mentioned factors are put into practice.

Since 1996, eleven universities in seven countries are involved in a project funded by the European Union. This is called REM (Réseau d'Enseignement Multimedia)[1]The main objective of this project is to create a telematics-based environment for co-operation between lecturers and students in international settings. The project, currently in its third year, aims to produce a distributed database of multimedia resources for teachers training accessible through the Web. It is also aimed at creating collaborative teaching experiences between universities across Europe, including the delivery of common courses.

So far the University of Barcelona, one of the participant universities, has created several modules in the areas of Environmental Education, Open and Distance Learning and European Learning.

The REM chapter of the University of Barcelona has already organised several collaborative experiences in this project, such as web-based course delivery, and international debates on different issues. In this paper, we analyse some of the issues arisen from the experience.

3. Evaluation Approach

As Cullen points out [Cullen et alt., 1995], focusing on innovation as the subject of evaluation implies evaluating the project in all its complexity, considering both space and time dimensions and in relation to its integration in the project, in the programme and also in organisational and social environments. It is also important to understand the nature of the innovation, not as a finished product or service, but as a process. The evaluation should be multi-faceted, contextualised and evolving and there should be a holistic approach to needs.

Following this approach, we focused the evaluation process in the study of a number of factors when planning to study the key issues related to the use of this new learning environments. These were: institutional/organisational issues, communication processes, teaching and learning processes, expectations and attitudes of participants, and technological factors.

The students and the lecturer who participated in the experiences were chosen from a "Environmental Education" regular course. The lecturer had already participated in the design of the module as subject matter expert. Students were selected on the basis of computer skills (basic use of computer programs) and their command of English. The trial itself lasted for one month and a half.

For the gathering of data, we used several methods and tools. We decided to collect relevant data, so we used both traditional and innovative tools to obtain different types of information. We used observations of pupils while they followed the module, face-to-face meetings and personal interviews. But we also followed some work sessions in which we digitally recorded the students' interactions with the Web-based material by using a program that created a file with the path students followed up throughout the module. We used a program called "Lotus ScreenCam". Since this program also allowed us to record sound, we asked the students to "think aloud" during some sessions, so as to reconstruct interactions in a reliable way.

The main and most useful source of information were the personal diaries the students sent to the tutor weekly, in which they reviewed critical aspects of their work, motivation and learning.

A thorough evaluation of the process and results was undertaken during and after the experience in order to identify, describe, analyse and critically assess the results of using a so-called "REM module" in combination with face-to-face interactions. A similar process was undertaken for evaluating the second experience, an asynchronous international debate, that we describe later.

Now that the evaluation analysis has been completed, we will move on to present some of the most relevant results.

4. First experience: Web-Based Module Delivery Combined with Face-to-Face Regular Classroom.

At the beginning of 1997, REM-Barcelona organised a "pilot course" using a Web-based interface for delivering a module which belonged to a course on Environmental Education. The course is attended by student teachers in their second year.

Learning arrangements were carried out around three main figures: the tutor, the lecturer, and the technical staff. The role of the tutor was very important. First, the tutor was in charge of the day-to-day

[1]You can find more information about this project in http://etic.doe.d5.ub.es/rem

communication, which meant answering the students' queries about the module content and organising the virtual environment. The regular lecturer received and marked the assignments, and then contacted the students to reply them. The technician was in charge of keeping the system running and solving any query from the participants related to the functioning of the system.

In order to give support to the lecturer and students on the uses of the communication tools, we also included a Web-based module called "Telematics Tools", which belonged to another REM course area. This training took place in both face-to-face and self-learning sessions. For two weeks, participants learnt how to use different telematics tools such as e-mail and distribution lists, querying databases and net search, and became familiar with the Web environment.

4.1. Institutional aspects

The University of Barcelona provided computer rooms with enough equipment for the students. Nevertheless, we found numerous management problems, something we consider to be characteristic of traditional institutions such as the UB. For instance, those responsible for the labs were reluctant to give access to the students. In addition, many technical problems arose during the experience: old communication protocols that needed to be updated, different software versions, etc. The fact that the University has a centralised maintenance service was a disadvantage for setting up the whole experience.

The Environmental Education lecturer participating in the experience showed much interest in it from the very beginning. The lecturer wanted to offer the students a different concept of learning in a new environment. The lecturer was also enthusiastic about being in contact with innovative technologies. However some problems arise, in our opinion, when putting innovations into practice, since some attitudes are difficult to change. For instance, the distance tutoring methods were not totally assumed by the lecturer, as demonstrated by the fact of sometimes giving feedback in the regular classroom instead of using e-mail. It was not a technical problem, but a "cultural" one [Fullan 1993], [Sancho 1993]. Lecturers need to become familiar not only with the new tools, but also with the flexible learning interaction processes. Such changes take time.

4.2. Communication processes

The students followed the module and other activities during a time-sharing schedule independent from the regular face-to-face one. The communication framework set up during the experience was based on e-mail and distribution lists. In addition, we included Internet Relay Chat. We then designed two main areas of communication in the virtual classroom:

- Private area. It was a space very close to the participants. There was one-to-one interaction (teacher - student and/or student - student). The communication needs of that area were covered basically by regular e-mailing.
- Public area. It was a common space that allowed participants to express their opinions in public, share their homework, etc. The communication needs of this area were covered partly with an e-mail list and partly by using World Wide Web as a vehicle to deliver course material. Internet Relay Chat (IRC) was used as a secondary tool to contact piers.

With respect to the message flow, students sent as many as 113 messages. The distribution list (public area) received 43% of them, while the Environmental Education tutor received 33%, the regular lecturer 18% and the technical staff 11%. Regarding these figures, we must make it clear that we are not including personal messages between students, since we decided to respect their privacy.

From this data, we clearly see that the level of communication was high, considering that the students had never used these tools before. Most of the messages were related to the module content. The low number of messages related to technical or institutional problems demonstrates that, although there were some problems in this respect, the communication was successful and achieved its aims. Participant students were surprised by the fact that Computer Mediated Communication tools were so effective and able to communicate not only knowledge, but also personal emotions.

We identified some gaps in the communication processes which had to be filled. First of all, students needed more practice at using tools, for the 4-hour training sessions we delivered were not enough. At the end of the experience, all these problems could be overcome. Management of the computer rooms also hindered the communication processes to some extent, for the labs were open for all university students at the same time. This meant those involved in the experience found it hard to access a computer.

More important than that was the lack of feedback by the regular lecturer. The students indicated that the face-to-face lecturer was not sending responses as often as they expected. This means the lecturer needs to play a much more active role in this setting. We also detected some problems of information overflow. The students were not used to accessing the fragment-based information in the WWW and felt stressed ("I felt sunk in an ocean of data").

4.3. Design of the materials and activities

All students pointed out that both the materials and the learning activities had been very innovative. The students showed a positive opinion about the content of the Environmental Education module, as well as about the introductory module (Tools for Communication) they completed. They were positively impressed by the possibilities of the hypermedia content organisation, including access to materials in the Web different from the ones specifically included in the pages. The selected activities achieved the learning goals and allowed reflecting on the contents in a different way than in the face-face class. The Chat, integrated as an important learning activity in the designed module, was also considered as a positive experience for students. However, the fact that no other REM universities participated (as originally planned) hindered its efficiency. Chats integrated in the activities of the module are an opportunity for communication and reflection, but they are useful with piers not belonging to the Campus.

We have detected some minor problems concerning the materials. For instance the use of video-clips caused some problems because of the poor quality of the images and the still slow delivery over the net. On the other hand, the sequences selected were not very significant for learning, given its short duration.

Students had the opportunity of printing the materials, so they did not need to read for long in the computer screen. Another problem was posed by the fact that some materials were in English, and although foreign language skills were relevant in the selection process, students had problems in reading these texts on time. This shows the need to find new ways of organising texts, such as using translated documents in all participants' languages combined with abstracts of the same documents.

There are opposed opinions regarding the organisation of materials and the scheduling of activities. While some students said that the freedom of browsing the module contents caused a waste of time, others appreciated this possibility very much. We consider this to be related to the different learning styles, but we do not have enough information at present. Therefore, this issue should be taken into account for further research.

Some participants find it hard to organise their time in flexible learning environments, since they have to combine a fixed class schedule and the flexible interactions of telematics. As a result of this, some tensions arise.

4.4. Participants' expectations and attitudes.

Participants' expectations varied depending on their roles and responsibilities. We basically analysed the expectations of students and lectures.

Fourteen students were willing to participate in the experience. Six of them were selected according to a main criterion: their command of English. Other considerations, for instance computer skills, previous experience in international projects and further activities in the Environment area were also considered. As a result of the selection procedure, we had a group of students with different skill levels and experiences. The expectations of the students were different according to their background.

The expectations were formally related to the contract the students agreed to sign up. They committed themselves to browse the course module, contact students from other Universities, learn new Internet tools, and have an e-mail account for a semester. The students could have the module recognised as part of the subject "Environmental Education", since they were formally assessed. They then stated their commitment to develop the module activities, answer two questionnaires, participate in an entry-training course, and produce a personal diary as well as a final report. At the end, the students also received a certificate of participation.

During the trial process, we took into consideration the attitudes of the students when confronted with new learning situations. We concluded that there were no negative attitudes towards the teaching methods and tools used during the experience. On the contrary, they adapted very well to the new learning environment. It is important to mention that students reacted well to the new demands of the activities proposed. They soon realised that they had a much more active role in their learning process. They increased their level of reflection [Knapp & Petersen 1993] during the course, evolving from providing mere descriptions to relating the environmental issues to social and political contexts. This was shown in the written assignments, which were qualitatively different from the oral discourse of the face-to-face classrooms. Furthermore, a new attitude appears to arise in the relationship between students and tutors/lectures: a more friendly environment emerged around the electronic mail, as demonstrated by the use of more informal language between all participants than in the regular classroom and the greater number of enquiries. Students were definitely confronted with the possibility of breaking the narrow wall of the classroom.

The expectations of the lecturer were ambiguous to some extent, and in fact close to reproducing the models of the face-to-face teaching. The lecturer did not have a clear idea of the new teaching role. This fact suggests that it is probably more difficult for lecturers to change attitudes than it is for students. Maybe the accumulated experience of a professional career hinders the understanding of new teaching methods in some way.

5. Second Experience: International debate

The second experience was an international debate with 30 participants, between students and teachers, from 4 REM universities. These were Bangor, Nottingham, Illes Balears and Barcelona. The debate, called "Environmental Education in a Distance Learning Environment: The Role of the Teacher", was also part of the module on Environmental Education.

Participants were regular lecturers of this subject in the universities mentioned, students, tutors and two secondary school teachers doing practice in Environmental Education. The local tutor of the University of Barcelona acted as moderator.

The main goal of the debate was to test an adapted version of the Lehrer model [Lehrer et al., 1994] in a telematics-based situation. The Lehrer model is an important component of REM pedagogical foundations. It organises contents in four basic steps: planning, transforming, evaluating and revising. This provides a very solid base for students, who can research a knowledge area and then discuss their findings in an organised way, by following the mentioned steps.

All participants could also access a base document for brainstorming (a sub-phase of planning stage) the discussion. This document, "Computers and the Environmental Education", was available in English and Spanish. In this case, English was the language used in the discussion.

From the technical point of view, the debate was hosted in the server of the University of Bangor and developed in a First-Class server. The role of the moderator was unobtrusive. He had to make sure that the messages were related to the topic of discussion and decided when to shift to the next step according to the model mentioned before. A Web page (http://www.doe.d5.ub.es/etic/Debate/index.html) was created for all those interested in analysing the debate process.

According to the participants, the results were highly satisfactory, although we detected a far too great influence of the Anglo-Saxon lecturers in the discussion, given that the debate was carried out in English. Too long messages hindered the discussion, since the participants did not take into account the limitations of the textual-based exchange. Local students in Barcelona and in Balearic Islands, although they were relatively fluent in this language, sent less messages that the students from the UK Universities.

The role of the moderator, who kept the discussion very open, was also an obstacle for coming to conclusions in the different stages of it. We assume now that the moderator should lead the discussion, and set clear rules of debating from the very beginning.

6. Some recommendations for the future

Despite the difficulties mentioned, we have demonstrated that the REM telematics-based collaborative teaching and learning environment is feasible, not only in our traditional universities, but in nearly all learning situations. The REM pedagogic model proved to work in a satisfactory way, for it allowed flexible course delivery and international collaboration.

With this experience, we have paved the way for REM to successfully undertake course-lecturing collaborations in Telematics environments in the future. This experience has clearly demonstrated that Computer-Mediated Communication learning tools can be used in traditional institutions, such as most of the REM universities, although improvements are necessary in many respects.

First of all, if REM deals with collaboration, we have to determine how, who, and when the collaboration takes place. During the validation, there was a feeling of disappointment, especially among the students. This was due to the fact that the promise of international participation in the course delivery was finally honoured in the breach.

It is also important to ensure the in-site institutional collaboration before launching a programme of activities, and to make sure that we will have support for solving technical and organisational problems. If we want this kind of learning system to become commonplace in traditional institutions, we need much stronger support from them, as well as a policy of innovation able to integrate experiences like that in the day-to-day teaching. We do not mean that research teams should make a greater effort to solve all the technical and management issues. The solution would be a shift in the way large institutions (based on face-to-face education) incorporate flexible teaching methods. There is a need for a new mentality. Education institutions are to consider the introduction of innovative methods and technologies as part of their policy, which means planning resources and facilitating the involvement of the regular staff.

In that respect, staff training is a key issue, not only in relation to the use of telematics tools, but first and foremost, in the implementation of flexible teaching methods. Easy access to telematics tools should be ensured in the institution, and ideally in the participants' home.

There is a clear tension between a flexible approach to the delivery of the courses and the need to have a fixed timetable. This will be much more important in future REM collaborations, especially if we also consider another added problem: the different course calendars of Universities in Europe.

Finally, language problems are also a key issue in international learning settings. At the European level, in which language diversity is seen as a cultural plus, there are not clear responses to that.

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Mental Models and their Role in Teaching and Learning

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Abstract: Mental models are cognitive structures that have an important impact on everything we do - particularly, teaching and learning. This paper discusses the basic nature of mental models and summarises some work we have been undertaking relating to a study of how multimedia and hypermedia techniques can be used to develop rich mental models. A case study is described relating to the teaching of the subject of Human-Computer Interaction. The work that has been undertaken is intended to illustrate how multimedia environments can be used to develop and enhance learning activities within different domains.

1. Introduction

As a result of their interaction with the world human beings develop internal representations of it. Such representations in the head are called mental models. One purpose of these representations is that they allow us to solve problems and use artefacts such as computer systems. The literature of mental models in psychology dates back to Craik [Craik, 1943]. Different conceptualisations of mental models have been developed and reviewed by van der Veer [van der Veer, 1990].

Given that there are many different conceptualisations, it is not surprising that unanimity about the organisation of mental models is lacking. According to Staggers and Norcio, many authors think mental models are organised structures consisting of objects and their relationships [Staggers and Norcio, 1993]. On the other hand, Redish suggests that they consist of propositions, images, rules of procedure and statements as to when and how they are used [Redish, 1994].

Wilson and Rutherford discuss the relation between mental models and other proposed types of knowledge representation in humans [Wilson and Rutherford, 1989]. From their discussion, it is possible to conclude that knowledge structures such as schemata and frames are hypothesised to represent 'background knowledge'; mental models would be the instantiation of such structures when they are used to plan actions, explain and predict external events.

In our view the study of mental models investigates the real world and its cognitive representation (both internal and external) - this is discussed in more detail in the following section. Unfortunately, neither a uniform framework nor a uniform terminology currently exist to facilitate this. Therefore, in this paper we present our own perspective for discussing mental models - building on the previous work that has been described in the literature.

It is our conjecture that all environments and experiences generate sequences of stimuli that can be used either to activate a person's existing mental models or initiate the development of new ones. The relationship between environments, experiences, stimuli and mental models is illustrated schematically in [Fig.1].

Within this diagram the importance of learning activities are twofold. First, if a model (for any given situation) does not exist then learning processes provide the mechanisms by which new models can be generated. Second, if a model exists, but it leads to incorrect behaviour then, through reflection, remediation and reconstruction processes the model(s) can be adapted and amended to take into account feedback that is derived from unsuccessful experiences. Modification of mental models therefore takes place in such a way that the next time they are used in a similar situation they will lead to correct behaviour being exhibited.

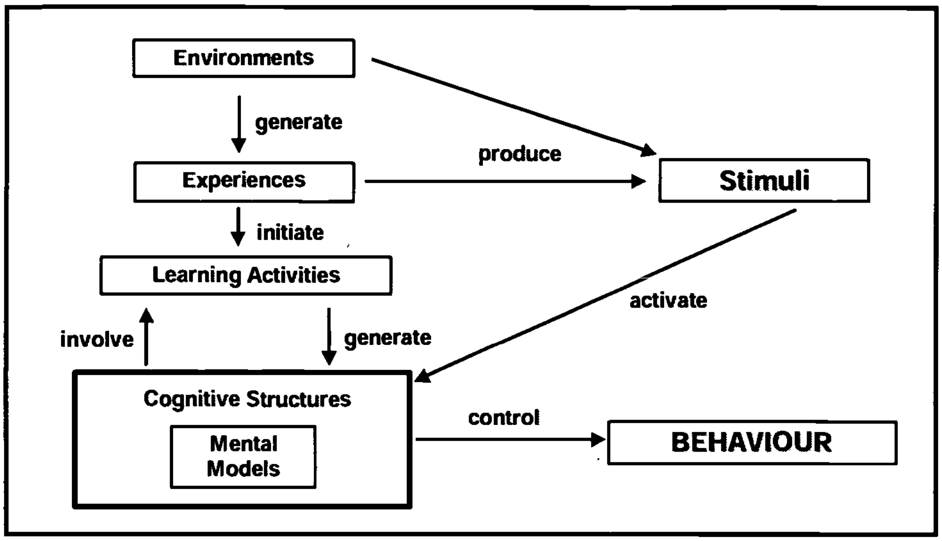

Figure 1: Overview of the learning process

As can be seen from [Fig. 1], mental models are developed as a consequence of learning activities; these may be both conscious and sub-conscious. Thus, as is illustrated in [Fig. 2], when a student reads a book, attends a lecture, performs an experiment or uses an item of CAL software, mental models are created (if they do not already exist) or are enhanced (if they do exist). Similarly, in a 1:1 (or small group) conversational situation (such as a tutor/student or a student/student dialogue), knowledge transfer similar to that indicated in [Fig. 2] occurs. The knowledge transfer that takes place is driven by the mental models owned by each of the communicating partners. Of course, the 'quality' and nature of the dialogue that occurs on any given topic will critically depend upon the richness of the mental models that each dialogue partner has. Naturally, during the course of a conversation mental models may be adapted as a result of the acquisition of new knowledge acquired through the dialogue process. In our view, the process of becoming an 'expert' in any particular discipline involves (in part) the development of rich and powerful mental models relating to that subject domain.

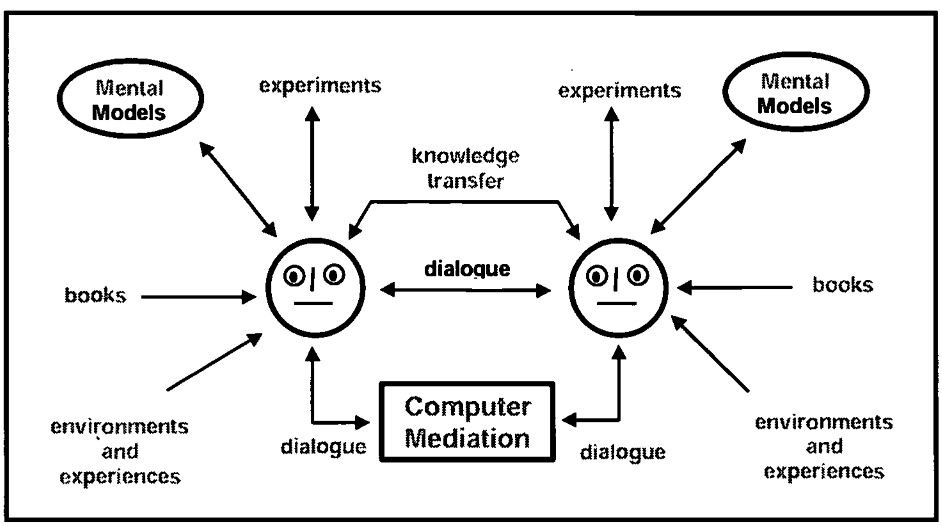

Figure 2: Development of mental models through learning activities

Mental models are an important consideration for designing resources to support teaching and learning activities. Because of their importance in the context of developing multimedia and hypermedia teaching/learning resources, the remainder of this paper discusses some of the currently available methods for their study. It outlines a case study that illustrates some of the approaches that we have employed for studying mental models within the context of teaching human-computer interaction using both a conventional approach (lectures and practicals) and by means of electronic course delivery.

2. Studying Mental Models

In the work described in the following section of this paper we have employed a range of methods to study both the declarative and the procedural knowledge embedded in mental models and to relate these models to task performance. Because of their underlying importance to research in this area, this section of the paper reviews some of the more important techniques that are currently used for studying mental models. It then outlines the framework which we have employed in order to undertake the work described in the case study that is presented in the following section.

2.1 Representation of Declarative Knowledge

There are two broad types of declarative knowledge. These are: (a) knowledge about concepts (their attributes and the inter-relationships between these); and (b) knowledge about the relations that exist between concepts. Within any given domain, (a) can be measured by asking people to identify important concepts and the meaning of these. The literature on mental models has focused on (b) and the following techniques have been used to perform measurements in this area: ratings, sorting, diagrams and laddering.

Ratings can be used to measure the network relatedness of paired concepts [Cooke and Rowe, 1998]. Participants individually rate each pair of concepts (for one or more dimensions of relatedness) on a scale ranging from slightly related to highly related. If the number of concepts exceeds 25 to 30, [Cooke, 1994] advocates the use of a ***sorting*** technique. Here participants sort concepts into 'piles' or concepts per pile and then label the piles after sorting.

Diagrams can be used to measure in a graphical way the network relatedness of concepts [Cooke and Rowe, 1998]. In this approach, participants draw diagrams of the domain being investigated (or part of it); the diagrams consist of concepts and links - reflecting the different types and strengths of relationship involved.

Laddering is a structured interview technique which can be used to measure the hierarchical relationship of concepts [Cooke and Rowe, 1998]. Participants are asked to identify certain key concepts followed by additional ones which are either subordinate to or superordinate to those initially identified. This is preferably done in the context of a problem statement in the domain being investigated.

2.2 Representation of Procedural Knowledge

In order to measure procedural knowledge the following techniques have been used: action sequences, concurrent protocols (think aloud and constructive interaction) and teach back.

Action sequences can be used to investigate the network representation of actions [Cooke and Rowe, 1998]. Here, the actions carried out by participants during task performance are recorded chronologically. These are then analysed for patterns.

Verbal ***concurrent protocols*** can be used to measure network representations of procedural knowledge. In this approach participants verbalise all of their thoughts during task performance. There are two important techniques. First, *think aloud*, which is a technique in which participants produce their verbalisations while carrying out a task individually [Cooke and Rowe, 1998]. Second, *constructive interaction*, a technique in which two participants solve a problem together [Rutherford and Wilson, 1992].

Teach back is another important technique for studying procedural knowledge [Van der Veer, 1990]. Here, after exposure to some target system, participants are asked to describe (on paper) to another person how to perform a given task using that system. In doing this, subjects use their own preferred mode or representation. These descriptions can then be scored to measure the following aspects of mental models: completeness, correctness, interaction levels and style of representation.

2.3 The Current Research

Our approach to studying mental models is depicted schematically in [Fig. 3]. In this diagram there are two important perspectives: ***reality*** (the world as it is); and ***representational space*** (the world as it is represented - for example, in books, films and computers). In our view, the study of mental models links these two perspectives together. Mental models exist in the domain of reality; their study attempts to place exteriorisations of them into representational space. The process of exteriorisation involves using the techniques described in the previous sections of this paper in order to build representations of mental models verbally, on paper or within a computer system. Exteriorisation processes are normally triggered by stimuli that are derived from various sources - for example, researchers studying mental models and conversations with others - see [Fig. 2].

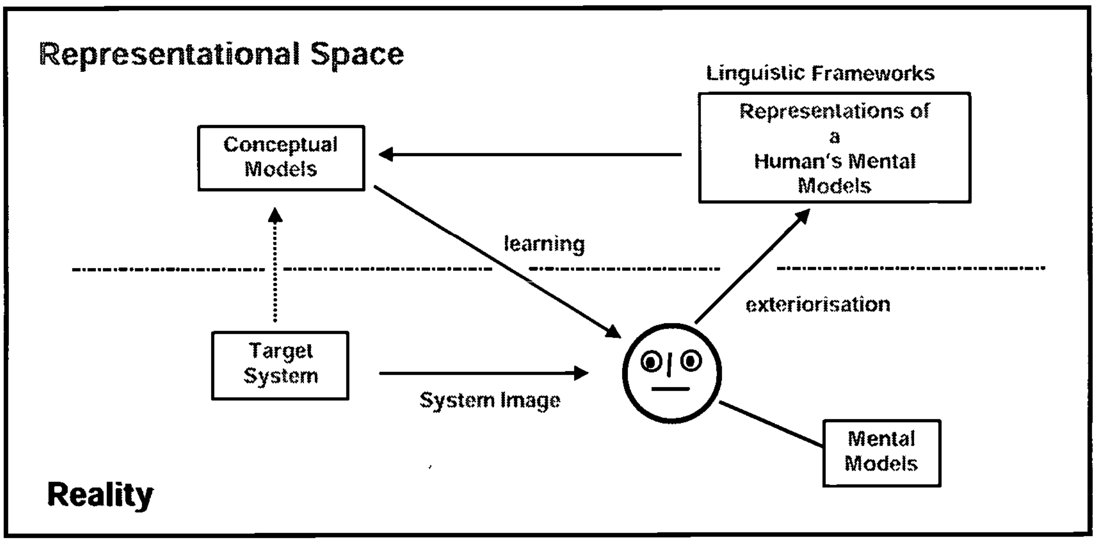

Figure 3: The representation of mental models

As well as experience with a target system (through its projected system image), users can acquire mental models through the study of existing conceptual models [Norman, 1988; Staggers and Norcio, 1993] - for example, the use of computer manuals to understand the way in which various computational processes work.

In order to capture mental models within the representational space depicted in [Fig. 3], some form of linguistic framework is needed. This may be a mathematical notation (for example, a metanotation), a language of some form or a diagram. Van der Veer, for example, uses several different 'modes of representation' in his work on teach back: visual description, visual-spatial images, use of icons, production rules and programs [Van der Veer, 1990]. The various techniques that we have used in our research are summarised in the case study that is presented in following section.

3. Case Study

The case study described in this section of the paper relates to the teaching of the subject of Human-Computer Interaction (HCI) as part of a final year modular degree course. It deals with experiments that students undertake in order to study text editing and word-processing systems.

Text editing and word-processing are probably two of the most common processes undertaken using a computer system. The study of the HCI involved in these activities is therefore of significant importance from the point of view of (1) designing end-user interfaces to editing and word-processing software, and (2) studying the mental models that users construct as a result of exposure to this type of software. Therefore, in this type of study students are usually exposed to a variety of different text editing and word-processing-systems; they are then asked to 'exteriorise' the mental models that they have acquired as a consequence of using the different systems. The software items used in our HCI course are readily available packages running within the Microsoft DOS, Windows 3.1 or UNIX environments. Typical examples of the systems employed are *edlin* and *edit* (DOS), *notepad.exe* and Microsoft's *Word for Windows* (Windows) and *vi, sed* and *awk* (UNIX system).

In order to enable us to study students' mental models (and their performance at text editing) we conducted an experiment using *Word for Windows*. Students were required to carry out two types of task. Tasks in the first category involved the use of the *Word* system while those in the second category did not. For the first category, ***action sequences*** were recorded; these enabled us to study both mental models and task performance. For the second category, a variety of other methods were used to investigate the students' mental models - ratings, sorting, laddering, diagramming and teach back. The first three of these methods were used to assess the students' knowledge of the relations between concepts. In the ***rating*** task, students had to rate the pairwise similarity of concepts. In the ***sorting*** task, students sorted domain concepts into piles and labelled these. The ***laddering*** task involved several steps. First, students were presented with either a text editing or word-processing task description. They then had to identify a sub-set of concepts (from a given list of domain concepts) that applied to the task. Subsequently, they had to identify the superordinate and subordinate concepts applying to the task. Finally, they had to identify subordinate concepts from a list that did not apply to the task. In the ***diagramming*** task students had to construct a diagram of domain concepts and their relationships; they also had to indicate the strength of each relationship. In order to study the procedural knowledge associated with the use of *Word for Windows*, two methods were used: action sequences (described above) and teach back. In the ***teach back***, students had to explain on paper (to a fellow student) how to carry out a given text editing/word-processing task.

4. Discussion and Future Work

The preliminary results from the study revealed that students formed two broad types of mental model - generic and specific. ***Generic models*** were those which applied 'across the board' to all the text-editing and word-processing systems that were used. Primarily, the generic models involved an understanding of two major concepts. First, the general principles underlying the use of text editing and word-processing systems; these involve ideas relating to the creation, storage, retrieval and maintenance of various types of electronic document. Second, an appreciation of the basic types of operation that are necessary to achieve these goals - for example, the concepts of insertion, deletion, copying, moving, searching, replacing, and so on. The ***specific models*** also involved two types of understanding. First, a detailed understanding of how a particular text-editing or word-processing system (such as *Word for Windows*) actually operates. For example, when using *Word for Windows*, the model of the editor involves a knowledge of the concepts of screen-based editing and mouse interaction. Second, an understanding of the types of operation available within a given editing system and a knowledge of the action sequences needed to achieve particular text-editing goals. Naturally, as we would predict from the GOMS model of text-editing [Card, Moran and Newell, 1983], the different action sequences used to achieve particular goals in any given system depends upon the level of expertise and experience that a particular student has gained with that system. More experienced users were found to have a wide repertoire of problem solutions for a given task (and could easily choose the most effective one in any given situation). In contrast, novice users of a given system did not show this repertoire and selectivity.

We believe that the outcomes of this research have several implications for the design and use of multimedia and hypermedia teaching resources. For example, the graphical representations of the models of text-editing and word-processing systems that we have derived could be used as a basis for the development of interactive teaching and learning facilities to support these activities. These graphical representations could be further augmented through the use of animation techniques in order to illustrate to students how particular types of operation are performed. Naturally, multimedia augmentations of this sort could be developed for all the different types of text editor described in this paper. Using this approach, we believe that it is possible to design and create highly motivating interactive learning resources which will lead to the effective and efficient creation of rich mental models - with a corresponding increase in task performance.

In our future work within this area, we intend to use the techniques described in this paper in order to investigate a variety of issues that are of major importance in the teaching and learning of the subject of human-computer interaction. For example, we are currently formulating some experiments that are intended to enable us to study the types of mental model students develop as a consequence of: (1) using web browsers; (2)

reading information from computer screens; and (3) trying to explain the relationship between various screen design parameters and end-users' behaviour. We believe that the outcomes of this research will provide us with a valuable basis for the development of multimedia and hypermedia material to support the teaching of these aspects of HCI.

5. Conclusion

Mental models are important because they are assumed to form the basis of all human behaviour. Indeed, the current study lends considerable support to the hypothesis that mental models form the basis for effective task performance: the richer a student's mental model then the better will be his/her performance. Within this paper we have outlined how mental models can be measured using a variety of techniques. Our study has reflected the importance of designing learning activities so that they create both generic and specific models of text editing and word-processing. Although the current work deals with this particular domain, we believe that this finding is applicable to many other areas.

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An Object-Oriented Model of a Computer-Enriched High School

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Abstract: Information and communication technologies offer new tools that can contribute to facilitate, enrich or help us to rethink the way teaching, learning and management activities are carried out in schools. This paper describes the work in progress of a research team at LICEF Research Center (Télé-université, Quebec, Canada) in developing an object-oriented model of a computer-enriched high school. This work is being carried out within an action-research project called *L'école informatisée Clés en main* ("The turnkey computer-enriched school").

1. Introduction

The implementation of information and communication technologies (ICT) in Quebec schools has been on-going since the 1980's. However, although several innovative instructional uses of technology have emerged, recent reports point out that Quebec schools still do not sufficiently take ICT into account [Berthelot 1994; Comité consultatif sur l'autoroute de l'information 1995; Conseil supérieur de l'éducation 1994; Conseil de la science et de la technologie 1994; Fournier & McKinnon 1994].

A variety of factors contribute to this situation, notably the lack of four elements essential to the successful integration of ICT in education: a systemic perspective; a long-term vision; consultation; and a clear school model facilitating the optimal use of ICT [Guidotti 1994]. In 1994, a research team from the LICEF Research Center (Télé-université) developed a systemic model of a computer-enriched high school as part of a project called *L'école informatisée Clés en main* ("The turnkey computer-enriched school"). The high school level was targeted because the educational use of ICT is not as widespread as at the elementary level [Bédard Hô 1994; Danvoye 1993]. The objectives of this project are to build a model of a computer-enriched high school and to develop an information technology implementation procedure that could serve as a framework for all Quebec high schools. This paper presents the work in progress regarding the model.

2. What Is a Computer-Enriched High School?

A computer-enriched high school implies more than simply the installation of cables, hardware and software. Rather, it implies a complete rethinking of the school in all its functions in light of the potential of ICT. It is not a matter of just introducing technology into the organization but rather of redefining the organization through the use of technology. This redefinition must focus on organizational processes, since a process crosses functional borders and is independent from the organizational structure [Bernier, Pinsonneault, Rivard & Blouin 1995]. Process reengineering allows us to take a new look at school processes. Process reengineering is a concept borrowed from industrial engineering and is an organizational design approach based on information technology [Aubert, Bouchard & Gingras 1995].

A school may be seen as an organization where different actors (students, teachers, non-teaching professionals, managers, parents, etc.) receive, consult, process, handle, produce and communicate information in order to accomplish various activities such as teaching, learning or managing [Rocheleau & Basque 1996].

These processes are governed by a set of principles and can be carried out with tools such as job aids, hardware and software. ICT offer new tools that can contribute to facilitate, enrich or help us to rethink the way these processes are carried out.

3. How Is the Computer-Enriched High School Model Designed?

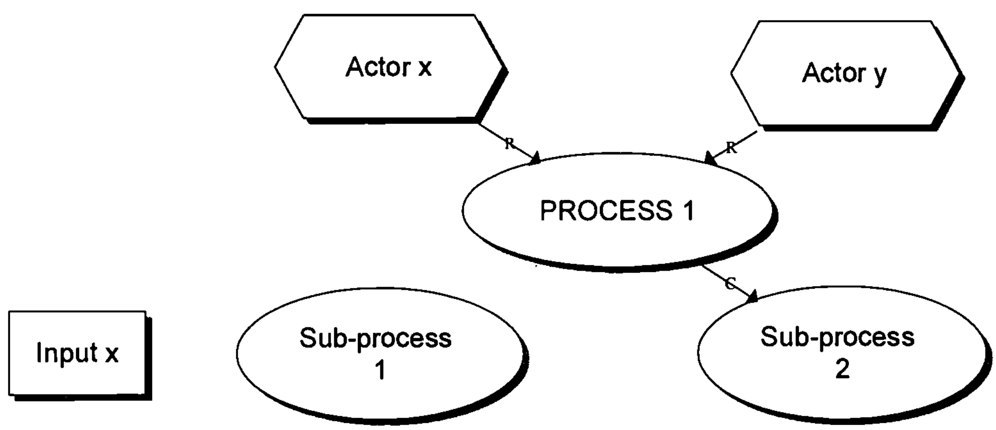
The model is designed according to the *object-oriented modeling* technique developed by the LICEF Research Center [Paquette 1996]. It uses a formalism according to which various object types are represented by specific graphic shapes, linked by arrows and a qualifier that give a meaning to each type of relation.[1]

Our model has three types of objects [see Fig. 1]:

- *Processes* (ovals). A process is a set of sub-processes and tasks that uses inputs and transforms them into products.
- *Actors* (hexagons) that are responsible for processes.
- *Inputs/products* (rectangles) include printed documents as well as hardware, software and data. Those tools are identified in a generic manner; examples of existing tools are provided so that each school may choose tools according to its specific needs and to keep pace with technological developments. Hence, it is a variable-geometry type of model.

Five types of relations may exist between objects:

- *is composed of* (C)
- *is input to/product of* (I/P)
- *precedes* (P)
- *is responsible for* (R)
- *is a sort of* (S).



The model includes four levels:

- The first level [see Fig. 2] shows the four main processes that contribute to achieving the school mission: insuring student learning. These processes are: Teaching; Learning; Managing the school; and Insuring use of multimedia resources.

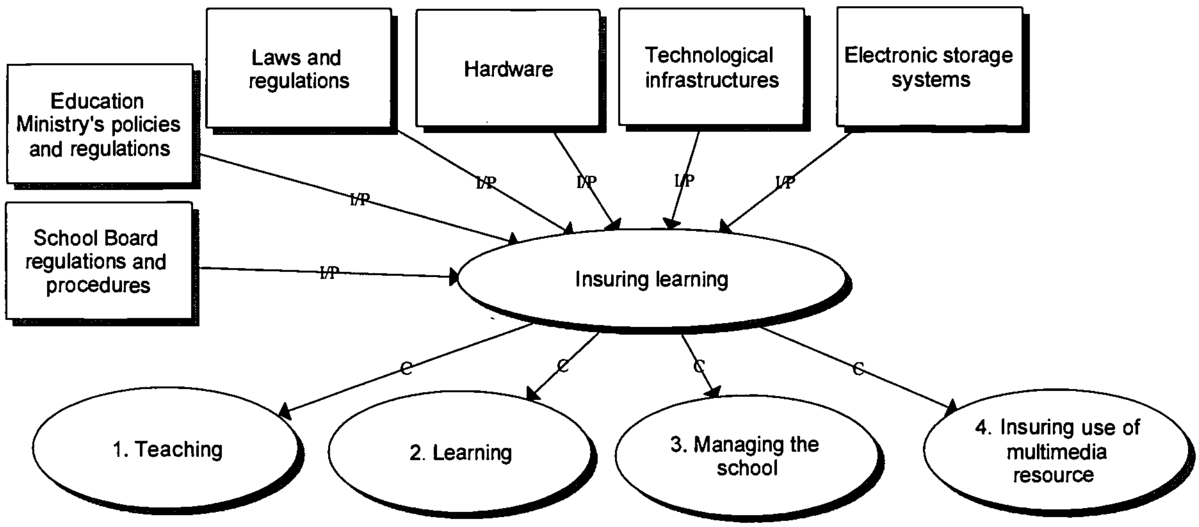


Figure 2: Processes that contribute to achieving the school mission (level 1)

- The second level [see Fig. 3] shows sub-processes that are linked to each of the four main processes. For example, the actor "Teacher" is responsible for the "Teaching" process. This process can be broken down into five sub-processes: Planning the learning environment; Organizing the learning environment; Implementing learning activities; Supervising the learning environment; and Assessing student learning.

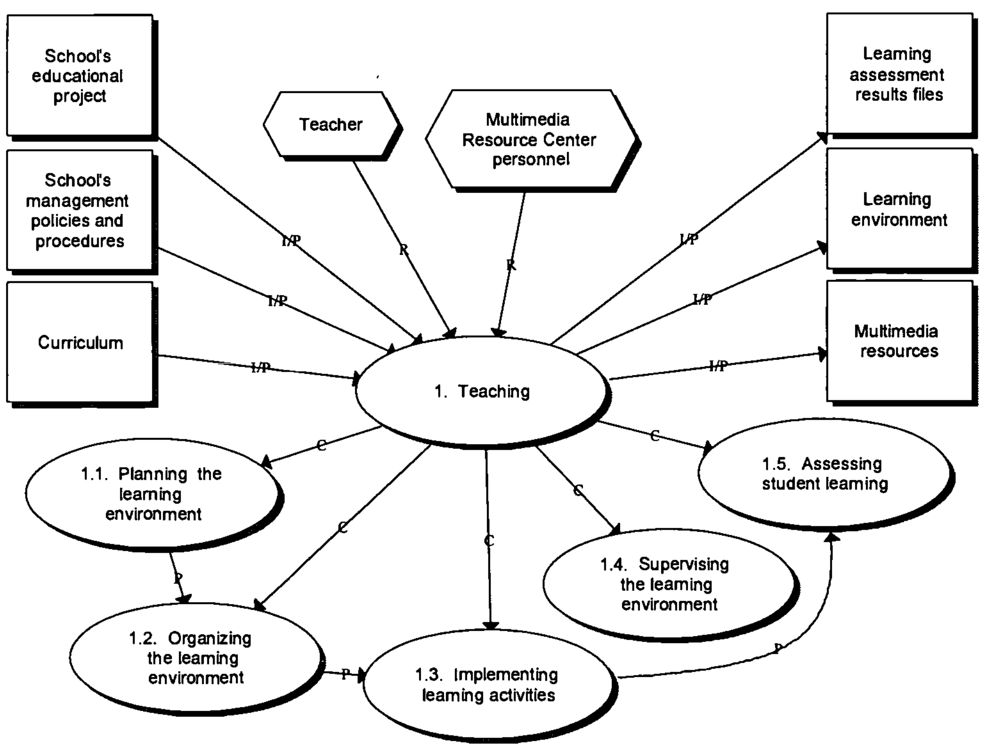


Figure 3: The "Teaching" process and its sub-processes (level 2)

- The third level [see Fig. 4] shows tasks related to each sub-process. For example, "Planning the learning environment" is broken down into four tasks: Planning learning activities; Planning instructional materials; Planning learning support infrastructures; and Planning assessment of learning.

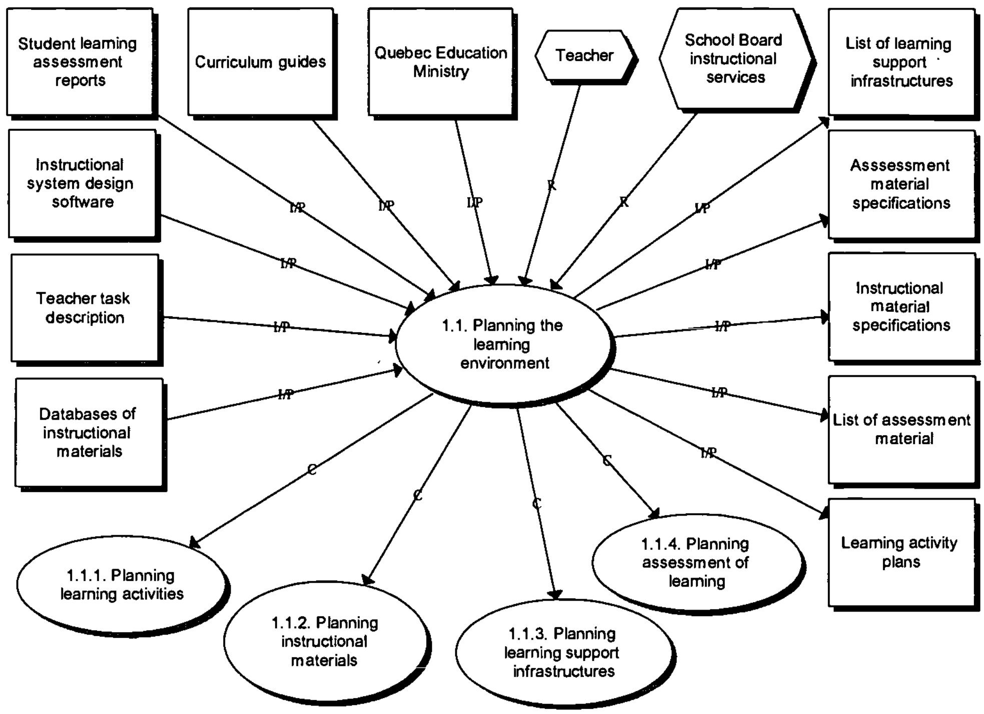


Figure 4: Tasks of the sub-process "Planning the learning environment" (level 3)

- The fourth level does not have any sub-processes. It shows only the actors and inputs/products related to each task [See figure 5 for an example].

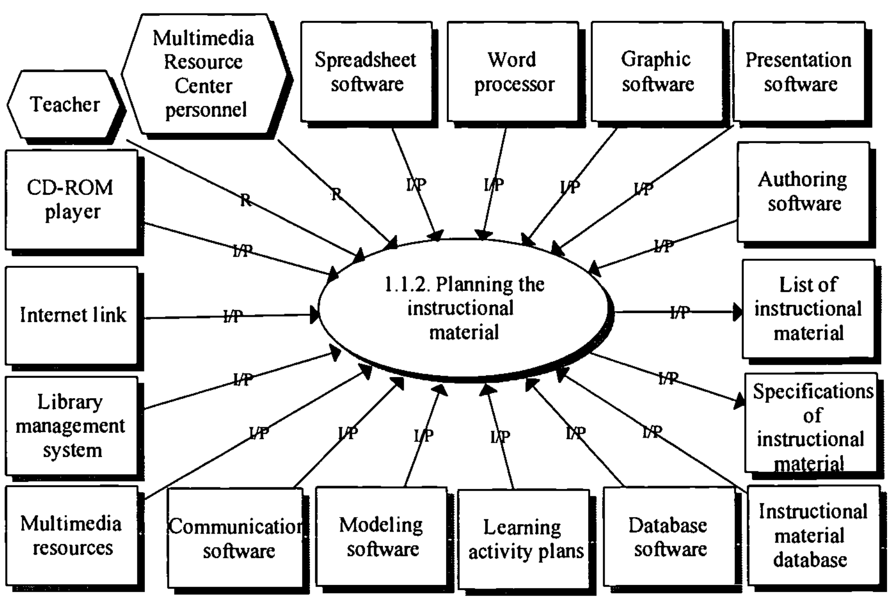


Figure 5: Actors and inputs/products related to a task (level 4)

While developing the model, computerized notecards were produced for each process. These notecards contain a definition of the process, one or several categories of actors who carry out this process, and a list of all inputs and products (including computer tools). They also provide more detailed information about principles that govern the use of computer tools within each school process. In addition, each category of tools has its own descriptive entry.

The model is based on a theoretical framework for each school process; the goal was to bring about a new vision of education through the use of technology. The main principles enunciated in the theoretical frameworks [Basque, Rocheleau & Winer 1998; Michaud & Rocheleau 1998; Rocheleau 1998] are:

- Cognitivist and constructivist learning approaches for the *Teaching* and *Learning* processes;
- Systemic management and learning organization principles for the *Managing the school* process;
- A resource-based pedagogical approach for *Insuring use of multimedia resources*.

The model and notecards are based on readings about ICT educational integration as well as from action research in two Quebec high schools. The action research project enables us to both support and observe changes as they occur in schools integrating ICT into all aspects of their activities [Basque, Rocheleau & Chomienne 1996]. This information was used to build the model.

4. Conclusion

This model does not remove the school's responsibility in making technological choices; however, it facilitates decision-making by offering a global and integrated view of various uses of technological tools, in a flexible electronic format.

The decision-makers in a school can use the model to plan short or long term ICT implementation and to pinpoint processes, sub-processes or tasks that should be given priority within the plan. They can also obtain a portrait of a particular tool's possible uses across the four processes in order to make a strategic choice among existing tools.

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Learning with the Internet
A Typology of Applications

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Abstract: Reflection on the forms and possibilities of Internet use in education does not keep pace with the speed with which access for schools is provided worldwide. For an in-depth educational discussion, we need to differentiate types of Internet applications. We will present a model that was developed for the categorization and evaluation of (stand-alone) interactive media ([Baumgartner 1995] [Baumgartner and Payr 1994 and 1996]) and that we use now to contribute to a more detailed and specific educational discussion of Internet use. After a short review of the foundations on which the model is built we will illustrate its application to the Internet, using existing sites as examples.

1. Internet as medium, Internet as tool

In order to submit the multitude of Internet services and applications (like e-mail, Telnet, FTP, Gopher, WWW, mailing-lists, newsgroups, chats, computer supported collaborative work etc.) to theoretical inspection, we have to distinguish between three basic aspects of software use, namely as
i - subject
ii - tool or
iii - medium

i) Software entered the classroom as a subject: programming languages, application software and the like. The issue was to learn the use of software and to train skills and qualifications that were deemed necessary for the labor market.

ii) Software is considered a tool (cf. [Taylor 1980]) if it is not the skilled use of an application etc. that is in itself the issue, but the use of application software to realise student projects and carry out tasks in various subjects (e.g. publication of a student newsletter or design of a database for collected data). This kind of software use is characteristically „pedagogically neutral“, that is, the design of the educational setting remains completely open. Of course, using software to do a certain job presupposes a certain mastery of it, so that acquisition of the necessary skills (as in i)) is often integrated in the tool aspect.

iii) Software is a medium in those cases where the software itself transports contents (educational software in its broadest sense). Applications range from simple vocabulary drills to complex simulations. In this aspect, the software is not pedagogically neutral, but always transports (often implicit or hidden) theories about the user‘s learning process.

The medium aspect is the central domain with which the discipline of educational technology usually deals. The first part of our discussion of Internet applications will also fall into this domain, for which especially the multiple uses of the WWW are typical.

2. Dimensions of the Learning Model

The heuristic model of learning that we have proposed before ([Baumgartner and Payr 1996]) is based on work by Dreyfus and Dreyfus [Dreyfus and Dreyfus 1987] who distinguish five steps in the learning process – from novice via (advanced) beginner, competence, fluency to expertise. Starting from these steps, we have opened up the model to three dimensions: action (of the learner), teaching/learning, and organisation of the learning process [figure 1].

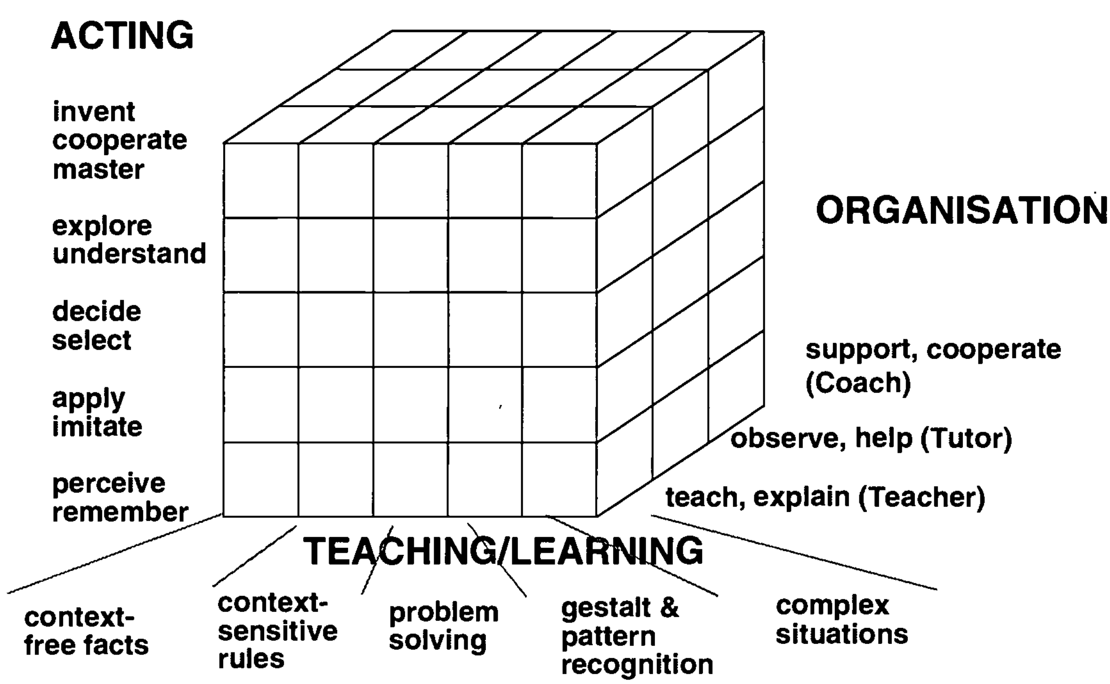


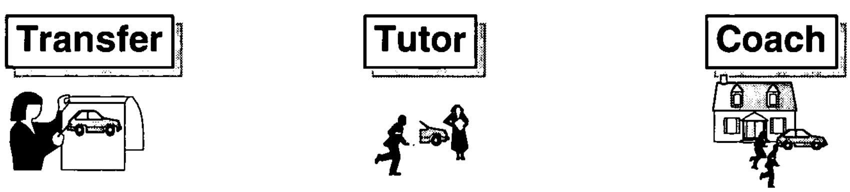
Figure 1: A 3D heuristic model of learning

The dimensions of the heuristic model needs some further explanation:

Learning/teaching dimension: With its help, rough definitions of subjects and learning goals (e.g. „solving equations") can be refined. For example: Should the students be able to solve equations following a certain method, should they also be able to choose the method, or should they even learn to construct systems of equations out of everyday situations (text description)? In the first case, the contents are context-free rules (level 1). In the second case, the rules to learn are context dependent (level 2). Level 3, in this example, would mean solving whole systems of equations, using and selecting all the rules and methods available. On the highest levels, the problem has first to be constructed from a real world situation so that it can be solved with the known methods.

Dimension of action: This dimension lists the forms and possibilities of interaction between the learner and the „world" (society) and recognizes that novices are not able to „take in" a complex situation as a whole. This can be easily misunderstood as an old-fashioned hierarchical conception of learning, whereby novices have first to rote-learn facts or be drilled in rules until they can finally pass on to more complex tasks. But this is not what we mean: this dimension should rather reflect the experience that learners develop themselves strategies for interacting with the world, obviously in order to avoid stress and information overload.

Dimension of social organisation: This dimension describes the role of the teacher, but also that of the media: are they „teacher" (= explain, demonstrate), „tutor" (= observe, help) or „coach" (= accompany, cooperate)? [figure 2].



• Transfer of propositional knowledge	• Presentation of predetermined problems	• Action in real (complex and social) situations
• to know, to remember	• to do, to practice	• to cope, to master
• Production of correct answers	• Selection of the correct method and its use	• Realization of adequate action strategies
• Verbal knowledge, Memorization,	• Skill, Ability	• Responsibility
• to teach, to explain	• to observe, to help, to demonstrate	• to cooperate, to support

Figure 2: Social organisation of the learning process

3. Internet Applications and the 3D Model

We will now try to distinguish types of Internet applications from the perspective of the learning model:

1. *Learning facts and rules/remember, receive*: every application whose main purpose is to present and transfer contents (verbal, multimedia) falls into this group. Most of the Web, being a networked information resource in the first place, thus falls into this category. The main activity of the user (interaction) is to navigate among pieces of information.

> *Example*: The examples for this type of application are therefore very numerous, almost as numerous as the number of web sites of institutions, electronic journals, project presentations, companies etc. There are, among them, also lots of sites with educational contents and goals, as for example the exhibition „Auschwitz – Terminal to Holocaust“ (Auschwitz – Endstation Vernichtung, [http://www.wsg-hist.uni-linz.ac.at/Auschwitz/HTML/Seite1.html], last access 04-04-98), created and realised in the Web at the University of Linz/Austria. This site has a simple and predominantly hierarchical structure. From the index, the user can visit the different chapters, composed of authentic photos and easy-to-read texts. Difficult terms e.g. expressions that were coined by the prisoners, can be looked up in a glossary by clicking on them.

2. *Rules, procedures/apply, imitate:* Internet applications falling into this group are characterised by exercises and tests. They do not only present contents but also offer the users interactive possibilities to control whether they are able to apply what they have learned. The learner acquires and tests procedural knowledge.

> *Example*: We chose the „Waste Management Game“ as an example for such an application (Mülltrennungsspiel, [http://www.kraftwerk.co.at/mllmanagerspiel.html], verification unsuccessful on 04-04-98!). In the training section the user selects different types of waste (e.g. spraycans, oil, fax paper ...) and the correct type of wastecan is demonstrated graphically. In the quiz part, the user must himself „throw away“ correctly randomly presented objects and substances.

3. *Problem solving/decide, select:* This group of applications deals with more complex problems that have to be solved in the Internet. While on the lower level, individual steps and operations were presented, trained and tested, the learner now has to select herself the steps and procedures.

> *Example*: Tutorials containing tasks and interactive practice, e.g. the hypertext textbook accompanying the VSNS BioComputing Course at the University of Bielefeld ([http://www.techfak.uni-bielefeld.de/bcd/Transfer97/welcome.html], last access 04-04-98). This textbook is the cornerstone of a complex media-supported distance course. It contains assignments that the students have to submit on Web forms. However, the assignments are not analysed automatically but by the teachers and tutors who use electronic communication to give feedback and support. This integration of human tutors is a good solution to the long-standing and mostly unsolved problem of analysing and supporting automatically the complex learner actions and decisions on such an advanced level of learning.

4. *Gestalt perception, pattern recognition/explore, understand:* open learning environments and simulations are applications supporting learning processes on

this level. The goal is to perceive and understand holistically processes with their causes and effects, and to discover common characteristics and pattern in diverse „cases".

Example: An interesting example for such an environment is the Open University's „Art Explorer". An article with interactive demonstrations is openly accessible in the Internet ([http://www-jime.open.ac.uk/jime/01/jime-01.html], last access 04-04-98). The Art Explorer is an interactive introduction to the history of art. The main purpose is awareness of old and acquisition of new „habits" of seeing. The tasks include grouping of pictures, developing 3D patterns from geometrical forms, or transforming individual objects and figures in paintings. There is no pre-defined solution and no feedback for the individual tasks. The goal is to support students in the acquisition of „seeing skills" without feeling controlled by external interpretations.

The site „Wild Wings Heading North" ([http://north.audubon.org/], last verified 04-04-98) is quite a different application also falling into this group. The project was designed specifically for schools: In spring 1997, ten wild geese were caught and marked with transmitters. Their signals were detected as they pursued their northward migration towards Canada and Alaska. The route and current position of each goose could be requested via the Internet, where they appeared on a map of the U.S. so that children were able to accompany „their" favorite goose. Background information on habits and migrations of wild geese, a discussion forum and a little game where children could make their bet on the way a certain goose would take next accompanied the maps. By its very nature, the „result" of this project was completely open, even for the researchers involved. Nobody knew at the start how many of the geese (or of their transmitters!) would survive the yearly migration and where they would travel. The site made it possible to discover and understand a phenomenon of natural life beyond the limits of space and time.

5. Complex (real) situation/invent, master, cooperate: Internet applications on this level typically are the very tools that experts use in their work. They can also be adapted „student" versions that introduce students to the use of the full-fledged tools. Some sections of the above mentioned BioComputing Course fall into this group, namely the integration of international online databases of DNS sequences. These databases are commonly used by researchers to check whether a certain sequence is already known and registered.

Another typical application is the „CyberLab" of the University of Osnabrück ([http://marvin.physik.uni-osnabrueck.de/CyberLab/], last verified 04-04--98), running an experiment that studies magnetic surfaces and layers. The computer controlling the experiment and processing its data can be directly accessed via the Internet (observation is open for all, but – of course – only authorised users can actively control and modify the experimental setting). The experiment can be run from a distance by all the associated researchers. The data are not only presented graphically (in as real time as the Internet permits), but are also logged in files that the remote researchers can analyse afterwards. Such remote experiments or even complete virtual labs will be of increasing importance in the Internet: they can help to use more economically the increasingly complicated and costly lab equipment, making it available to a large number of researchers and students simultaneously.

On this level of learning, we would also have to mention all the Internet services for communication and cooperation (like newsgroups, mailing-lists, online chats or Internet tools for CSCL, e.g. the Basic Support for Collaborative Work developed by the German

National Research Center for Information Technology GMD [http://bscw.gmd.de/]) when they are used for cooperative work on student or research projects.

Finally, the Web itself, seen as a whole, is a real and indeed complex situation. Its contents are „real" (that is, not specifically selected, processed and/or simplified for educational use). With the Internet, the „world" enters the classroom more massively than ever before, creating new problems and challenges. Mastering this situation demands new skills. We do not mean technical or programming skills here, but the skill to arrange, analyse and evaluate huge amounts of information and to use them for one's own learning and knowledge.

4. Internet: Chances and Challenges

The examples discussed before can also be used to illustrate the features that distinguish Internet applications from stand-alone educational software:

- *Integrated media and (communication) tools*: A complex learning environment like the BioComputing Course contains not only information resources and interactive software, but also tools specifically tailored to communication and teamwork among participants. This seamless integration of interactions with software and interactions with teachers/co-students is only possible in the network and offers new possibilities for the design of technology supported social settings for learning.
- *Up-to-date information*: Accompanying the wild geese continuously on their migration would hardly be possible without the Internet. In the Internet, the signals and data need only be processed in one place while being accessible from everywhere at any time and on demand.
- *Accessibility*: Other examples like the waste management game could be equally used locally and distributed traditionally. But this is only true if we look at one application at a time. The added value of the Internet is to be sought on another level: namely by making applications like this one accessible to everyone, easy to use and cross-platform portable.

The learning model that we have used here to distinguish Internet applications can be seen as a first orientation for the design of media supported learning situations. Starting with the types of Internet applications and their features, teachers are able to ask concrete questions concerning their target group and to develop, from there on, models for the educational uses of the Internet. The complexity of the information resources, the multitude of interaction types and the integration of media and tools are the new challenges for the teacher. At the same time, the Internet, with its possibilities for networking and cooperation, also offers possibilities to answer to these challenges.

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A Proposal for Wide Area Multimedia Instruction in a Northern Environment

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Abstract : This paper consists of a brief outline of a proposed research and development project in which the authors intend to explore the possibility of delivering complex course materials to students in remote locations of northern Canada. Although the project will focus on presentation using the World Wide Web, it will also explore various means of compensating for the limitations of slow Internet connections.

Background

The University of Northern British Columbia is located in the city of Prince George which is in the north central area of the Canadian province of British Columbia, and is roughly 700 kilometers away from the nearest larger population centre. It is a one hour flight or an eight hour trip by automobile to reach Vancouver, Edmonton or Calgary. The University was opened for full operations in 1994 with the mandate to meet the post secondary degree needs of citizens in communities that are up to 500 kilometers from the main campus in Prince George.

The size and sparse population of our mandated area mean that faculty must adjust teaching methodology to deal with the problems of distance delivery. It must be emphasized that UNBC does have a central campus in Prince George, which is a city of around 70,000 inhabitants and most teaching is done in traditional face -to-face fashion. However, it is imperative that the institution also deal with our regional students. For this reason, courses have been given by telephone, live video link, video tape, printed mail, and local lecturers at satellite campuses. None of these methods has been completely satisfactory, and as a result, we have a relatively large number of students who are willing to take the time and spend the money to move to our city to complete their education.

Past Efforts in Regional Delivery

A recent development in the struggle to provide better services to our regional students is the offering of instruction via the World Wide Web. In 1995 -96 one of the authors of this paper, Beeler, received a provinc ial government grant to develop software for four English courses on the Web [Beeler 1997]. This software package was designed to deal with the special problems of web teaching in our vast northern environment. Although things are improving rapidly, as of two years ago the backbone network in northern British Columbia was not yet able to manage the high speed transmission of intensive graphics and sound. Moreover, the computers available to students in our northern region were often nearing the end of their useful life cycle and barely, if at all, capable of multimedia presentation. Therefore, the package developed for our English Web courses used a database structure to create virtual web pages of manageable size and transmit these on demand to the student. This greatly reduced the load on web connections by increasing the load on the server. The package included monitoring software to allow instructors to have some idea of the time that students spent in various sections of the material as well as a Web Conferencing system (called Natter) which was designed to replace classroom discussion.

Limitations

The success of the English courses has prompted interest in providing a broader spectrum of courses to our regional students through the Web. A significant number of students at UNBC are taking courses of study directed towards Environmental Science, Forestry, Natural Resource Management and Business. Additionally, many of the students pursuing degrees in the first three categories are located in more remote parts of the region that UNBC serves. While it is not possible for these students to complete their studies in these remote locations, it is desirable that they be able to take their first year or two regionally before traveling to the Prince George campus to complete their studies. It is often necessary for these students to delay taking some courses, especially those in science (with labs) and mathematics, until they get to the main campus. This obviously causes difficulties, and in many cases, makes it impossible for students to even begin their studies in the home communities. An example of a course that causes difficulties is Math 152 - "Calculus for non-majors". This is a course needed by students in all of the disciplines listed above, and it is required very early in their studies as it is a prerequisite for many courses. Until now this course has never been offered by UNBC away from the Prince George campus. Preliminary research indicates that these same imperatives apply to non-university training in our region. Courses are often delayed until expensive teaching programs can be set up locally, or students are sent south to learn new skills.

The WEB based courses currently offered by the English program have been very successful, but there is clearly a need to branch out and offer additional courses and perhaps allow students to make significant progress towards science degrees away from the central campus. Although the model used by English could be easily altered for many other humanities courses, there are certainly drawbacks in using this method for a course like Math 152. The courses in English were primarily text based. The students were able to participate in discussions (using the Natter discussion group software designed for this purpose) and turn in assignments online. This would be very difficult, or perhaps even impossible for students in a mathematics course without having the students learn some sophisticated mathematical typesetting system such as TeX. Additionally, students in mathematics courses often find it extremely difficult to read a mathematics text without a supplementary form of explanation. This supplementary explanation is usually verbal. Previous models for Web course delivery do not allow for this kind of supplemental instruction. Without feedback, discussions, verbal explanations and the ability to monitor student progress a Web course in mathematics may be no better than a traditional correspondence course. In recent years there has also been a growth in CD-ROM based texts for mathematics. Certainly the multimedia enhancements of a CD-ROM text have the potential of making a course much more accessible to the student, it still lacks monitoring and discussion forums. In all of these cases, Web based courses and correspondence courses, there have been few attempts that could be described as successful. Student attrition and failure rates have usually been very high.

The challenge that we are faced with is developing a course that incorporates the aspects that made the English courses successful and introducing enhancements that make it usable for a first course in Calculus as well as non -University training.

Proposed new delivery system

Clearly the pagination protocol developed for the English project is useful in a mathematics course. It is also generally recognized that it is a good idea to parcel out the information to the students in such a way that they must proceed through the material in a linear fashion, since students of mathematics are usually unable to understand more advanced material before gaining a good understanding of the basics.

The key idea of our proposal is to not only present the course textually and with pagination, but to also have a synchronized *audio voice over* corresponding to each page. Thus, the course would have a virtual lecturer. This would be enhanced by having some markings in the text to draw attention to the passage that the lecturer is currently discussing. This may be achieved by having parts of the text "flash" or change colour to indicate the textual/auditory correspondence. The idea of this system is that it simulates to a traditional classroom lecture experience that is used successfully worldwide -- a classroom lecture being delivered by overhead transparencies with the lecturer indicating particularly relevant parts of the text by pointing to them on the overhead or using a light pointer. We believe that this system is technically possible, but the research will involve investigating the various audio protocols available for Web transmission and systems of presentation of mathematical typesetting. The work will involve developing a method to synchronize the audio with the visual presentation. We believe that this will result in system of curriculum delivery that not only mimics a successful traditional classroom style, but also allows students to view some pages repeatedly if necessary. The material would be parceled out one lecture at a time, but students would always be able to review previous lectures. Students would be encouraged to treat the parcels as individual lectures and not try and cover several in a single day. Of course, the technical limitations of the network mentioned above would have to be taken into consideration. It is likely that a hybrid system would be needed that would retrieve high volume materials from a CDROM. Additionally, the possibility of high-speed connections based upon ISDN technology or cable-modem links will have to be explored as an alternative that may become more economically feasible in the near future.

The lecture presentation would also be enhanced by the inclusion of appropriate video clips in addition to the audio. These video clips could contain demonstrations designed to enhance understanding of the material, or simply images of the lecturer providing an explanation. This adds a more personal touch to what students may view as a rather impersonal course delivery scheme. An example of the anticipated use of video is to have the instructor appear at the beginning of each lecture to give some motivation for the particular lecture and review some of the important aspects from previous lectures that will be used. This would allow students to identify the course with a particular person and give it a more human touch. There are various video protocols available for Web use and it will be necessary to experiment with them to determine the most appropriate system for our diverse needs. It will be necessary to develop some software tools to integrate the video and audio components into the paginated lecture structure.

The second difficulty that we address is a method of monitoring student participation and understanding. Ideally this would be done in an unintrusive way without the ethical dilemmas associated with having the instructor monitor the time that students spend online working on the course. This monitoring would be performed by having a question or two at the beginning of each lecture referring to material from the previous lecture. Should students not be able to answer these questions, they would be encouraged to go back and review the previous lecture. It may even be useful to occasionally prevent students from continuing until they have demonstrated some understanding of material already covered. The questions would have to be created in such a way that the response requires no special knowledge of mathematical typesetting, questions would elicit single word or numerical responses. We will be experimenting with various technologies (Java, Perl based CGI Scripts or ActiveX) for embedding these quizzes.

As most students of calculus are aware, an integral part of the learning experience is asking questions and having an opportunity to discuss course material. Students often have difficulty enough verbalizing these questions, and it would be impossible to have students only access this discourse via email or other strictly text based medium (without requiring students to learn TeX). While we would encourage comments and questions by email or a Web based discussion forum, we would also allow students to fax in or scan and transmit questions to the instructor. These questions could be hand written and would be scanned and posted to a discussion portion of the course site (possibly anonymously). Instructors could then answer the questions and make the answers known to the whole class. Although this system is not immediate, it may even have advantages over the normal classroom discussion, since it forces students to clearly think out their question and write it down. It would also take advantage of the asynchronous nature of Web based teaching in general. One of the advantages of this format of instruction is that it does not demand that all students and instructors be present at the same time. Students who work at full time jobs could still participate in the course at their convenience.

We will also be examining the feasibility of synchronous teaching technology such as the use of a shared whiteboard with the instructor and an Internet telephone link. With proper lab co-ordination and reasonable class size, it would be possible to have the transmission shared by several students using an open microphone and speakers.

Finally the course would also involve students submitting homework assignments that would be graded and returned to give them constructive feedback. This delivery system could be either by fax or by scanned images attached to email messages. The course would also include midterm tests and final exams which the students would write in their own region. These could be administered with the assistance of local colleges or high schools.

It is likely that when such a course is offered many of the students will be distributed in pockets rather than completely isolated. If this is the case it would also be beneficial to have teaching assistants that offer tutorials in the particular region on a regular basis, perhaps one tutorial every two weeks. This would benefit the students by allowing them to clear up any major difficulties that they might encounter.

It should be noted that there would be a heavy responsibility on the students in such a learning environment which would extend beyond the usual learning of the material. The proposed research project would include experiments to find the optimum balance of lab equipment and technical training for students and lab monitors. It is hoped that this project will provide a cost effective method of providing instruction beyond simple textual transmission that will be applicable to both academic and technical material.

Conclusions

It is clear that there several possible avenues of research in this rapidly expanding area of education and training. It is obvious that the need for Web based distance instruction can only increase in a university framework. Moreover, the need for a more technologically competent workforce in our region will make the proposed project relevant in a non-university environment. Northern Canada has traditionally had a resource based economy with most employment opportunities available in non-skilled positions. It is a responsibility of institutions like UNBC to expand the economic base of the North, and as the economy shifts its focus, educational institutions as well as business interests will have to adapt to the necessities of providing more highly trained individuals. We believe that our project will provide the means to apply technological solutions to the problems presented by the sheer size of our region.

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Integrating Face-To-Face and Online Education: a Case Study

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Abstract: This paper describes the study of a mixed onsite/online approach adopted for a training course called EDIT (Educating with Internet and Telematics); the topic of the course itself was the use of network resources to support schooling.
The distinguishing feature of the approach used is the alternation between complementary face-to-face training and online activities.

Introduction

The term mixed training is used to indicate a form of training that draws on specific aspects of both face-to-face teaching (classroom lessons, basic introduction to technology, etc.) and online education (discussion, assisted distance exercises, etc.).

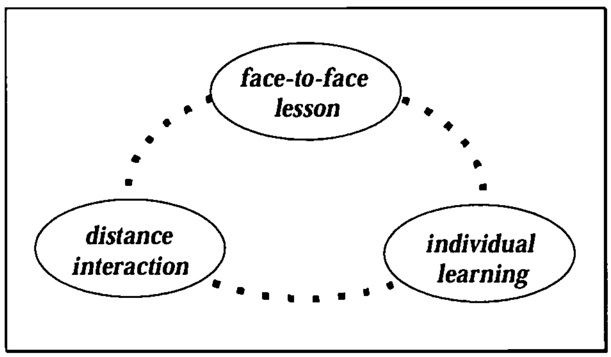

Figure 1: The cycle of mixed onsite/online training.

As Figure 1 shows, mixed training features a three-stage cyclical process: traditional face-to-face teaching; a self-study phase usually based on the reading of articles and books; and an online phase centred on discussion, exercises, collaborative work, etc.
Hereafter, we shall examine a mixed-approach teacher training course whose subject was the application of network technology to education.

Case Study: the Edit Course

Sponsored by the Pistoia City Council, EDIT was initially planned as a traditional-style course but following an agreement with the council's Resource Centre for Educational Innovation, it was subsequently redesigned with the aim of testing a specific mixed approach for teacher training.
The designers of EDIT bore in mind the shortcomings of both face-to-face training (usually limited to a series of meetings lasting just a couple of hours) and of online training (where it is assumed that the participants are willing and/or able to interact principally in written form). These limits are even more evident when the course objectives involve highly innovative themes and call for a degree of technological know-how.

The Course Objectives

The main objective of EDIT was to provide teachers with methodological skills for using network services to support their work in class. This embraced a number of secondary goals: acquisition of knowledge and skills in the use of the major network services; acquisition of know-how in employing telematic resources to support teaching activities; acquisition of basic knowledge for designing online courses; devising ideas and plans for the possible uses of telematics in co-operative learning.

Contents

The course topics were both technological and educational/methodological in nature, and included: Internet services such as E-mail, mailing lists, computer conferencing and the WWW; ways of using the network to access and share information and knowledge; aspects of planning online courses; the main strategies for using telematics in co-operative learning.

Participants

Out of the twenty teachers (of various subjects) who participated in the course, seventeen taught at upper secondary level and three at lower secondary. They all had some basic know-how in computers and network services. It should be noted that when the teachers signed up for the course they had no idea about the methodology that would be adopted, and hence did not know what type of effort would be expected of them.

The Learning Methodology

As stated earlier, the methodology adopted for the course was mixed: four face-to-face events were held at intervals ranging from a week to a fortnight, during which exercises, group discussions and self-study were conducted online.
In accordance with the overall approach, the onsite events held at the Resource Centre centred around the subsequent online activities. Hence, there were lessons on theoretical/methodological aspects, as well as practice with the tools and network services to be employed in the distance activities.
EDIT was a "project-based" course, meaning that the participants were engaged in the production of educational projects to be implemented after the course had ended.
All the teachers were provided with a course guide and an information pack containing the reading material related to the learning activities within the course.

Course Structure

EDIT was held over a five-week period and comprised four face-to-face events and three periods of online activity managed by the course participants themselves (Table 1).

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
29.01	*2 weeks*	12.02	*1 week*	19.02	*2 weeks*	05.03
Face-to-face	Distance	Face-to-face	Distance	Face-to-face	Distance	Face-to-face

Face-to-face events   Distance activities

Table 1: The EDIT course schedule.

Over the whole span of the course, individual work (reading, exercises, etc.) alternated with periods of interaction with the other participants (colleagues, tutors) either in face-to-face or distance mode.

Networking was done using the FirstClass (FC) computer conferencing system, which has a simple graphic interface and offers users a series of functions for interpersonal communication (synchronous and asynchronous) and file sharing.

Phase 1 (onsite) The topic of the first meeting was an overview of the main network services that can be used for teaching. After the introduction, the teachers were divided into work groups and explored the functions of the computer conferencing system that would later be used to handle network communication.

Phase 2 (online) This covered a period of two weeks. The teachers were set two tasks: to get familiar with the computer conferencing system, and to explore several network services. The latter activity was managed by opening up two secondary work areas on the FC system to handle the WWW and E-mail activity organised into mailing lists.

Phase 3 (onsite) The second face-to-face meeting dealt largely with theory. The focus was on two areas: the use of telematics as an auxiliary technological support in teaching; and the special characteristics of online courses, in particular design considerations and collaborative learning strategies.

Phase 4 (online) Given that there was only a week before the next face-to-face meeting, the participants were asked to carry out further investigation of what they had seen so far. This included suggested reading on the methodological approaches to the work and to online collaborative learning. In addition, the teachers carried on with the practical telematics exercises they had begun in previous phases.

Phase 5 (onsite) The aim of this face-to-face meeting was to consider what kinds of network activity the teachers could adopt in the classroom after their training was completed. Consequently, the meeting began with explanation and discussion regarding the key aspects of collaborative learning, with special attention to the management of the online learning process. To these ends, the teachers were divided into three work groups, one for lower secondary level and two for upper secondary.

Phase 6 (online) The aim of the last network-based phase was to discuss and clarify the draft projects developed at the previous face-to-face meeting. Consequently, a separate FC work area was devoted to discussion and delivery of the participants' draft projects. By the end of this two-week period, before the final face-to-face meeting, three draft projects had been delivered: the two mentioned above and a third one which was drawn up after the deadline.

Phase 7 (onsite) During the last meeting, group discussion and clarification of the draft projects finally took place. The focus subsequently shifted to the planning of measures for putting the projects into action.

Evaluation of the training course

Evaluating a distance training course poses a series of problems at different levels, but two in particular stand out: evaluation of learning and evaluation of the participants' level of involvement, seen in terms of time and of activity effectively carried out at a distance.

This problem is less critical for mixed training courses as there are opportunities for face-to-face interaction in which the participants' performance can be monitored. What's more, basing distance communication on the computer conferencing system means that one can access the automatic recordings (log files[1]) that the network server makes of each participant's activity (messages written, messages read, level of interaction with other participants, the time and duration of online connection, etc).

Evaluation of the EDIT course was therefore based on these two evaluation techniques, as well as analysing the results of an end-of-course questionnaire that sought the participants' evaluation and general feelings about the experience as a whole. Without a doubt, the most interesting of these techniques from a research standpoint was the monitoring of the online activities the participants engaged in between one face-to-face meeting and another.

[1] In these files the computer conferencing system automatically records every single action that the participants perform during network interaction: reading/writing of messages, chatting, duration of connection, etc.

The participants' level of online activity

With the exception of more exercise-oriented activities, general online participation was noticeably lower than expected. In short, discernible interactivity did not take place. By and large, the participants confined themselves to the tasks set by the remote tutors, rarely engaging in meaningful online exchanges about their different opinions and/or proposals.

The likely cause is the fact that only sixteen percent of the teachers had access to the network in their school: the others had to go to the Resource Centre to take part in the online activities. It must also be recognised that this innovative learning method calls for a far greater effort than traditional onsite courses, especially given the more active, initiative-taking role that the participants are required to assume in the process of their own training.

Computer conferencing communication

When making quantitative evaluation of computer conferencing communication, we must take account of two factors: the types of activity that the participants have engaged in (exercises, discussion, group work, collaborative production, etc.); and the management strategy consequently adopted by the tutors. This is especially true where online training is concerned. Both the two factors may strongly affect the messages produced both by the tutors and by the participants.

The ratio of tutors' messages to participants' messages in the EDIT course was roughly one to three.

It is safe to say that this is a fairly well-balanced ratio, considering that the course included both exercise/tutorial activities (requiring greater tutor "presence") and discussion/exchange activities (where the tutor acts as moderator and is less directly involved).

Conclusions

The case study we have reported is an experimental course called EDIT on the educational use of telematics. In this course, telematics was used simultaneously as a study topic and as a tool for conducting the online part of the training process. This allowed the teachers who participated in the course to get first-hand knowledge of the potential and limitations of telematics applied to education.

While the overall results of the project were satisfactory, the pacing and content of some areas of the course need to be adjusted. For instance, the training course would benefit from a longer time span, and greater effort should be made to ensure that at the outset of the course the participants all have a similar level of technological competence.

From the standpoint of the adopted approach, the project has undoubtedly yielded positive results. This is borne out by the positive feedback from the participants and by the surmounting of problems often faced in onsite training (the lack of communication and support offered to teachers between one meeting and another) as well as in online training (the difficulties posed when communicating solely in written form).

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A Hypermedia Learning Environment by Students for Students

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Abstract: This article discusses an cooperative approach for developing educational hypermedia in an university environment. We report about experiences from the development of ORWelt, a hypermedia learning environment for Operations Research. The project team consists of researchers and varying groups of students. We argue that if adequate support is provided this model is a way to address lack of resources, while at the same time providing a valuable educational experience for students. We describe the development process with special focus on quality assurance and offer some suggestions for transferring this approach to other problem domains.

Background

The objective of the ORWelt project is the development of a complex hypermedia environment for business students learning Operations Research (OR). OR is a complex subject area dealing with the use of mathematical methods to solve business problems. OR methods are used by faculty and practitioners in several fields, e.g. production planning, transportation, personnel planning and finance. The fundamentals of OR teaching are comparatively stable over time and there is an established standard content for introductory classes including linear programming, mixed-integer programming, modeling techniques, network algorithms and often basic discrete simulation. Though our students differ in their faculty background (we have business students, students of business computing as well as engineering students) they all have one in common: They need OR as a basic technique and they need to transfer this basic knowledge to very different real problem situations. Realizing that traditional forms of education do not support the adequate transfer of knowledge, the need for a new way of teaching was acknowledged [Cunningham, Duffy, Knuth 93].

The ORWelt project started in February 1996 with the intention of providing a hypermedia learning system covering all standard introductory material, supplemented by tests. Additional case studies are meant to provide different contexts for the methodological content. In some subject areas that are of special interest to OR teaching at the University of Paderborn advanced topics should also be included.

The long-term objective of the ORWelt project is to change the way of teaching towards application-oriented learning [Blumstengel, Kassanke, Suhl 97]. Lecture time should be used more efficiently to discuss realistic problems while teams of students learn part of the material (especially basic algorithms) with support from the learning environment. It can also be used as a reference and for exam preparation.

In 1996, the researchers were faced with a situation of very limited resources. At this time, no external funding was immediately available while on the other hand there was a lot of content to be covered.

In addition, we expected the participation of students in the development process to be a valuable educational experience for them. It is recommended that students not only learn how to navigate in a hypermedia information space, but how to create one [Honebein, Duffy , Fishman 91]. Writing hypertext is not intuitive and requires certain skills in structuring information. "Unfortunately, even though you can easily get some ideas about hypertext authoring from your experience as a hypertext reader, we face the general problem that people have not learned how to structure information in hypertext networks the same way they have learnt to write linear reports through writing endless numbers of essays at school." [Nielsen 95]. Furthermore it is quite demanding for students to develop educational material.

Development Process

Preparation of the Project

Before starting the actual development, a questionnaire was mailed to OR instructors in Germany. It included questions about the content of relevant classes, the use of software (especially educational software), the additional need for such software as well as instructors' expectations and concerns.
Students are questioned on a regular basis about their computer literacy, frequency of computer use, available hardware equipment and attitudes towards computer-based learning, including expected advantages and disadvantages.
The project started with an experimental phase followed by iterative refinements of the development process leading to the process steps presented here.
From the beginning students were participating in the development of ORWelt. We used teams of typically 2-3 students attending a project seminar with a total of 2-6 groups per semester. The students are majoring in different fields, namely business studies, business computing, industrial engineering, computer science or business education. The seminar is held by a group of two problem domain specialists and one or two programming specialists. The authoring environment we use is Asymetrix Toolbook, currently version 5.0 (Instructor II).
After an initial agreement about the content scope students are required to give a midterm presentation of their storyboard. This gives a detailed account of their concept for presenting and visualizing the material. Students use a two-level storyboard approach [Fisher 94]. On the first level they present the overall structure of their hypermedia network. The second level consists of detailed visual outlines for all pages. The storyboard can either be presented in electronic or in non-electronic form while students show clear preference for the electronic form.
At the end of the term the student teams give final presentations of their modules. The seminar sessions are mainly used to discuss different ways to visualize a certain concept, programming techniques and guidelines or particular problems the participants face.
Since initially instructors and students were inexperienced alike in hypermedia design, the first semester was used as an experimental phase. Students had to cover certain topic areas, but no styleguide was available. The intention was to collect ideas and promote creativity concerning navigational tools, styles, designs, user interface elements and the use of hypermedia elements in a phase of explorative prototyping.
The resulting programs were indeed very different, but all quite colorful. Students experimented with different media and interface design styles. Most prototypes were mainly linear and while navigational support was provided, it was not sufficient for more complex systems.

ORWelt Approach

We chose a modular approach for structuring ORWelt, so students can work quite independently in their problem domains. Requirements for navigation and features of the system were derived from the explorative prototypes. For getting a consistent user interface, basic guidelines and module templates with common navigational features were developed for the next semester.
A few methodological core areas were implemented as first modules of ORWelt:

- Linear Programming,
- Simplex-Algorithm,

- Duality,
- Sensitivity Analysis and
- Branch and Bound.

At the same time guidelines for navigation, animations, use of colors, hyperlinks and the common glossary were developed and refined.
As a next step, components for other topic areas like:

- Simulation,
- Warehouse Location Problems,
- Basic Stock Control,
- Modeling Techniques,
- Applications in Production Planning and
- Case Studies

were developed with additional test modules for most of them.
During the whole development process navigational tools were refined and system functions centralized by researchers of DS&ORLab. By now the features of the system include a graphical browser, customizable guided tours, bookmarking, annotations, history function, full-text search and anonymized log files.

Introducing Students to hypermedia design

For introduction into Toolbook and its programming language OpenScript we decided to start each semester with a whole-day Toolbook workshop.
A very detailed programming styleguide is available by now as well as documentation guidelines and refined module templates for topic and test components.
The feedback process for the modules written by students was refined several times. Besides the permanent detailed feedback during the development process we conduct an evaluation session after the final presentation.

Evaluation Cycle

The modules are evaluated by the problem domain specialists together with at least one programming/system design-specialist. Evaluation sessions typically last for 3 to 4 hours per module. The criteria we use are (ranked):

1. content: correctness (the scope was agreed upon already at the beginning of the semester)
2. adequacy: usefulness of hypermedia elements
3. formal correctness: adherence to programming-, style- and documentation-guidelines

Based on the detailed evaluation protocol, a separate meeting with each group is held. It is used for discussion of the protocol and to reach agreement upon further changes that are still necessary. The student teams get about two weeks time for revision of their work followed by a second evaluation session. In some cases, a second revision is necessary. The documentation is due about two weeks after completion of the software. The formal grading uses the following criteria (ranked):

1. level of creativity, adequate visualization, realization of agreed upon changes
2. quality of midterm and final presentations in class
3. formal criteria (documentation etc.)

Outlook

During the last two years we have developed more than 500 pages of content with lots of animations and interactive elements as well as additional 170 glossary entries. All main topic areas are covered on an introductory level, some even deeper. So far, a total of 30 students has participated in the development process.
Further development will concentrate on case studies and advanced topics (like genetic algorithms). A further integration of linear optimization software (like it is already used in the component about modeling techniques) is also planned and a translation into English is intended.
The prototype is currently tested by 60 students in an introductory OR class. It is used as an additional resource for learning by individual students or student teams. To further confirm positive feedback from students we conduct a thorough evaluation using log files and questionnaires. The results will be available by April 1998.

Experiences , Suggestions and Conclusions

One potential problem of the described approach is that quality of content and content representation developed by students might be low or at least not sufficient for learning purposes. Since there is a large group of students involved, there might be very different styles of writing and visualization which affect the common "look and feel" of the system. Also, the need for standardization in such a large system limits the creativity of the students involved to a certain degree.

So, quality assurance is a major concern during the whole development process. Our experience suggests:

- If the instructors' initial skills on hypermedia design are quite low, an experimental phase is very helpful to determine system requirements and potential problems.
- Standards and guidelines are crucial, but can hardly be stated in detail right from the beginning. Instead, they have to be developed and refined over time.
- Good hypermedia design is not intuitive! Today's students usually start with a presentation of the content very close to a paper-based form: The first designs are mostly linear, text-focussed, use illustrations with few interactive elements and often make inadequate use of animation. So, it is very important to give continuous feedback starting in the early stages and discuss in detail different representation forms and their specific use for educational purposes. Since good design is much more demanding for students, it has to be supported by instructors.
- For good quality, programming / design and content specialists' support is equally important.
- An advantage of the presented approach is that students generally understand very well how to teach fellow students. They know of the specific learning problems and needs concerning the material from their own recent experience. Often it is easier for them than for instructors to assess what is difficult and what not.
- Diverse development teams are definitely a plus because they allow to take advantage of different skills and talents of team members. If there are inexperienced programmers in the teams (which is almost always the case in our project) it is crucial to keep the level of programming skills required as low as possible. This gives students time to concentrate on content and content representation. Also, it avoids unnecessary bugs and frustration. Therefore, we use a specialized authoring environment which offers a powerful script language, graphical tools and direct manipulation. In this case, ease of use for the developer is more important than performance. A large part of the system's common functionality is encapsulated in system components. Also, through templates, a library of functions and strict guidelines we provide a clear and easy framework for the technical realization of planned representations.

Through the cooperative development involving student teams a system covering a large scope of content could be realized in short time. Good quality can also be achieved, but permanent support is essential. However, the selected approach does not only provide one possible solution for capacity problems, it is also useful for the students involved. They acquire a deep understanding of the particular subject area and different contexts of its use. Students are encouraged to present the material in a way that supports learning. They have to develop good representations, examples and test items and to relate their modules to the existing parts of the system through hyperlinks. In addition, they learn useful skills in hypermedia design and programming fundamentals.

From our experience with the ORWelt project we recommend to transfer the cooperative approach to other problem domains.

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Hypermedia As a Means for Learning and for Thinking About Learning

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Abstract: The paper refers to a project aimed at designing, implementing and evaluating a hypermedia system, IPER-3, facing the three 'classical' problems in the history of mathematics (trisection of the angle, quadrature of the circle, duplication of the cube). The aim of the project is to study the opportunities offered by this kind of technology to the presentation of mathematical topics both in teacher training courses and in classroom work.

Introduction

In this paper we refer to a project aimed at designing, implementing and evaluating a hypermedia system, the IPER-3 system, facing the three 'classical' problems in the history of mathematics (trisection of the angle, quadrature of the circle, duplication of the cube) and some issues which have developed around them. The aim of our work is to study the opportunities provided by hypermedia systems in dealing with topics of interest for the training of teachers and/or for class work, exploiting the possibility of a non-linear presentation, representation of heterogeneous pieces of information, modularization, increment and flexibility of use, as discussed in the literature [Conklin, 1987; Tomek et al., 1991].

In the paper, first of all we motivate the choice of the history of mathematics and, inside this, the choice of the three classical problems. Then we present the structure of the hypermedia system IPER-3 and some design and implementation choices which are interesting from a teaching viewpoint. In the last section we analyze an experience of actual use of the system and delineate some possible developments of this type of activity.

Background

The field of knowledge of the history of mathematics appears particularly suited to a representation of a hypermedia type. At the level of both research and, with the due change of scale, work in class, tracing the history of mathematics is a complex activity in which there coexist two different investigation needs, the purely 'informative' one (characters, events, dates, places, etc.) and the 'conceptual' one of the analysis of ideas. Discovering history also means consulting sources including illustrations, manuscripts and various documents, and, since the same topic can be viewed in various milieus and in various epochs, it also means referring to history in general, art, geographical and ethnic situations, etc. In common texts of the history of mathematics, because of the very structure of the book, it is very difficult to handle the non-linearity of the historical development of ideas and hence, for the non-professional historian (for example, a student or a teacher) it may prove difficult to grasp the various connections or the influence of the context and, consequently, also the thread linking the developments of these ideas.

In making our choice to work with a hypermedia system in the history of mathematics we have taken into account, on one hand, these aspects of history and, on the other, the specific characteristic that hypermedia systems have of lending themselves to presentations of a different type than the book, being more dynamic and flexible in both spatial and temporal representation.

The association between the history of mathematics and computer technologies is not a new one. Apart from the massive use made of databases for the organization of historical material, which here does not concern us, it must be remembered that much information of a historical type is available on the Internet. Some students who have participated in the experience have used this resource for getting first information on certain historical facts, which they have then compared with other (more canonical) sources.

Apart from the reasons linked to the specific characteristics of the medium used, the choice of the history of mathematics is also connected to our opinion on the role that this discipline has in the teaching of mathematics [Furinghetti, 1997]. We believe that this role is central in the training of the mathematics teacher, in an outlook which has to do not only with knowing facts, which is certainly important, but above all with epistemological reflection as an integral part of the teacher's craft. In this sense history may be one of the contexts which can be

activated both for constructing concepts and for attaining awareness of the epistemological obstacles lying behind the difficulties met. These considerations concern not only the training of teachers, but also classroom practice.
Within history the choice fell on the three classical problems for a 'structural' reason: they are a multifaceted subject, a catalyst of many theories and many cultural contexts but one which for this very reason is mortified by the traditional presentation. Moreover, we were interested in the teaching implications of the three classical problems. These implications are linked to their cultural importance which is due to the fact that mathematicians attempted to solve them using the rule and the compass. Only in modern times it was proved that this way of solving them is not possible. The importance of this subject, from the teaching viewpoint, is founded on the belief that it is necessary to account for the reason why algebraic structures were introduced.
In the way of presenting the historical content we bore in mind the exploratory character of this work and we did not choose to consider a single type of user. For this reason, on one hand advanced developments are suggested, while on the other the language and form of presentation are conceived in such a way as also to be accessible to secondary school students, and some space has been devoted to topics of an elementary type (e.g. the detailed explanation of certain geometrical constructions).

The Iper-3 System

As already stated, the IPER-3 system deals with the quadrature of the circle, the trisection of the angle and the duplication of the cube. The present prototype only gives full development of the quadrature of the circle. Work is still in progress in relation to the other two problems.

Information islands and viewpoints

IPER-3 consists of a structured set of information islands. Here the term 'information island' is used to mean an organized set of pieces of information which can be accessed by means of hot-words, buttons and sensitive areas. The information islands are six: 'introduction', 'classical problems' (one for each problem), 'rule and compass', 'glossary'. It is to be observed that the pieces of information thus organized are interconnected.
The 'introduction' allows one to obtain general information on the system and on the three problems dealt with in it. From this information island one can get to the specific ones for each of the three classical problems. The latter are structured in accordance with four "viewpoints". Viewpoints give the possibility to deal with each classical problem according with a different perspective: "general information", "historical development", "solutions", "tools".
The "general information" viewpoint identifies information of a general character (presentation of the problem, different formulations of the problem, cultural references, anecdotes, etc.). The "historical development" viewpoint identifies a section presenting some of the main contributions to the study of the specific problem in various periods. The "solutions" viewpoint is structured in accordance with the type of approach followed for the solution (geometrical, analytical). The "tools" viewpoint is closely linked to the previous one: it concerns the instruments used to arrive at the solutions proposed (mechanical, geometrical, etc.).

Each perspective has an internal pathway (see Fig. 2 for an example of an historical pathway concerning the problem of the quadrature of the circle) and also allows access to information, referred to the same topic at hand, from different viewpoints, as shown in Figure 3. For example, the quadratrix was one of the tools used to face the problem of the quadrature of the circle (see Frame 1 of Fig.3); by means of this tool a geometrical solution to the problem was obtained (see Frame 2 of Fig.3) by Dinostratus (see Frame 3 of Fig.3). It is also possible to see the dynamic construction of the quadratrix from both the tools and the solutions viewpoints (Frame 4 of Fig.3).

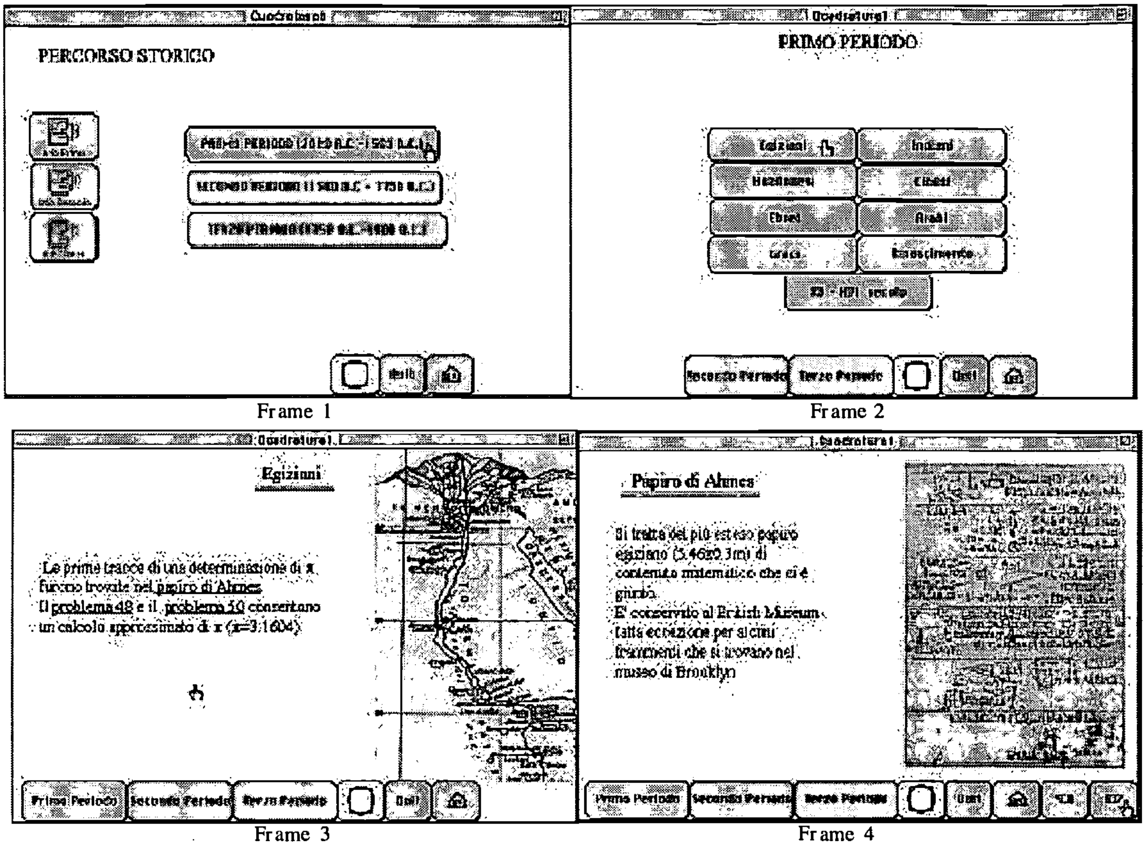

Fig. 2: Four IPER-3 frames referring to the historical development of the problem of the quadrature of the circle

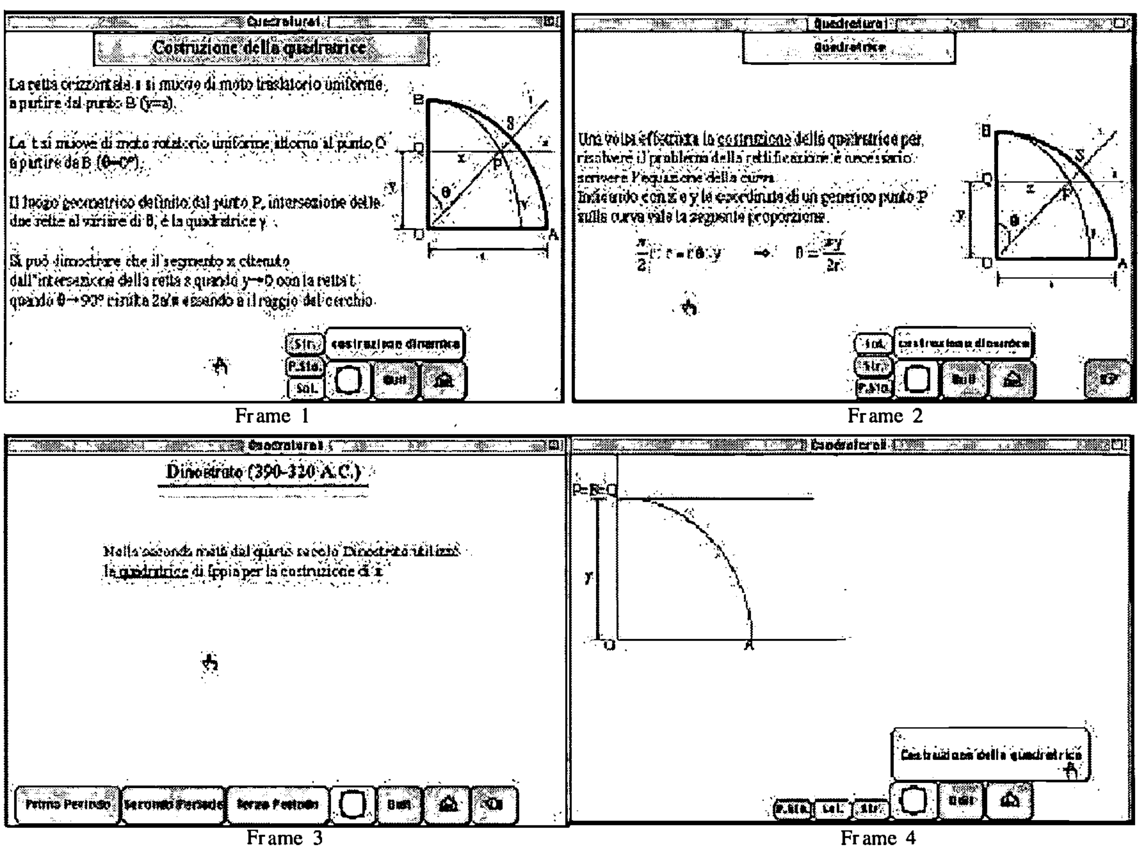

Fig. 3: Four IPER-3 frames relating to the quadrature of the circle

It was felt to be useful to devote a specific information island to the rule and the compass in order to accentuate the link between the subject we are dealing with and Euclidean geometry.
The information island relating to the glossary is made up of information sheets briefly explaining some important terms. The user accesses the glossary by selecting the words or phrases which in the text are boxed (e.g.: geometrical constructions, absolute field of rationality, etc.).
For the mathematical and/or historical contents to put into the system use was made not only of the specific literature but also of notes on teaching experiences in classes at upper secondary schools, and of the Internet. The latter constitutes a work instrument supplying an enormous information patrimony which is continually expanding, though with some limits from the historical viewpoint (frequent lack of bibliography, approximate notices, etc.).

The interface

The system's interface has been designed in such a way as to be as user-friendly as possible, even for people who are not expert computer users, and for this reason reference was made to some of the principles and guidelines of human-computer interaction relating to user-centered design discussed in [Norman, 1986]. The interface is based on an icon paradigm: from the implementation viewpoint, this corresponds to the creation of buttons which are often semantically evocative. The icons are distinguished into two categories: those for handling the system, and those related to the topics faced. In creating the buttons, to guide people in using the system and reducing the risks of confusion often linked to the use of a hypermedia system, use was made of colors, voice and pictures. Color takes on three fundamental functions: it characterizes the perspective, characterizes the different sectors within the perspective (for example, the historical development is subdivided into three periods, each marked by a different shade of green), and distinguishes buttons according to their function (e.g. light blue ones allow management of the system). The voice is used to give an instruction or to suggest a cognitive pathway to follow. The pictures provide a visual support for information (maps, or photos or drawings of mechanical devices, etc.). In the system it is also possible to activate dynamic constructions and step-by-step constructions. The former are used to visualize the generation of curves obtained by means of movements of geometrical entities (e.g. two points on two different lines, the quadratix of Dinostratus, etc.), the latter to visualize in successive steps the solving procedure for geometrical problems (e.g. the construction of a segment whose length is the square root of x).

Experimentation With The System

Organization of the experimentation

The first experimentation of the system was carried out with university students in the mathematics degree course who were studying for a specialization in teaching. The experimentation, carried out during the last month of the course, was divided into the following phases:

- Introduction to hypermedia. This phase provided an introduction to hypermedia systems as a means of representing and accessing information. The theoretical basis of such systems was presented; concepts, definitions and explanatory examples referring to their main characteristics were given.
- Presentation of IPER-3.
- Use of IPER-3 by students. They were initially assisted in using the system and then left free to explore.
- Writing of a report by the students (individually) on their impressions regarding the use of IPER-3 and the way they had explored the knowledge incorporated in the system, as well as what they had learnt about hypermedia systems.
- Creation of a project (only on paper, not implemented) by the students, divided into two groups, to complete IPER-3 as regards the problems of the duplication of the cube and the trisection of the angle.

We consider the population chosen as suited to this type of experience. Thanks to the course they were attending, the students were wholly used to dealing with mathematical topics and hence it was possible for them to focus their attention on the means of transmission and the type of mediation. Furthermore, many of them had attended the course on the history of mathematics.
The considerations made in the pages which follow are based on the students' reports and on their projects for the completion of IPER-3.

The students' observations

The students' reports were analyzed by means of a reading grid in which observations were collected in accordance with the following main parameters: observations of a technical nature on the computer and the software, observations on the mathematical contents and how it is organised in the system, observations on hypermedia as learning instruments, observations on their own work and reactions.
Table 1 shows the most significant observations which emerged from the students' reports. In general, we notice curiosity and appreciation in relation to the technological instrument, but also some diffidence regarding its teaching potential.
The students' observations show up a rather generalized need for guidance in the exploration of a new subject; hence the suggestion to include features in the interface (some suggest a sound-based guide) to which one can have recourse in case of uncertainty about which way to go.
The request made by many that in the opening pages there should be a statement regarding the impossibility of solving the three classical problems in an elementary fashion, may indicate some resistance towards the 'open' and exploratory approach which the system would allow. This impression may be linked to the fact that the majority of the students consider the technological instrument as useful for revision, but not for a first introduction to the subject. By contrast, some students emphasize that the possibility of following personal pathways is the aspect they perceived as most positive in the use of IPER-3.
The content chosen is judged very positively in that it makes it possible to deal with mathematical contents in a way which is not static but follows a historical evolution lending itself to different readings (solutions, instruments, epochs) and permits connections between topics often dealt with separately from one another.

Students' projects for completing IPER-3

In the projects made by the students for the completion of IPER-3 we noticed both common tendencies and diversified ones. Both groups exploited certain elements (color, icons) and accepted the IPER-3 idea of distinguishing various approaches to the problem. Hereunder we report some observations on they way of working.
The "Trisection of the angle" group with respect to the prototype added the viewpoint "curiosity", but created no explicit links between this viewpoint and the others. It is interesting to observe that, thanks to curiosity, the students used the Internet source in addition to books. This source was also exploited to obtain figures, portraits, etc. The group realized the importance of dynamic constructions. The necessity of a user's manual was suggested. In the last part of the project they highlighted the links (and hence they stressed their importance) with some graphic schemata for describing their work, which in the other groups did not happen.
The "Duplication of the cube" group introduced the new viewpoint "demonstrations" which makes navigation more flexible, considering whether one is interested in a given theorem in itself or only in its enunciation in order to go on dealing with a given topic. However, subsequently the group did not make good use of this route with appropriate links, maintaining, by and large, a marked sequentiality in the treatment.
Summing up the behaviour of both groups, it can be stated that in one of them (Duplication...) the worry about the mathematical contents prevails over interest in the medium. In the other group greater interest was observed in hypermedia opportunities. Having worked on the basis of an existing prototype accelerated and facilitated both acquisition of knowledge of the specific problems studied and hypermedia design, but it did not prevent students' elaborations which were to some extent new and personal.

Prospects

The system presented is a prototype of a way of constructing a hypermedia system in the history of mathematics. Our way of working with it (in both the construction and utilization phases) can also be considered a prototype and we feel we can make some considerations on it which are transferable to other situations. The points on which we wish to focus our attention are the following:

- working with a hypermedia system can promote *meta-cognition;*
- a hypermedia system can be seen as an *environment which lends itself to the study of the dynamics of teaching and learning processes.*

The concept of meta-cognition is present in many theories of education, though with varying interpretations due to the different frameworks (psychology, mathematical education, etc.) and authors. We refer to a recent article [Robert & Robinet, 1996] for an overview of the studies which rotate, in a more or less broad sense, around this concept. We are particularly interested in the approach to meta-cognition, closely linked to practical teaching situations, found in [Schoenfeld, 1987]. In this paper the concept of meta-cognition is introduced explicitly and the author explains that it is necessary to interest the student in knowledge of knowledge ('thinking about thinking'). The author makes a classification of those elements which he considers most important in meta-cognition: knowledge of one's own thought; control of one's own thought in work situations; mental representations. Schoenfeld describes four modes of developing meta-cognitive skills in the students: using videotapes on badly organized ways of working in mathematics on the students' part, highlighting the teachers' way of working in mathematics in front of the students (with constant questioning and changes of strategy), organizing discussions with the class in which the teacher has the controlling role, getting the students to work in small groups in which the teacher periodically intervenes on the solving strategies.

We can deduce from the analysis of our experience that working with hypermedia serves precisely to promote a new mode of developing meta-cognition skills. From students' observations we can see two different levels of metacognition that the work have stressed: the reflection on how one faces an articulated content (see Points 3 and 5 of Table 1) and the reflection on how teaching a complex topic on the basis of one own experience as student (see Points 2 and 4 of Table 1). The idea of reflection on strategies is inherent in the very idea of 'non-random navigation' in the hypermedia. Becoming aware of one's own way of approaching a topic is detected in the phase of discussion on the use of IPER-3, and even more in the project completion phase, in which contents are organized in accordance with conceptual schemata differing from one group to the other (see the different viewpoints introduced by the two groups).

Hypermedia technologies, in an appropriate use context, can be a means for having information on the students' conceptual networks, since when they work on rendering their strategies explicit they provide the teacher with a key to their mental schemata. In this sense the work with an hypermedia system can offer a different perspective to the study of the dynamics of teaching and learning processes. This observation is an hypotesis we have done after analysing students' work. The study of this hypotesis was not an objective of our experience but it appears an interesting perspective for our future work.

We believe that, over and above the interesting practical aspect linked to easy access to information, seeing the hypermedia as a promoter of meta-cognition and as an environment for studyng teaching and learning processes is a significant approach to the analysis of the role that this instrument can play in the teaching/learning of mathematics.

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1. **Observations of a technical nature on the computer and software**
   There is appreciation for the use of different media, e.g. sound.
   There is appreciation for the interface and the use made of 'evocative' icons; it is seen as useful to always keep the buttons in the same position on the screen and to limit their number.
   It is considered useful to be able to keep more than one page open at a given moment with the same interface layout.
2. **Observations on the mathematical content**
   The history of mathematics is considered an interesting subject; in particular, the importance of being able to see the historical evolution of a mathematical problem is stressed. It is observed that usually mathematics is 'imposed' as something finished and bare.
   Students observed that it would be possible to utilize IPER-3 with secondary school students, marking out some possible itineraries to follow (e.g.: general information, simple line constructions, rule and compass constructions, demonstration of the transcendence of π).
3. **Observations on the way the content is organized in IPER-3**
   The need is pointed out to state, in the first phase of the system, the impossibility of solving the three classical problems in an elementary fashion. This is seen as important because the user by himself may not become aware of this impossibility.
   According to some, the hypermedia should be constructed after the users have been identified.
   The need is stressed for innovative instruments for school updating. Obviously, it is observed that in its present formulation IPER-3 is incomplete for any teacher desiring to use it for updating.
4. **Observations on hypermedia as a learning instrument**
   It is considered a useful instrument for looking deeper into a given topic and for revision.
   By contrast, it is considered a distracting instrument for the first approach to a subject for those who have no knowledge of the contents.
   Freedom of navigation is seen as useful, though it is pointed out that there is a need to guide focusing on the main topics.
   It is observed that a hypermedia instrument can permit the development of greater mental elasticity, favoring a linkup between different topics.
   It is observed that instruments of the type examined can be useful for accustoming students to using other technology-based learning instruments.
   There is positive consideration for the opportunity given by hypermedia to connect kindred topics with one another.
5. **Students' observations on their own work and reactions**
   A student observes that she feels the need to be able to construct the geometrical figures on her own, instead of finding figures already drawn (from this point of view step-by-step constructions are positive).
   Almost everyone notes the usefulness of the instrument in the revision phase (better than notes); in any case it is an instrument seen as a support to the book.
   Some stress that instruments of this type provide an opportunity to approach technology, and to promote a new work mentality.
   All express their own curiosity and interest.

Table 1: Overview of students' observations

Interactivity in Videoconference-based Telepresentations

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Abstract: How does one design for interactivity in videoconference-based telepresentations? Observations of instructional interactions in videoconference-based telepresentations that were made during a series of sessions between a university in France and one in Quebec are reported. Two communication channels were used: 1) voice, image and data transmission over ISDN lines, and 2) data transmission over IP. Four highly interactive instructional methods that could take advantage of this technology were tested. Two major processes were analyzed: preparation and delivery. Results indicate the potential and limits of the four instructional methods, as well as requirements of the two processes.

Overview of the Project

As part of a larger project between Quebec and France on Methods and Tools in a Virtual Campus, the following learning situation was studied: two groups of university students on two sites, participating in a series of sessions on one topic, with telepresenters on either one or both sites; two communication channels: voice, image and data transmission over ISDN lines, and data transmission over IP. Observations were made in both Quebec and France; those reported here are from Quebec, with a focus on which instructional methods can take advantage of this technology and under which conditions.

The Design Questions in Videoconference-based Telepresentations

Telelearning situations require detailed instructional design in order to best provide opportunities for effective learning, following general instructional design principles [Gagné et al., 1992] as well as principles specific to distance learning [Bourdeau & Bates, 1997; Laurillard, 1993; Romiszowski, 1997]. The modeling of these situations in a Virtual Campus Environment [Paquette et al., 1995) requires a detailed knowledge of the actors, actions, possible events, as well as the conditions and constraints. The focus of the observations was on understanding the potential interactivity in various instructional methods as well as identifying the conditions for good or reasonable success. Telepresentations are viewed primarily as unidirectional techniques, most suitable/appropriate for lecture-type teaching. While current trends in education and training are to increase interactivity and learner activity in learning situations, university teaching still relies mainly on lecture-based teaching. Innovative telelearning situations appear at the other end of the spectrum with inter-individual and team-based transactions based on asynchronous communications [Bourdeau et al, 1997]. However, group learning remains the basis of most university teaching, and the design question to be tackled is: what interactive instructional methods can be applied in a video-based telepresentation, and what conditions need to be fulfilled in order to ensure effective and significant instructional interactions?

In a course on Techniques and Tools for Instructional Telecommunications, four instructional methods were applied and tested: team-teaching, panel, seminar, and laboratory. Team-teaching involved two professors, one on each site, who prepared (using e-mail and videoconferences) and presented the course together, sharing the floor and also sharing the IP application for presentation and annotation. The panel was a session where several experts on both sites presented on and discussed a common topic. The seminar involved two students on each site who prepared and gave a presentation on their respective work. The laboratory included a manipulation of the telecommunication tools to illustrate various capacities in transmitting voice and image. These four methods were selected for their potential to support interactivity between actors as well as for being appropriate to university teaching, to the content and objectives of the course, and to the teaching style of the professors involved. A lecture-type method was included for comparison. Two specific challenges were considered: having students as telepresenters, and having two telepresenters interacting spontaneously between the sites. Preparation for instruction as well as technical tests were conducted over a period of several months before the experimentation.

A set of specific issues were considered: 1) the geographic distance, which meant that there was a significant time difference (5 hours), 2) the cultural distance, which is reflected in differences in curricula and academic practices, 3) developing a consensus on the most meaningful tele-presence modalities, and 4) a concern for not letting the tools take too much room, both physically and psychologically. Part of the preparation process included the production of instructional material that had to be digitized, edited in a hypermedia format, installed on the server in France and tested before the session, thus reducing the flexibility of making last minute productions or changes. Discussions among the design team members related largely to the optimal balance between planning and spontaneity, a discussion topic which is typical of a hybrid situation between on-campus teaching - that relies on live events, and distance learning - that requires detailed and extensive planning.

Technological Tools and Room Organization

Tele-Amphi, developed by the CNET research center at France Telecom, was tested used in this trial.Tele-Amphi is original in that it unites a traditional synchronous switch-based network with pseudo-synchronicity on an IP channel. A video-communication channel runs on a set of ISDN lines, and carries voice and image, and more rarely data. A second channel runs on IP and consists of an application software that connects multiples sites on a server where instructional material has been installed, and manages synchronous delivery to the sites; a set of functionalities allows annotations on the spot and alternating control from either site. This software has editing capabilities for high quality hypermedia material, and management capabilities for files and libraries by sites and by authors. A data projector with very high resolution is required for displaying the material on a large projection screen.

Adequate space and room organization for a participating group is a critical issue, as group interaction means sharing a common physical or virtual space, and such technology requires space, connections, lighting, etc. [McVey, 1997]. On the Quebec site, the room was equipped with a turnkey videoconferencing system that includes a control panel for the telepresenter, programmable cameras, video screens, one printed document (or 3D object) camera system, one computer with Internet connection, and microphones for each participant. The telepresenter has to select the image source (scene, printed document or 3D object, video tape, computer screen, combination of these) to be displayed on both sites, to check the display sent from the distant site, as well as to address both sites visually and verbally; participants can take the floor by pressing a button on their desk, thus activating their microphone as well as causing a camera to focus on them. The room lighting is calibrated to send a good quality video image of the scene. Introducing a data projector for high quality material disturbed this calibration and caused major problems in lighting and room organization, as well as disturbances from having two visual foci for participants. A different room organization was found on the French side, with a manually operated video camera, while individual microphones were available on each desk. Differences between the two sites reflect a different emphasis placed on the quality of the image of the class (for tele-presence and social interaction) or on the display of instructional materials.

Methodology

The experimentation took place over a period of nine weeks, and delivery consisted of a series of six sessions of two hours each. The time difference meant that all sessions were held in the late afternoon (Quebec time). Two groups participated, each of them having approximately twenty students. Data collected include observations, recordings and interviews. Two observers used a grid to collect data on the instructional methods, and the instructional events, with specific emphasis on the use of the technological tools. All of the sessions were videorecorded in two ways: the participants were filmed live, and a recording of images and sounds transmitted over the phone lines was made automatically. A series of individual interviews with participants was conducted by the observers in order to complement the data collected by observation. Qualitative analysis of the data was conducted with a framework of categories to allow understanding and interpretation of instructional events, and triangulation was used to come up with a unified set of data. In addition to the data collected during the delivery process, the documentation on the preparation process was used for interpreting the results.

Results

Results indicate a good potential for highly interactive methods, a high level of motivation among participants, and several conditions for success. A number of negative events can be traced to to various technical and logistical problems; others can be seen as stemming from a lack of preparation, such as communication breakdowns, or simply as an inherent limit of the situation, such as the loss of eye contact. Launching time took too much of the learning time; many participants were to shy to use the various media; visual quality was not up the sound quality. The combination of synchronous and asynchronous tools proved to be promising and should be effective with the upcoming generations of Internet tools , such as increased bandwidth allocation and reservation protocols for synchronicity.

Analysis of the results after triangulation produced three categories: 1) impact of technological tools, 2) social interactions, and 3) efficiency of instructional methods. The technological tools were very much appreciated in that they gave the opportunity to interact in real-time with other professors and students and share with them, an interaction that is otherwise not available; provided access to high quality instructional material that could be annotated from any site was of great value to participants. The high level of motivation also created high expectations that could not be fulfilled. The reduced channel of communication in a tele-presence situation as compared to a physical presence caused a feeling that we call "sensory deprivation" where participants on each site want to share all of the details and nuances of the events at the other site, and feel deprived that they cannot. Also noted is the technological risk associated with increased interactivity: the more interactivity (between actors, sites, resources), the more "time-to-tools" (delay or bugs) required, time that was seen as stolen from "time-to-students". Consequently, as soon as a tool required too much attention to make it work, the reaction was to skip the interaction and move on with less interactive modes.

Social interactions are known to play an important role in group learning, and again, the limitation of the communication channels did not allow real socialization between participants; time dedicated to getting familiar with each other should have been planned; on-campus life allows continuity in social exchange which was not compensated by any means, leaving all participants with a feeling of having missed something. Eye contact, considered a key for success in instructional transactions, was too often lost, not only between sites, but also on the same site, given the attention requested by technological tools.

Efficiency of instructional methods was measured based on effective time, both presentation and interaction time. Interactive methods proved equally effective, while the lecture-type was more effective, which can be easily understood given the fact that more interactivity required more "time-to-tools", seen as non-productive time. Efficiency of all methods could be improved by investing more time and effort into preparation of instructional events and material, including a back-up plan in case of breakdowns. We have every reason to believe that interactive methods have the potential to be effective in telepresentations, but we need to learn how to handle unusual and unexpected situations.

Toward the Modeling of Interactive Telepresentations

Knowledge gained from this experiment is being used to further the modeling of one case, Interactive Telepresentations, within the framework of the Virtual Campus Environment at Télé-université [Paquette et al., 1995]. A Telepresenter is defined as a role that can be played by various actors such as professor, student, expert; she or he presents content by addressing other actors verbally and visually, by showing documents that can be seen by actors on all sites, and by interacting with other actors in various ways. Several instructional methods can be applied, and several types of instructional events can take place, based on design principles as well as on teaching style. Tools used include video-communication, application software for delivery on all sites, data projector, and room-size shared virtual space. Certain conditions specific to this case apply, such as duration and rhythm for interactions, adequate room organization and lighting, appropriate ratio between preparation and delivery processes, and time for participants dedicated only to social interaction Coordination aspects are crucial to this type of instructional events, and could benefit from an interdependency analysis such as the one done for collaborative telelearning [Wasson & Bourdeau, 1998]. This modeling includes transitions between various multimedia spaces (individual, team, and group) and communication modes, both synchronous and asynchronous.

Conclusions

Maturity in interactive telepresentations require not only more integrated and more robust solutions, but also more design knowledge, based on both principles and experience. Among conditions for effective interactivity are: increased ratio of preparation vs. delivery time ; allow participants to become familiar with each other and be introduced to the use of the media before instruction time; room organization that provides adequate space and lighting. One question that remains partially unanswered is: when does the media act as an obstacle to interactivity instead of a way to interact? Transitions between sessions need further study, to obtain instructional design knowledge on transitioning between various media spaces. Alternative and innovative instructional methods need to be developed in order to take advantage of potential interactivity offered by this technology. Modeling and interdependency analysis can help gain the knowledge needed, as well as variations in experimental settings, such as intercultural settings, or heterogeneous technological platforms.

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Design Considerations in the Development and Delivery of Digital Learning Media

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Abstract: The growing use of the Internet and other digital modes of delivery for higher education challenges universities to identify new criteria for the design, production, and quality assessment of programmes delivered via digital learning media.

This study reports on phase one of a research project undertaken by a team from the University of South Australia and Victoria University of Wellington to design and deliver educational applications of digital learning media, and to identify criteria for assessment of the efficacy and quality of the use of such media from a comparative analysis of three credit-bearing courses delivered in both on-line and conventional modes of delivery.

The paper examines a set of assumptions derived from a constructivist approach to learning design, in the context of a case study of an Internet-based course on electronic publishing, known as "Infotrain", developed at the University of South Australia, by Philip Marriott and Michael Brittain.

CONTEXT OF THE STUDY

Digital learning media is most often encountered either in the form of self-contained courses of instruction on CD-ROM discs or by the presentation of interactive learning programmes on the World Wide Web. In the future, other digital technologies including DVDs (digital video discs), digital satellite transmissions and fibre-optic cable are anticipated to supersede CD-ROMs and the present form of the World Wide Web.

Although courses on a CD-ROM disc and Internet-based programmes engender fundamentally different learning experiences, both of these new modes of educational delivery have provided individual learners worldwide with new patterns of flexibility.

The focus of this paper is primarily upon Internet-based learning activities. Accordingly, all references to digital learning media herein refer to courses offered on-line which may be supplemented by storage of intellectual property such as textbooks on an associated CD-ROM disc.

This paper is the product of four years of research and experimentation with emerging educational technologies in an effort to identify the most appropriate uses of the digital learning media. One application of this research has been the creation of an Internet-based course on electronic publishing, known as "Infotrain" at the University of South Australia, by Michael Brittain and Philip Marriott. This course, which has be active since 1995, serves as a case study against which theoretical approaches to digital design may be considered in context and evaluated.

FUNDAMENTAL PREMISE

The basic premise underpinning this project is the belief that widespread adoption of digital learning media requires academic staff to completely rethink the nature and practice of higher learning.

The advent of digital learning media profoundly alters the relationship of the learner to his or her university, tutor and course material. The control of when, where and how one learns shifts from the provision of the academic manager to become the primary responsibility of the individual learner.

An extensive literature search was undertaken in order to delineate contemporary views of educationalists of the best practice for the design and delivery of digitally presented learning media.

The main thrust of the design approach advocated in this paper is to shift the teaching process from "subject-based" instruction to "problem-based" learning. The tasks and exercises component challenges students to:

a) Discover what they already know about a subject and attempt to apply that knowledge to find methods of solving similar problems which are likely to arise in their professional and private lives. This orientation meets the design criteria that generic course material be applied, coherent and problem-based.

b) Attempt increasingly difficult tasks supported by hints, model approaches and methodological suggestions (but not "correct" answers).Problems posed will be supported by Socratic instruction (whereby student questions are answered by questions which encourage the student increasingly rely on their own powers of analysis).

CURRENT BEST PRACTICE CRITERIA FOR DIGITAL LEARNING DESIGN

The following ten design principles have been delineated from an extensive literature review should be considered in the production of educational applications of digital multimedia:

Principle 1: Foster Critical Thinking as Well as Core Skill Competencies

Constructivism (a cognitive approach to learning in which the core objective of educational design is to facilitate the development of critical thinking and problem-solving skills) is superior to content-oriented curricula which promotes rote learning. [Clift & Chambers, 1994]

Principle 2: Create Problem-based Learning Modules

Problem-based learning techniques engage learners by posing relevant problems in a context which challenges the learner to discover how to use theoretical concepts within a discipline as practical tools of analysis.

Principle 3: Frame Problems in Learner's Life Context

People learn best when presented with problems which they may reframe to be relevant to their life circumstances, goals and interests.

Principle 4: Non-linear Problem Sets

No single solution path can be deemed correct and will enable the learner to utilise virtually any aspect of the materials available on the CD-ROM (or Internet) in an integrative fashion to synthesise a solution. In solving problems, a learner is encouraged to first subjectively formulate the criteria by which an optimal solution to the given problem may be judged.

Principle 5: The Essential Role of the Mentor

Learning, as with all forms of communication, entails an intersubjective social negotiation of meaning through interpersonal discourse. Accordingly, a mentor-learner relationship is crucial to optimal learning experiences. An application of an non-programmed design approach to learning media design rejects structured non-linear instructional modules, as well as the production of mere linear digital textbooks, in favour of media which present problems without any predetermined solution paths. Such non-structured learning experiences will require the participation of a mentor who can provide cues and Socratic support to the learner as he or she constructs meaning relevant to a specific context or vocation.

Principle 6: Making Optimal Use of Digital Storage Potential

Educational uses of digital multimedia are most effective where the vast storage capacities of the media are used to simulate the array of relevant information pertaining to a discipline which the learner must develop skills at searching and evaluating for use in solving the type of problems typical of the discipline being studied.

Principle 7: Making Optimal Use of the Unique Random Access Characteristics of Digital Media: Hypertext

The digital learning media should be designed such that regardless if it is in a CD-ROM, DVD or World Wide Web format, the learner can readily access from within the programme the unlimited resources of the Internet. Hypertext encourages a decentering process by potentially linking all texts in unmapped and unprogrammable network paths. [Landow & Delany, 1990] It is this attribute which merits close attention in the design of digital multimedia. Hypertext challenges us to comprehend how documents are related. We no longer can experience a book as the authoritative and permanent product of an author. With hypertext, a document is no longer linear or fixed. With hypertext all documents are dynamic and fluid "re-writings" produced by their readers.

Principle 8: Foster Navigation Skills and Access to the Totality of the Resources Available

Learners are empowered to creatively draw upon the totality of the resources available to them in the search for solutions to problems. The learner would then be encouraged to utilise the digital technology only as a starting point to commence the search for the required solution. In this manner, the self-confidence and initiative of the learner would be fostered as would the recognition that all knowledge is dependent upon underlying assumptions.

Principle 9: No Preferred Solution Path

The design of multimedia rejects predetermined non-linear structures for learning materials on CD-ROM or the World Wide Web, as well as linear programming, in favour of media which present problems without any predetermined solution paths. Such an approach to the use of multimedia simulates the unstructured nature which one often encounters problems in the workplace and every other facet of life. This compels a learner to utilise his or her own judgment in formulating a solution rather than seeking to replicate the solutions proposed by course designers.

It is recommended that where possible, problem sets be presented to voluntary study groups of learners for collaborative problem-solving and mutually supportive learning interactions.

Principle 10: A Guide Through the Labyrinth

Implementation of Principle 9 above serves to promote an unstructured approach to making sense of the world by grasping whole systems, rather than minute analysis of their perceived parts, reinforces the central role of the mentor in the learning process. Without an interactive guide, an "unstructured wholeness" approach to the presentation of problem-based learning modules could leave a learner submerged in his or her options in a labyrinth of information.

A theoretical rationale for the indispensability of the interpersonal interaction between a mentor and a learner, in an optimal learning experience, can be found in the work of the social constructionists who contend that all perceptions of reality (including learning) are constructed from discourse and negotiation.

Biocca [Biocca and Levy, eds. 1995] has theorised about the social construction of a learning experience embedded within the design of the course materials. Each educational technology entails the communication of a discourse that influences how learners think about reality. The pre-programmed, self-contained course material frequently encountered on CD-ROM and many Internet-based courses are not able to simulate a dialogue that will meet the learning needs of any individual learner. This requires personal interaction from an intelligent and perceptive mentor. Accordingly, an optimal learning strategy recognises the essential role of human interaction whose support of the learner facilitates a constructive dialogue as the learner constructs meaning from the educational experience.

Educational multimedia may supplement a learning experience by presenting a powerful simulation of a particular facet of the external world. However, what digital multimedia commonly lacks is the ability to interact dynamically and intelligently in a discourse with every learner about what such a simulation means.

The provision of a dialogue is the role of the human mentor that facilitates and manages the learning experience of an individual acquiring the cognitive and domain skills of a discipline. Again what is sought is not the acquisition of specific content knowledge but rather the growing sophistication of a learner in addressing problems typical of a discipline by using theories and concepts as tools of analysis. This process of development in a person's cognitive reasoning capacities is best facilitated by a dialogue with an accomplished mentor. Until machines are capable of fully simulating the cognitive and social repertoire of humans, the role of a mentor will continue to be an irreducible element of an optimal higher learning experience. The mentor fades from the learner's endeavours as he or she becomes more confident and self-reliant.

THE "INFOTRAIN" CASE STUDY

Infotrain [Marriott and Brittain, 1995a, 1995b] was developed in the period 1995-1996 at a cost of approximately A$50,000. Upon opening the course for enrolment in 1996, Infotrain attracted 50 students. Soon, the course generated hundreds of emails each week as learners gained competence at interacting on the Internet with their tutors and "classmates". In 1997 approximately 97 students are enrolled, across a wide range of disciplines. The project team has analysed the Infotrain experience from the perspective of three stages:

a) Trialling

b) Learner feedback

c) Reflection by course managers based on 3 years' experience of delivery

Feedback from Infotrain students suggests that they tend to fall into one of two groups: those who drop out of conventional classroom lectures and rapidly rely solely on the Web-based course materials to complete their studies, and approximately 30% of the students who require continuing contact to achieve learning objectives. It is recognised that for many students the social aspects of the learning experience are a vital component and for these students non-verbal communication elements within the classroom context are as important as the expressed verbal content. Other factors appear to be a need for some to enjoy the "theatre of the lecture hall", the presence of a mentor to help the learner impose personal discipline to performing one's learning tasks as well as a guide to suggest pathways through the labyrinth of information confronting students on-line.

Underpinning the Infotrain initiative is a desire to create a flexible and efficient learning environment. As Infotrain has matured since 1995, each iteration of the course has made a closer approach to this goal. Students may take the course in a structured teacher-centred, lecture-tutorial way, or a student-centred, internet-based, distance manner. They can also move backwards and forwards between these two options as they wish - attending lectures and tutorials for a few weeks before changing to an online approach. The same materials are used in lectures and online. Students can work in groups or as individuals. Ideally we would like students to have the opportunity to determine their rate of progress through the course - however the present constraints of assessment timelines and staff workloads have not made this workable.

The ability to rapidly apply the results of student feedback has enabled the fast development of the online materials. We are presently looking at a means of easily localising content. The intention is to target the Infotrain materials to specific client groups. In 1998 Infotrain will offered at the University of South Australia and Victoria University of Wellington. A cut-down version of Infotrain to be delivered by CD is under development for the general public.

CONCLUSIONS

The authors have derived the following preliminary conclusions to be considered in Phase II design of new courses incorporating digital media:

a) Digital learning media has the potential to transform the very concept of the traditional university by deploying distributed expertise and altering resource requirements for the provision of quality learning experiences. Infotrain has demonstrated that there is a new role emerging for tutors which necessitate a redefinition of how a University must commit scarce time and teaching resources. This emerging mode of delivery raises the prospect that international networks of tutors may emerge to collaborate on courses offered simultaneously at several institutions throughout the world.

b) These transformations will require academic staff to develop new qualifications, skills and tutoring methods. Of primary importance for academics will be the acquisition of excellent navigational and searching skills and the ability to transmit those capabilities to one's learners.

c) Current best practice is served by cognitive and constructivist approaches to course design. Digital learning media should be to foster critical thinking skills as well as generic competencies. Learners should be encouraged to use content-specific principles as tools of analysis rather that required to replicate course content.

d) A substantial percentage of learners require continuous interpersonal contact to achieve satisfactory learning outcomes. It is urged that the regular synchronous or asynchronous participation of a mentor be regarded as an indispensable element of the learning process.

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Distributed Learning Environments: Pedagogy, Implementation, and the Early Adopter

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Abstract: Pedagogy embodies the beliefs one holds about students, about the various attributes of media technologies, and about the essential qualities of the content at hand. Teachers make decisions based on the interactions of these beliefs. Therefore, it is imperative that one begins the process of designing and contemplating instruction with a consideration of the beliefs one holds concerning the components of this instruction. This paper offers some observations about the pedagogical implications for teaching and learning gathered from our experiences with the development of two types of distributed learning systems: the North Carolina Information Highway, a video-based system and CaseNET, a World Wide Web-based system.

The widespread interest in network-based learning – partially spurred by the 1993 introduction of the World-Wide Web – has instigated an examination of the underlying structures and assumptions in K-12 and higher education concerning what constitutes sound instruction, and the role that distributed learning environments play in such educational endeavors. What is emerging from such interests is a recognition that traditional teaching practices are often at odds with those to which the new media lend themselves. The result is often a state of cognitive dissonance in which the teachers and students struggle to bring old knowledge to bear on new situations. In a recently released report entitled *Technology and the New Professional Teacher: Preparing for the 21st Century Classroom*, the National Council for Accreditation of Teacher Education [NCATE 1997] offered the following:

> Teachers may be forgiven if they cling to old models of teaching that have served them well in the past. All of their formal instruction and role models were driven by traditional teaching practices. Breaking away from traditional approaches to instruction means taking risks and venturing into the unknown. But this is precisely what is needed at the present time. (Pg. 5)

The "old models" and "traditional approaches" mentioned in this study are deeply rooted in the beliefs teachers hold about teaching and learning, as well as the images they hold of themselves as teachers and their students as learners. These images provide the foundation for the development of certain metaphors which teachers use to guide their practices in instructional environments. What we offer in this paper are some observations about the pedagogical implications for teaching and learning gathered from our experiences with the development of two types of distributed learning systems: the North Carolina Information Highway, a video-based system and CaseNET, a World Wide Web-based system.

The North Carolina Information Highway[1]

The North Carolina Information Highway (NCIH) is a video-based information delivery system developed by a consortium of state agencies and private industry. Widely regarded as one of the most well-developed information systems in the United States, the NCIH is a fiber-based network that utilizes the latest telecommunications technology – including ATM and SONET – to create a statewide network for information transfer. The following vision is offered from the NCIH website:

> The implementation of the network will result in the construction of an information highway ... analogous to the building of the interstate highway system in the 1950s and 60s. Just as the structure of interconnecting multi-laned highways has provided a faster and more efficient way to move products and people, the high-speed network will carry information to all points of the state reliably and economically. This information includes ... interactive video-based education classes for sharing the best teachers to improve the quality of instruction and to offer advanced courses ... to all of the state's students, statewide access to books, periodicals and technical journals contained in our leading research libraries, and vivid, detailed results of complex engineering and biological/medical calculations performed by our supercomputer for universities and advanced research centers.

Indeed, the NCIH is a technically advanced and sophisticated system. North Carolina now boasts a digital infrastructure that is unparalleled, and supports the potential for commerce, education and communication between individuals at all ends of the state.

However, a lack of consideration for pedagogical issues and an ill-conceived vision for its use in learning environments have hindered utilization of the system for educational purposes. For example, the cost for utilization is prohibitive. The implementation model employed by the developers requires sites to secure funding to participate. Although the state Office of the Controller provided grants to qualified applicants for one-time expenses, no clear vision for sustained funding has ever been advanced. One consequence of this is that sites that have secured funding are almost compulsive about using the system, even if it does not address a clearly articulated need. Another consequence is that the statewide system reaches many fewer locations than projected.

In addition, data is not part of the standard NCIH package – though it is an option. This may, initially, be viewed as a possible oversight; in fact, it is not. The NCIH is, by design, a video-based network. This fact makes explicit some implicit beliefs which decision-makers and developers hold about the nature of the delivery of effective "interactive" education, since video sites rarely have the computing capacity requisite for a combined video- and computer-based learning environment. The composite result of such conditions is that many school systems have been effectively left behind because resources went toward building a system they could not afford and that the system that has been built is used more to justify its use than with good pedagogical practice in mind.

What is evident to us, concerning the dilemma presented by the NCIH, is that decision-makers associated with the design and implementation of the system are clearly operating under some assumptions about teaching and learning that are not conducive to the effective utilization of the environment *for teaching and learning*. The most obvious fallacy lies in the assumption that teaching via the NCIH is really the same as teaching in a classroom. When the traditional approaches fail to elicit the expected responses, many are unable to make the appropriate adjustments required to make it work. While Newton's law – that every action has an equal and opposite reaction – does not quite fit here a version, modified for human terms, which reads that every action has unintended consequences fits very well. What we see is a large number of unintended consequences that are not always recognized as artifacts of applying traditional pedagogical practices to new communications environments. What has been noticeably lacking is any systematic way of looking at the various telecommunications tools and analyzing them in terms of what they can and cannot do within a learning environment.

Alan Kay [Kay 1992] of Apple Computers suggests that people often view new technology in terms of solving old problems before learning that the new technology may make the old problems irrelevant and bring with it new problems or issues. His primary example is the motion picture camera. It existed for 50 years, used primarily as a novelty and as a way to bring a stage play to audiences – using a fixed camera in the position of the audience, focused on the actors on a stage. Such was the prevalent model until D.W. Griffith introduced the motion picture as a distinct art form, through use of close ups, wide-angle shots, different camera positions, and cutting from or into action, and so forth.

The same can be said of the computer and of telecommunications technologies and their use in teaching and learning settings. First efforts historically have been to use the technology in the context of existing pedagogies. Yet, if one studies and understands the inherent characteristics of the various technologies -- what the technology can and cannot do – one begins to recognize the need to break down the old models and get to the essence of what we want to accomplish. To achieve this recognition requires an analysis of the various modes of communication and interaction enabled by the technology, itself, that are conducive to supporting the kind of learning and engagement desired.

Some [Perkins 1990; Pea 1990; Salomon 1990] have suggested that distributed environments result in a diffuse sense of cognition – where what is "known" lies in the interaction between individuals and artifacts, such as computers and other technological devices. However, Kozma [Kozma 1991] suggests that:

> Some students will learn a particular task regardless of the delivery device. Others will be able to take advantage of a particular medium's characteristics to help construct knowledge. Many teachers, it may be said, are no different with regard to their instructional methodologies. (Pg. 205)

A focusing question for those interested in implementation would be: what enduring *cognitive and pedagogical effects* are enabled when an individual is engaged in and with such distributed environments? Previous conceptions of teaching and learning are informed or altered by interaction within such environments and, perhaps even more important, such interactions shape and alter the media, as well. In his reaction to Clark [Clark 1983], Kozma [Kozma 1991] offers the following support:

> Medium and method have a more integral relationship; both are part of the design....the medium enables and constrains the method; the method draws on and instantiates the capabilities of the medium. (pg. 205)

CaseNET[2]

CaseNET is a set of WWW-based courses jointly organized and offered by institutions of higher education and district professional development teams from the U.S., Canada and Norway. Participants include both inservice and preservice educators. CaseNET is not "distance education" in the typical sense of the term. Students meet physically at a particular site and given time and are guided by an instructor on-site. Course readings, instructional materials, and opportunities to discuss educational issues are available through Web-based discussions and videoconferencing.

Site instructors use case methods--similar to instructional approaches used in business, law and medicine--to bridge educational theory and real-life practice in schools through "slices-of-life" scenarios that capture situations in real classrooms. Participants attend to standards of learning and assessment, issues of teaching across the content areas, and challenges of using technology to solve problems in schools while applying an educational problem-solving model for making sound judgments in the demanding situations educators so frequently encounter.

CaseNET encourages participants to:

1. cooperate within teams and compare analyses across teams in search of solutions to real-life educational problems,
2. link with people from other sites to concentrate on case issues,
3. write cases for use in school-embedded staff development and/or in their classrooms, and
4. prepare for continued professional development through "reflection."

CaseNET is an attempt to match the inherent characteristics of certain types of communication tools with learning activities deemed useful for teacher development. Instructors are using technology with an understanding of what it is that students need to do to develop as professional educators and also with a clearer conception of what role they, as teachers, play in such an environment. In large part, both student and instructor are actively engaged in sharing, questioning, and directly experiencing the consequences of making teaching decisions. The developers of this environment have gone to great lengths to construct a distributed learning environment that allows for support and encourages the requisite behaviors listed above. Successful CaseNET instructors do not try to match the method to the media but, rather, extract the meaningful components of the media to support their pedagogical decisions.

The Role of Pedagogy and Belief

One's pedagogy embodies the beliefs one holds about students, about the various attributes of media technologies, and about the essential qualities of the content at hand. Teachers make decisions based on the interactions of these beliefs. Therefore, it is imperative that one begins the process of designing and contemplating instruction with a consideration of the beliefs one holds concerning the components of this instruction. William James, the founder of American psychology, suggests that belief must begin with the act of believing as it relates to hypotheses and options.

James introduces *live* and *dead* hypotheses in his essay *The Will to Believe* [James 1897]. Live hypotheses are ones that truly may be possible, for example: "Students learn best through direct lecture." Dead hypotheses are ones that are not believed possible. When competing hypotheses present themselves, belief is engaged, and a decision requiring action and decision between two or more *genuine* options must be made. Though options may be a combination of (1) living or dead, (2) forced or avoidable, and (3) momentous or trivial, a genuine option is one that is *living, forced and momentous.*

Options are *living* when a choice between to live hypotheses is presented, as opposed to a choice between a live and a dead hypothesis. For example, choosing between "Students learn best via lecture" and "Students learn best via student-directed activity" presents a live option, since either may be considered plausible. However, choosing between "Students learn best via lecture" and "All students are incapable of learning anything" is a dead option. An option is *forced* when the option of "doing nothing" does not exist. Choosing between instructional methods is often a forced choice, especially when presented with an unfamiliar teaching setting. Finally, an option is momentous when the opportunity to choose between competing hypotheses presents a situation that is unique, significant and irreversible. Certainly, choosing to teach via a distributed learning system like the NCIH or CaseNET would qualify as unique, significant and – for the duration of that particular period of instruction, at least – irreversible.

Genuine options exist for teachers in all instructional situations. However, when considering instruction via distributed learning systems, the element of clarity is often missing from the decision-making process, due to a lack of understanding of which options, exactly, are the genuine ones and which are not. The implications of these options are often less clear because of an inadequate amount of attention to beliefs and their roles. However, the pedagogical constructs, which result from the choices between perceived genuine options, are still explicit. These constructs are girded by the beliefs and assumptions teachers hold about how students think and how students learn, stemming from what Bruner [Bruner 1996] refers to as a "folk pedagogy."

The similarities between traditional instructional methods and those methods most effective within distributed learning environments that some have implied are not as closely aligned as many wish. Projecting such similarities upon the distributed learning environment suggests a certain amount of continuity and congruence with more familiar environments for teaching and learning, and tends to reinforce some reasonably poor teaching decisions. The instructional method that appears to offer the closest point of confluence appears to lie within the lecture mode so teachers and students often find themselves slipping comfortably into the roles of didactic teacher and learner which have seemed to serve them so well in more traditional environments.

There appears to be an inverse relationship between the amount of bandwidth available and the degree of creativity exhibited by the teacher and learners working within the distributed learning environment [Riedl 1994]. That is, the people with the largest amount of bandwidth, which often presents an environment that appears to be very much like a regular classroom as in the case of the NCIH videoconferencing environment, seem to be the least creative. Those with virtually no bandwidth – typified by those with simple modem access, only – tend to create very interesting learning scenarios.

There is a kind of "professional dissonance" that the use of narrow bandwidth causes when good teachers encounter it. Their habits and assumptions about teaching and learning are challenged –a bit of the Deweyan "problematic" is introduced – and they have to be more cognizant, more aware, more active in how they address the idiosyncrasies of the learning environment. Those with bandwidth, however, may fall more easily back on older, more comfortable models that fit – more of a "resonance," between new technology and old teaching. This opportunity is often unavailable to those without the bandwidth.

Successful implementation requires an understanding of the characteristic considerations of early adopters and a recognition of how these early adopters perceive the innovation [Rogers 1983]. How effectively the adoption and diffusion of a particular innovation proceeds is directly related to the:

(a) advantageousness of the innovation;
(b) compatibility with existing values, experiences and needs;
(c) level of complexity during use;
(d) testability; and
(e) observability of direct implications of the innovation [Rogers 1986; Wells & Anderson 1997].

Diffusion relies greatly on the ability to capture those characteristics and somehow relate them to those widely held beliefs common throughout the social/institutional culture system. Teachers who are not looking for different ways to do things do not venture into the narrow bandwidth environment at all.

Those who are looking for ways to open new experiences and exposures to their students do explore the technologies looking for ways to open new opportunities and, thus, we find more creativity. The desire to be creative and to do things differently is the impetus that helps these teachers move into more interesting ways to use the technology and to solve the problems that threaten to get in the way of their efforts. In order to successfully sustain creative and effective usage of distributed learning systems, teachers and decision-makers need to be tuned into the pedagogical assumptions which guide their decisions when planning for integration into educational settings.

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[1] The North Carolina Information Highway website is http://www.ncih.net
[2] The CaseNET website is http://casenet.edschool.virginia.edu

Avoiding the Plug-n-Play Syndrome

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Abstract: The Multimedia Teaching Strategies project at Memorial University of Newfoundland, Canada has its home page at http://www.cs.mun.ca/k12media. We focus on providing the classroom teacher with flexible instructional strategies for their classroom, which can be understood and adapted without requiring detailed expertise in the technology. This is achieved by the use of narratives of successful classroom experiences coupled with a breakdown of the resources and information needed to evaluate and establish similar activities (i.e. replication) by the teacher. In this way, we encourage teachers to think about technology integration in their teaching, without requiring any special prerequisite knowledge, training or aptitude with the technology. Thus, we seek to include teachers typically disenfranchised by the technology movement, and at the same time avoid the technology-driven curriculum in favor of pedagogically-driven uses of the technology.

Introduction

> *"What do you need?" the salesperson asks the teacher. "Well", answers the teacher, "What can a computer do for my students?" Aha! The salesperson has the opening he wants. "I know exactly what you need" says our salesperson. "It's the latest, fastest multimedia system with on-board MPEG III and 100X CD-Rom. It'll put the latest technological advantages at your students' fingertips." he exclaims.*

Often, teachers are not making the purchasing decision, but this scenario still illustrates the problem of a focus on the technology. The salesperson has no interest in the pedagogical needs of the students, and the teacher cannot make the connection between the technology and the curriculum without specific technology expertise. We often end up with a school containing the latest equipment, but no strategy for appropriate exploitation of this technology.

In our school system, we see teachers with little choice in their approach. Heavily laden with a full schedule, the teacher is doing counseling, administration, instruction, as well as instructional development. The pressure to integrate technology and multimedia into their teaching creates further demands. The situation has lead to a quest for what we call the "Plug-n-Play" curriculum. It is natural in this circumstance to look for ready-made solutions that can "plug into" your existing classroom milieu and prove immediately effective.

The Plug-n-Play Syndrome

Ready-made solutions are attractive in an administrative sense. They allow you to standardize classroom practice, making it easy to share resources; they distribute development costs among many technology users and come with vendor support; they guarantee a minimum level of delivery to the student.

In our Kindergarten to Grade 12 (K-12) school system, standardization is simply not feasible. Small rural schools with few computers and minimal Internet access are part of the same system as larger schools with industry-financed resource centers, local area networks and technology resource personnel on staff. Standardizing the level of technology support throughout the system is neither administratively feasible nor desirable. Where schools are comparable in technology resources, there are differences in the network configurations, distribution of technology resources, and the expertise and interest among the school staff.

Where plug-n-play curriculum is feasible, it tends to kill innovation at the classroom level. The components (e.g., CD-ROMs with packaged multimedia materials) are designed for a minimal technology platform, to which the classroom must conform. Moving beyond this minimal configuration becomes difficult; succeeding with less advanced equipment becomes impossible. Pick up any professional magazine that advertises commercial curriculum resources, and you find several articles focusing on the problem of standardized delivery, for example: "We've spent billions on innovative models designed to jump-start the school reform movement. But it will only have the desired impact if the dissemination process works" [Salpeter 1997].

The more serious drawbacks to plug-n-play learning are pedagogical; the materials come with packaged instruction to match its packaged curriculum. Individual learning styles, student learning problems, the local context and culture, or innovations in teaching technique become harder for the teacher to address, as control over the instructional elements are taken out of the teacher's hands. Innovation in the classroom is reduced to trying to get the newest piece of hardware, and is co-opted by an administrative activity, i.e. resource acquisition. Taking a portion of the responsibility for instruction out of the hands of the teacher is, we believe, a serious step. We run the risk of fostering the belief that the technology is all-important; that as long as the students have technologically advanced material and equipment, they have also advanced their learning. Promoted by commercial and administrative interests, this attitude may create a false sense that the environment has improved. Instead of being a vehicle for change, the technology has *become* the change. We believe that critical assessment and adjustment to the instructional environments has to be in the hands of the teacher if the materials are to be effective.

Even when these problems can be mitigated, there is difficulty finding “good” plug-n-play material to use: “Research shows that powerful, new technologies exist that can assist in developing better learning environments for all students... yet these technologies are not used by local public school teachers because they exist as isolated products, without a school-based curriculum tied to well-designed instructional strategies” [Wieburg 1997].

Teacher as technology expert (Beware of the "TechnoGeek")

Our bias is that teachers are the appropriate persons to decide how to use materials in their own classes. However, teachers themselves are generally reluctant to make decisions about the use of technology in the classroom because they are unfamiliar with it; they feel inadequate to assess the potential impact the technology will have on their teaching and classroom structure. Consequently, our local school system, like many others, has had many in-service training programs to provide teachers basic technology skills.

The danger in this approach is undue focus on the technology, rather than the student. It assumes you must know what the computer can do, and how the computer can do it, before you decide how you want it used in your classroom. There is some natural justification for this belief; after all, a fair understanding is required to confidently estimate the time, effort and benefits in a new approach. McKenzie [1996] puts it this way:

Teachers trained in one technology and mind-set sometimes find themselves gridlocked into old patterns and perceptions. Thrust into a world of new technologies, they persist in seeing them in terms of the familiar; the wordprocessor, for example, is viewed as a glorified typewriter with powerful editing features rather than as the idea processor it can be. To understand the computer's power for idea processing and improved composition, one must take a computer home, live with it, and write with it. Only by embracing the technology can one experience the kind of immersion that breaks through the surface understandings to a deeper level of involvement.

This kind of approach leaves the teacher continually in need of training; as new technologies appear, demand for teacher training will follow; in everything from printer technology to virtual reality the teacher will be playing "catch-up" [Ainge 1997]. Otherwise, we ascribe to the teacher technical incompetence to make decisions regarding instructional delivery. Once again, this is done in service to the technology: teachers will be given a standardized, general training which may not prepare them to think about their own classroom context or problems.

In our school system, we were faced with the situation that not every teacher could or would want to become a technology expert. We wanted to reach and involve teachers who were reluctant to adopt technology or had no means of thinking about multimedia technology in the context of their own teaching. For these teachers, there is a need for them to understand what the computer can do; but the teacher doesn't necessarily need to know how the computer does it before evaluating the merits of an innovation in their own teaching situation. This is the belief behind our Multimedia Teaching Strategies project.

The Project Perspective

Our project is a Web-based presentation of successful strategies for exploiting multimedia technology in the classroom. These strategies are not prescriptive, but rather anecdotal in nature, highlighting the elements of successful experiences drawn from different schools in the local area. An anecdotal approach encourages visitors to the site to investigate the experiences of other teachers who have used multimedia technology, and to think about how to adapt and use these approaches in their own classrooms. In highlighting these experiences, we attempt to capture underlying philosophy, resource requirements, successes and demands of each "experience". This is an attempt to provide the visitor the information they need to consider each approach in light of their needs and resources, without an in-depth and detailed expertise in the technology required to establish each strategy. When successful, the teacher can decide what they want to do with technology, and then seek the resources, expertise, advice and input they need to make it happen. The required expertise (as outlined with each anecdote/experience) can usually be extracted from within the school staff, the local community, and often found among the students in the classroom.

To us, having to learn the technology before conceptualizing its integration into the classroom, is analogous to learning how to run a typesetting shop before using textbooks in the classroom. Our belief is that teachers don't have to be able to construct technology solutions before they can think about appropriate application of the technology. Given appropriate teaching models and support, a teacher should be able to look beyond the technology, and instead think about how the classroom can be changed, and what new activities are now available. It should not require a great deal of familiarity with the workings of machinery. Like Ainsworth [1997], we believe the appropriate "expertise" lies in knowing the correct critical questions to ask:

Understanding the ***hardware*** *is easy. Hardware is the box that holds the ideas (software). If the box can't keep up with the software, get a better, bigger, or faster box. Hardware either works or it doesn't. If it breaks, call a mechanic. This is all you need to know about hardware.*

The second thing you must know about in order to be a computer expert is the ***software****, which is the interesting and exciting part. When you can pick out the really good software from the junk, you will have become an expert. To do that, you only need to learn to ask three questions. Ask simply:*

1. ***Do I need a computer to do this?***
2. ***Am I learning anything?***
3. ***Will this help me teach?***

Ainsworth's suggestion is restricted to the selection of software, but we want the teacher to go further, and envision specific projects and activities that integrate multimedia technology into their teaching practice. This is the claim that our project is intended to test -- is it possible to have a strategy for multimedia integration without being a technology expert?

Our research centered on extracting what worked for some teachers in our K-12 school system and identifying the elements that would help a teacher critically evaluate and implement any components of those experiences in their own setting.

The information for our Web site was collected via both informal and structured interviews. Sessions were video-taped for transcription or for playback to other teachers utilizing the Web site. (After all, we could not discuss the integration of multimedia without incorporating it into our site as well!) The site is structured as a guidebook, divided into five separate, but related, sections: Pedagogy, Equipment, Projects, Resources, and Skills.

The *Pedagogy* Section introduces some discussion of multimedia in the classroom through interviews with teachers and administrators working with multimedia, and their impressions of the technology. Included in this section are comments from a number of Educators with "hands-on" experience using multimedia to instruct. Sub-sections are divided by individual so that you can get a feel for each one's experiences and knowledge. Some may hold differing opinions so that you can get a feel for the true state of multimedia in the curriculum. The intent is to help the teacher develop a teaching philosophy that incorporates technology. By examining differing viewpoints and approaches, the teacher should start critically evaluating their own practice, and imagining what can be done to augment their approach to the classroom.

The *Equipment* Section is designed to introduce teachers to the equipment used for creating multimedia presentations. For most people, computer equipment is one of the most difficult things to learn about because it deals with the technical side of computers, and that may seem intimidating. Principally, this section provides explanation of the jargon and terms used in the narratives, so the site visitor will be able to get simple explanations when the discussions get a little technical. Furthermore, in spite of our concern about technologically driven instructional choices, we realize that good ideas can be sparked by the technology. Knowing about the equipment, you can extend the innovative uses of the technology for many years to come, making the computer work for you not the other way around.

The *Projects* Section introduces projects that we have created or found to be successful ways for using multimedia in the classroom. Links to a number of projects created by educational professionals that use multimedia to enhance instruction and improve understanding are provided. Projects are also analyzed in terms of their essential components - resources required, learning objectives, preparation, technical competence, and so on. We anticipate this will evolve into the "central" visitor location; the best insights and ideas should come examining other peoples' successes (and failures) and envisioning their procedures and activities as they correspond to your own situation.

The *Resources* Section is a place for teachers to go to find resources for their multimedia activities. It includes a searchable, on-line collection of programs, curricular materials, and plans. The intent is for users to search our database for particular resources, or to add specific resources that have been found effective or useful. Like many others, we are hopeful that a community of sharing can be encouraged at our site, (or nearby), for our intended audience.

The *Skills* Section elaborates on skills that are necessary to complete specific tasks that are typically needed in multimedia activities. These skills are looked at in smaller sections to target different components of a multimedia presentation. Although we stress that we do not support training, it is important for the teacher to have access to information about developing and applying each skill. In planning their multimedia activities, the teacher will need to decide from where the required skill will come: will they use a staff person, learn it themselves, use knowledgeable students, train all the students, or even bring in outside help?

Conclusion

Reaction to our project site to date has been slow building; different visitors are praising different areas of the site they have found useful. Unfortunately, these visitors are the technological elite, and we have yet to reach the "technologically challenged" teachers (to whom we hope to provide help) in any substantial numbers.

Our Web site is very much in development. As we anticipated early in the project, we have reached a stage in which we must attract users, including many who would not normally browse the World-Wide Web regularly. We have plans to produce supplementary media (mailouts, promotion through school boards, etc.) to attract teachers that are less immediately involved in technology. Our second objective at this stage is to increase the size of our resources, and produce more narrative examples of multimedia usage. The more ideas teachers are exposed to, the more likely they are to encounter something relevant to their own situation.

Overall, we are pursuing a "grass roots" approach; innovation must originate from the classroom. Our project is attempting to encourage and foster innovative effort and thinking at that level. Simply put, we ask teachers to examine the current strategies being effectively used by other teachers. Our job is to provide examples and/or ready strategies to allow teachers to investigate environments in which successful uses of multimedia have been shown, and extract general strategies that can be used in other environments with other resource bases. Therefore, once a teacher has judged the learners and the subject matter, and they are familiar with a number of multimedia concepts and experiences, they can then consider whether to attempt to build thematic units using technology with the potential of reinforcing what is taught in the classroom, or integrating the technology as a tool for the students themselves to create specific projects. Regardless, the solution lies with devising a suitable approach to technology integration, and we believe that a key component to this is familiarity.

Finally, we will look at our initial scenario again, but this time the teacher has developed a strategy or concept beforehand, and knows what s/he wants to do, but perhaps just not how to go about it.

> *"What do you need?" the salesperson asks the teacher. "Well", answers the teacher, "In two weeks my students will be working on a unit covering architectural styles, and will want them to create a computerized survey of some of our local buildings, including pictures of buildings. Our resource people tell me I can have two video cameras, and we can take images from them onto the computer. But I want to divide my class into 5 work groups. I haven't got the budget for three new video cameras. How can the other three groups collect pictures?" Now our salesperson has something to which to respond. "Well, we sell some inexpensive CCD cameras that hook up to almost anything. Do you have access to portable computers for your groups to use?"*

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Theorema: A System for Formal Scientific Training in Natural Language Presentation

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Abstract: Lack of formal training is hindering the application of high-level information technology in science and engineering. The *Theorema* project addresses this need by implementing a sophisticated automatic reasoning system with an easy-to-use interface which can be used in various interactive ways - both locally and over the internet. We report on the use of this software for the training of mathematics and engineering students in problem solving and theorem proving.

Background and Motivation

Deep understanding and skilled usage of mathematics and logic are essential ingredients of most scientific and engineering activities, particularly in the fields of Mathematics and Computer Science, but also in many other areas. In Information Technology applications, these skills are becoming crucial as the systems become more and more complex and only the use of formal techniques can guarantee their proper behavior.

Unfortunately - as the first author has learned over many years of didactic and research activity in mathematical logic - practical training in this field is severely under-emphasized in the vast majority of Math and Computer Science curricula all over the world. In contrast, at RISC-Linz we have offered for over a decade a comprehensive study and training program in mathematical logic and practical problem solving and proving [Buchb-Licht:81]. Based on this experience we are now in the position to develop concrete tools for the practical usage of the working mathematicians and for the students, which can assist them in teaching / learning mathematical logic and proving skills, as well as in mathematical textbook writing, problem solving, and scientific research.

In this paper we present the tools developed in the frame of the Theorema project for the training of students in Computer Science, Mathematics, and Engineering in the language of predicate logic and in establishing proofs in this language. These tools form an interactive theorem prover in high-order logic, written in the computer algebra system Mathematica 3.0 [Wolfram:96], which is presented to the user in the form of an intelligent environment for developing mathematical texts in natural language (e. g. in the style used by scientists in typical text-books).

The main objectives of the formal training in our system are:

- Language training: learn and train the use of mathematical language for concise and exact expressing of models.
- Formal models: learn and train how to build mathematical models for concrete real problems (defining concepts, defining properties, defining and exploring problems).
- Conjecture and prove: learn and train the formulation of conjectures about the properties of mathematical objects, *prove and disprove* conjectures.

The last activity - proving - is one of the most difficult formal activities for the human intellect, and consequently it requires most of the learning and training. Our system offers computing support for all the objectives mentioned above, however we will emphasize in this paper the proving and the proving-assisting capabilities of our software, which took most of the effort to develop.

We believe that providing computer support to the working scientist and to the engineering student opens the way for:

- a new understanding of mathematics and computer science;
- a new level of creativity and productivity in mathematics;
- a new quality of education of teachers and students, both at academic and pre-academic levels.

These aspects are certain to have a "boule-de-neige" effect on the general education in mathematics, computer science, and engineering, with obvious benefic effects on all sectors of human activity.

It is beyond the scope of this paper to document extensively the state-of-the-art in the field of automatic theorem proving, rather we will shortly review this (for more details see [Homann:96], [Buchb-et-al:97]). Currently the most successful and effective computer-assistants for the working scientist are the *computer algebra* *systems*, which contain a large collection of mathematical knowledge implemented as mathematical models and algorithms (Mathematica, Maple, Macsyma, Scratchpad, etc.). All these systems have quite efficient computing and solving capabilities (over numerical domains), but none of them offers support for constructing mathematical models and for proving (which is a lot more than just being able to compute with logic formulae - facilites recently added to few such systems).

On the other hand, a long-time research in automated reasoning produced a mature theory and many quite powerful systems for proving, however they are rarely used outside academic laboratories and quite unsuitable for use by non-experts. Their user-interface is most of the time quite cryptic, also the presentation of proofs and the way reasoning is performed differ significantly from the way human mathematicians operate on mathematical models.

The Theorema Project

Our project aims to close the gap between computing and proving by adding proving support to an existing computer algebra system. A similar approach is pursued by few other research groups: Isabelle [Paulson:96], Analytica [Clarke-Zhao:93], NQTHM [Boyer:88a], Nuprl [Constable:86], Coq [Huet_all:94], HOL [Gordon:93], Oyster-Clam [Horn:88], [vanHermelen:89], Redlog [Dolzmann_Sturm:96].

The distinctive features of Theorema are:

- integration of an existing rewrite rule language (Mathematica) into our logic;
- imitation of human proof style;
- natural language formulation of proofs;
- combination of functor style programming with proving;
- integration of proving into math textbooks generation and interactive math teaching;
- multi-style proving triggered by special context.

The Theorema system is being built up in the following layers:

- A *mathematical language* as a common frame for both non-algorithmic and algorithmic mathematics. The syntax of this language is implemented by using the syntax extension facilities of Mathematica and it allows to write logic formulae (theorems) containing executable parts (function definitions using induction and bounded quantifiers).
- The concept of "*functor*" as the general mechanism for building up towers of mathematical domains, which allows the user to construct mathematical models.
- A general *predicate logic prover* of a ``natural style" introduced in earlier papers by Buchberger (see e.g. [Buchb-Licht:81]).
- Various *special theorem provers* (and / or interactive proof developers) corresponding, in a natural way, to the various functors that build up mathematical domains. All these provers produce proofs that imitate the proof style of human mathematicians. By now, an induction prover for the natural numbers and one over the domain of lists over a given domain are already implemented, a prover for the domain of multivariate polynomials over a given domain of monomials is under way.
- A general facility that allows the *presentation of proofs in the form of ``nested cells"*, which is crucial for being able to read complicated proofs without losing the overview. This facility is based on the manipulation of cells in Mathematica notebooks and can be automatically translated into HTML collections.

For a more detailed description of the components, as well as of the theoretical and algorithmical background of the project, the reader is refered to [Buchb-et-al:97] and [Buchb-Vasaru:97].

Examples

Due to space limitations we can provide in this section only two examples of proofs produced by the predicate logic prover and by the prover by induction on natural numbers. Other examples produced by these provers and by the prover by induction on lists are presented in an extended version of this paper which is available on the internet at "ftp://www.risc.uni-linz.ac.at/pub/techreports/1997/97-34/edm.html".

Example 1: Predicate Logic. Universally quantified formulae are used here in order to define the relation of congruence by bidirectional less-or-equal. Then, one proves that the this congruence is transitive by using the transitivity of the ordering relation. Note the brackets on the right-hand side of the page, which show the hierarchical structure of the cells.

Prove

(~ ~ ⇒ ~) $\forall_{(x,y,z)}$ $(x \sim y) \wedge (y \sim z) \Rightarrow x \sim z$

under the assumption(s)

(~ : ≤ ≤) $\forall_{(x,y)}$ $x \sim y \Leftrightarrow (x \leq y) \wedge (y \leq x)$,

(≤ ≤ ⇒ ≤) $\forall_{(x,y,z)}$ $(x \leq y) \wedge (y \leq z) \Rightarrow x \leq z$.

We prove (~ ~ ⇒ ~) by natural deduction.

For proving (~ ~ ⇒ ~) we prove, for arbitrary but fixed values,

(~ ~ ⇒ ~ ') $(x_0 \sim y_0) \wedge (y_0 \sim z_0) \Rightarrow x_0 \sim z_0$.

We prove (~ ~ ⇒ ~ ') by the deduction rule.

We assume

(~ ~ ⇒ ~ ' . H) $(x_0 \sim y_0) \wedge (y_0 \sim z_0)$

and show

(~ ~ ⇒ ~ ' . C) $x_0 \sim z_0$.

From (~ ~ ⇒ ~ ' . H . 1) and (~ : ≤ ≤) we obtain by modus ponens

(~ : ≤ ≤ . C1) $(x_0 \leq y_0) \wedge (y_0 \leq x_0)$.

From (~ ~ ⇒ ~ ' . H . 2) and (~ : ≤ ≤) we obtain by modus ponens

(~ : ≤ ≤ . C2) $(y_0 \leq z_0) \wedge (z_0 \leq y_0)$.

For proving (~ ~ ⇒ ~ ' . C), by (~ : ≤ ≤), it suffices to prove

(~ : ≤ ≤ . A) $(x_0 \leq z_0) \wedge (z_0 \leq x_0)$.

We prove the individual conjunctive parts of (~ : ≤ ≤ . A):

Proof of (~ : ≤ ≤ . A . 1) $x_0 \leq z_0$:

For proving (~ : ≤ ≤ . A . 1), by (≤ ≤ ⇒ ≤), it suffices to prove

(≤ ≤ ⇒ ≤ . A) $(x_0 \leq y_0) \wedge (y_0 \leq z_0)$.

Formula (≤ ≤ ⇒ ≤ . A) is true because it is the conjunction of (~ : ≤ ≤ . C1 . 1) and (~ : ≤ ≤ . C2 . 1).

Proof of (~ : ≤ ≤ . A . 2) $z_0 \leq x_0$: *[this cell is closed]*

Example 2: Natural Numbers. Here the symbol "circled-plus" denotes the addition of the natural numbers, "x^+" denotes the successor of the natural number "x" (i.e. "x + 1") and "congruent" denotes the equality predicate.

PROPOSITION:

(T) $\forall_{\langle x \rangle}\ 0 \oplus x \equiv x$

under the assumptions

($\oplus$0) $\forall_{\langle m \rangle}\ m \oplus 0 \equiv m$,

($\oplus$+) $\forall_{\langle m, n \rangle}\ m \oplus n^{+} \equiv (m \oplus n)^{+}$.

PROOF:

We try to prove by simplification:

(T) $\forall_{\langle x \rangle}\ 0 \oplus x \equiv x$ *[this cell is closed]*

Now we prove the formula

(T) $\forall_{\langle x \rangle}\ 0 \oplus x \equiv x$

by induction on x.

Induction base for x:

(T. IB) $0 \oplus 0 \equiv 0$ *[this cell is closed]*

Induction hypothesis for x:

(T. IH) $0 \oplus x_0 \equiv x_0$.

Induction step for x:

(T. IS) $0 \oplus (x_0)^{+} \equiv (x_0)^{+}$

A proof by simplification works.

Simplification of the lhs term:

$0 \oplus (x_0)^{+} =$ by ($\oplus$+)

$(0 \oplus x_0)^{+} =$ by (T. IH)

$(x_0)^{+}$

Simplification of the rhs term:

$(x_0)^{+}$

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Using Theorema for Proof Training

One major use of the Theorema software is for training students how to construct mathematical proofs. The system is already used by us in the classroom in the frame of a lecture on proof training. The provers can be used at various levels of *interaction*:

Passive Mode: The student studies the proofs produced automatically (eventually embeded in a textbook), in one of the follwing formats: *printed* on paper (when no computer is available); as *HTML files* (when no Mathematica software is installed); as *Mathematica notebooks* (needs only the free version of the software).

The later two versions have the advantage that the proofs can be read at various levels of details, and they are also accessible over the internet.

The passive mode is intented to be used in the early stages of the proof-training process, when the teacher introduces the students to the proof-techniques in classroom presentations, and the students study individually the lecture notes distributed either on paper or electronically.

Interactive Mode: The student uses the Mathematica software and the Theorema software in order to produce proofs for a collection of theorems distributed by the teacher.This mode is suitable for the more advanced students, who can now interact with the system by modifying the theorems, adding new assumptions, proving additional lemmas, etc. In this way they get more insight into the proving mechanisms and they begin to train in formal model construction.

It is important to note that this increased level of interaction allows the students to learn individually at their own pace. This is crucial aspect in proof training, because typically the students have different background in formal mathematics, and also in various mathematical fields: some proof techniques are more familiar to ones than to the others because they are more used in the field of their particular background.

Active Mode: In addition to the *Theorema* provers, the student uses a special set of functions allowing a more intimate interaction with the provers. Namely, the proof is displayed in a step-by-step fashion, and the user has the possibility to direct the process in various ways:

- navigate backward and forward through the proof;
- remove redundant assumptions in order to simplify the proof;
- introduce additional subgoals in order to speed-up the process or to give "hints" when the problem is to complicated to be solved automatically;
- indicate which proof technique should be used at which point in the proof, etc.

Figure 1 (file "Figure1.doc") presents a typical screen when using the predicate-logic prover in active mode, with several Mathematica notebooks:

- "Proof Control" displays various buttons for controlling the proofs and the level of interaction.
- "Textbook" contains the theorems to prove. By selecting a command of type "Proof[...]" and then pressing "Execute" from the proof control window, the proof is initiated.
- "Proof Window" contains the actual text of the proof. In interactive mode, the partial proof obtained at the current stage is displayed with gray cells for the still unsolved subproofs and with framed cells for the most recent proof step which was executed. By pressing "Next Step" in "Proof Control" a further proof step will be executed.
- "Proof Situation" shows the current goal (formula to be proven) and the current assumptions.
- "Log Window" shows a trace of the proof steps and other operations performed.

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The IMEJ of Future Scholarship: A Prototype for an Interactive Multimedia Electronic Journal

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Abstract: Although hundreds of journals have gone online in the past few years, most are simply a translation of text from paper to electronic form. Very few of them take advantage of the multimedia capabilities of the Web. Web technology is ready to support a new kind of publication, one which augments text with motion, sound, 3-D images, simulations, and tutorial or experimental interactivity. At the same time, interest in computer-assisted instruction is high, and a journal that presents ideas for technology-based education -- especially a journal that can do so dynamically and interactively -- would have a ready audience. Bringing together these converging trends, we propose the creation of *The IMEJ of Computer-Enhanced Learning*, an "interactive multimedia electronic journal" in the new mold. We describe our conception of the journal, outline our editorial and production approaches, and raise the difficult issues which arise in the publication of an IMEJ-type journal.

1. Introduction

The time is right for a new kind of interactive multimedia electronic journal. We are not just talking about another online journal. And we are not defining "interactivity" as it has generally been defined in online journals thus far, which has been little more than the reader's ability to download articles or email comments to the author. We propose an interactivity that includes experimenting with demonstration software, taking sample tests, going through tutorials, running programs written by the author, initiating net conferencing meetings, playing movies or sound, manipulating graphs and three-dimensional images, and searching text and even video.

Opportunity and need are converging at colleges and universities across the nation in the creation of the kind of journal we describe. A growing number of schools are making it their policy that all students and faculty have their own personal computers [Burg and Thomas 1998], creating a flurry of teaching innovation, experimentation, and, for many, just plain worry over computer-enhanced learning. As laptop computers are being placed into the hands of university professors, they feel obliged to figure out what to do with them, fearing that they may be left behind in empty classrooms with their blackboard, chalk, and lecture notes. They want ideas for how to integrate technology into their teaching and use computers to deepen rather than distract from learning. But where "technology-supported learning" is the subject, flat paper articles in hard-copy publications are unconvincing and not greatly illuminating. Teachers need to see innovations in action; they need to fiddle with application programs, try the tutorials, hear the words, see how things work, and ask questions. An interactive multimedia electronic journal -- or IMEJ (pronounced "image"), as we call it -- is an ideal medium for this kind of pedagogical exchange.

The technology is ready to support IMEJ-type journals and is evolving in directions which will make such journals even more useful and user-friendly. Through programming languages and tools like Java, Perl, CGI scripts, Dynamic HTML, VRML, ActiveX, Macromedia Director, Shockwave, ScreenCam, streamed audio and video files, and net conferencing software for real-time video, Web pages can be loaded with motion and sound, give direct access to executable programs, and respond to user input. Movies and audio files no longer need be a test of the user's patience. With direct network access, greater bandwidth, single-user segments, and ATM networks on campus [Brown, Burg, and Dominick 1998], and with faster modems and ISDN or cable connections for remote access, users have the high-speed connections they need to make Web-based multimedia feasible

In short, we have the means to create an IMEJ. The interest and tools are there, particularly in the growing number of schools with ubiquitous computing. The technology has evolved to make interactivity feasible. The need for objective evaluation of efforts in computer-enhanced learning calls out for peer reviewed publication of teaching innovations. And publications of this type can offer the exposure and measurable reward-system that will continue to stimulate and disseminate worthwhile ideas for using computers in education.

In what follows, we describe the creation of an electronic journal to be edited and published at Wake Forest University. Since the fall of 1995, all incoming freshmen at Wake Forest have been issued new laptop computers, and as a result of this initiative, interest in the potential of computer-assisted instruction has been high. Our journal, *The IMEJ of Computer-Enhanced Learning*, responds to this interest. The journal can be visited at http://www.wfu.edu/IMEJ.

2. Background

What kinds of electronic journals already exist, in what ways do they differ from traditional journals, and what can be learned from them?

When the Internet became graphical and accessible to the general public through the World Wide Web, it didn't take long for librarians and researchers to see its potential as a publication medium. Already in 1989, prominent librarians were proclaiming printed journals obsolete and calling for a university-based system of self-publication [Rogers and Hurt 1990][Okerson 1991]. The public has quickly been spoiled by instant access to information, and, increasingly, year-or-more turnaround times for scholarly publications are considered into unacceptable. The quickened pace in the research environment, coupled with the high cost of hard-copy journals, inevitably has led to the emergence of online academic journals.

Hundreds of electronic magazines and journals, both scholarly and popular, can already be found on the Web. (See http://www.lib.ncsu.edu/stacks/, http://info.lib.uh.edu/sepb/sepb.html, http://gort.ucsd.edu/newjour/, and http://www.edoc.com/ejournal/ for lists.) The emphasis thus far has been placed on the initial, daunting task -- that is, transferring to the Web the huge body of already-existing journal literature -- rather than creating new journals of a more graphic, dynamic, and interactive nature. Notable projects and organizations that have tackled the job of moving journals online have included the Online Computer Library Center (OCLC), JSTOR, Project Gutenberg, Project Muse at Johns Hopkins, ACM's Digital Library, and The Scholarly Communications Project at Virginia Tech. (Charles Bailey's bibliography of scholarly electronic publishing offers a more complete list of "trailblazers." See http://info.lib.uh.edu/sepb/rtrail.htm.). Along with developing the technology and databases for large electronic collections, the early contributors in electronic publishing also have worked on devising new models for sharing and paying for electronic publications [Bailey 1994], creating search tools, and coming up with new systems for peer review [Harnad 1996] [Wheeler 1997]. The SuperJournal Project (undertaken by the University of Manchester in cooperation with the SuperJournal Consortium and the HUSAT Research Institute at Loughborough University) is one of the few projects that purports to move toward multimedia innovations, but progress in this direction has been slow. Much of the work in the first two years of this three-year project was devoted to making clusters of journals available to the academic community and, more generally, "determining the features and functionality that will make electronic journals useful to readers" (http://www.superjournal.ac.uk/sj/project.htm).

Among the newly-founded online journals, a small but growing number are billing themselves as "multimedia" publications, or cite the advantages of sound, movies, and animations in their self-descriptions. For most of these journals, multimedia extends no further than the use of chat forums for responses to articles, online review procedures, hyperlinked footnotes, static graphs and pictures, and downloadable software or pdf versions of papers. (See *The Journal of Interactive Media in Education* at http://www-jime.open.ac.uk/, *The Chemical Educator* at http://journals.springer-ny.com/chedr/, *Trincoll Journal* at http://www.trincoll.edu/~tj/trincolljournal.html, and *The Electronic Journal of Geotechnical Engineering* at http://geotech.civen.okstate.edu/ejge/Announce.htm and for journals moving toward multimedia). Very few of the journals use any significant amount of video or manipulable objects, and there is almost nothing that you could truly call "interactive." A few music journals are making good use of sound clips (*EOL* at http://research.umbc.edu/efhm/eol.html and *Music & Anthropology* at http://GOTAN.CIRFID.UNIBO.IT/M&A/, for example). But overall, the level of multimedia interactivity in existing journals is quite limited.

3. IMEJ -- A New Kind of Electronic Journal

In what way is the journal we propose different from what already exists?

- Our journal will have a significant level of interactivity, and will use pictures, motion, and sound extensively.
- It will demonstrate effective examples of computer-enhanced learning across the disciplines.
- It will use a search tool to index articles by author, title, date, discipline, or pedagogical method.
- It will combine narrative descriptions of technology-based pedagogical approaches with interactive demonstrations of tutorials, exams, exercises, simulations, visualizations, collaborative tools, communication mechanisms, or learning environments.
- Articles in the journal will be refereed by peer reviewers, who not only will accept or reject the articles, but also will offer thoughtful feedback about the pedagogical value of the application being presented.
- The presentation format of articles will be a collaborative effort of the author, the reviewers, and the production team of the journal.

Representative IMEJ articles can be viewed at our Web site, http://www.wfu.edu/IMEJ. The first full issue of the journal is planned for December of 1998.

Our first example article demonstrates the use of online tutorials and practice problems for students learning how to balance redox equations in a beginning chemistry class. The tutorials allow students to read through explanations and then test their understanding with questions that offer immediate feedback. Answers to the questions include motion and visual pointers back to relevant places in the figures. The tutorials are accompanied by a jotpad where students can record notes. Online exercises are also available as self-tests for the students. (See Figure 1.)

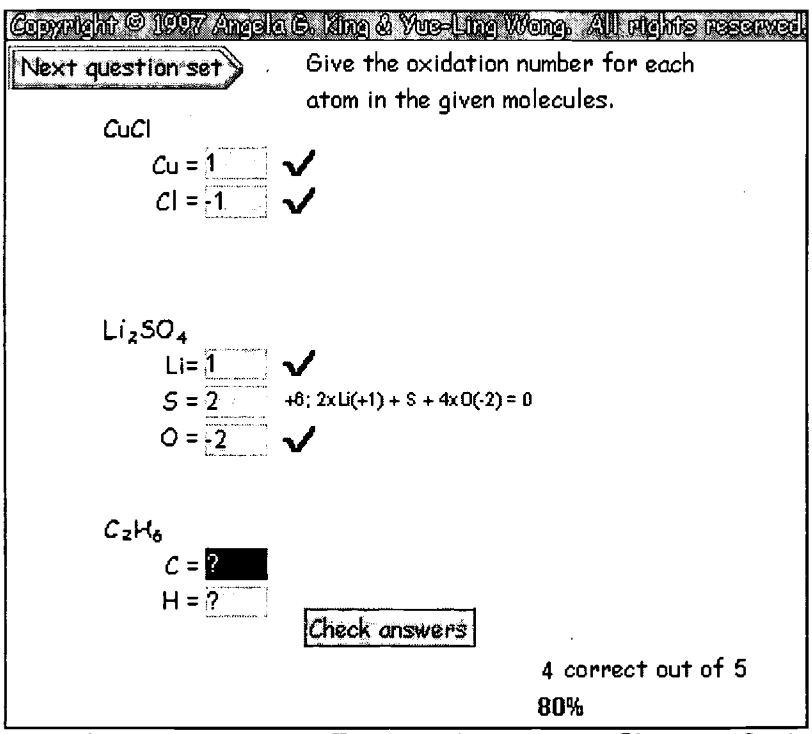

Figure 1. An Exercise in Redox Equations for Beginning Chemistry Students

The tutorials and quizzes are written in Macromedia Director and Shockwave. To guide the reader in the use of the tutorials, we also give an .avi screen-capture movie showing a tutorial as it is being run. Since the tutorial programs are Web-based applications, links to the fully implemented versions, runnable by the reader, have been placed in the article as well.

Our second example article shows the use of a Lotus Notes-based environment called the Wake Forest Template in an English writing seminar. The Template, designed and implemented at Wake Forest University, is a Lotus Notes filing system built upon a metaphor of cabinets and drawers. A cabinet can be set up with special drawers for course material, the schedule, and online discussion and collaboration. In the discussion drawer, students can brainstorm as they develop ideas in their pre-writing phase; post rough drafts of their essays; comment on each other's work with different colored "pens"; and collaborate on a final document [Brown 1997]. Template cabinets are accessible through the Lotus Notes client software (part of the Wake Forest "standard load" of software on laptops); or, for participants off-campus who may not have Lotus Notes on their computers, the cabinets can be entered via a standard Web browser served by a Domino server. Figure 2 shows the discussion drawer of a cabinet shared by students at Wake Forest University (in North Carolina, USA) and Acadia University (in Nova Scotia, Canada), whose assignment was to write about their different perspectives and sense of place in the world. This shows how the cabinet looks when accessed through a Web browser.

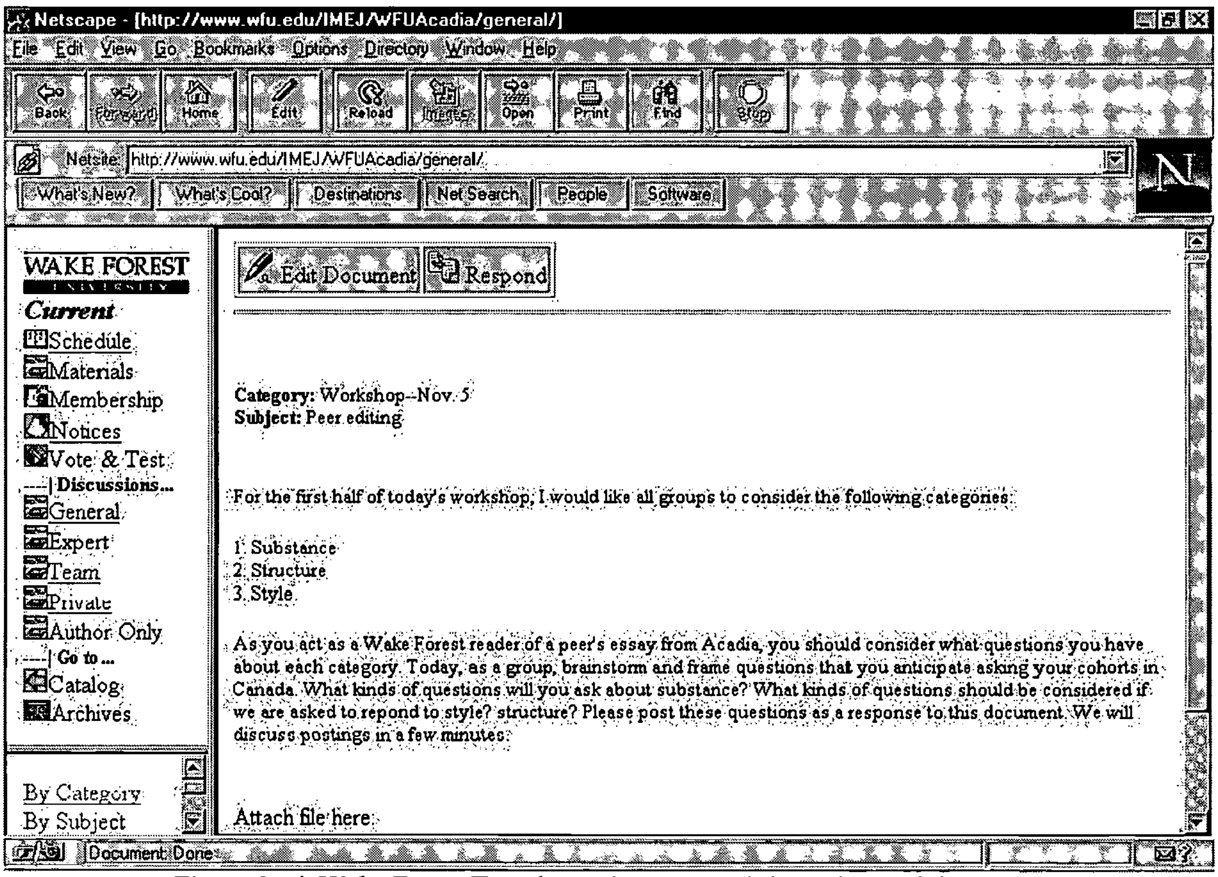

Figure 2: A Wake Forest Template cabinet viewed through a Web browser.

This IMEJ article allows the reader access to a "simulation" of the actual cabinet used by the Wake Forest and Acadia students. The simulation was made by downloading the html files of Web pages created by the Domino browser and customizing them so that certain features of interest could be pointed out to the reader. The Web pages were then annotated with audio files to focus the reader's attention on important points and to help the reader navigate through the cabinet.

4. Challenges

The representative articles we have published thus far should show that an engaging level of interactivity is already possible in electronic journals. Yet we do not mean to imply that all the problems are solved. To guide others in similar multimedia publishing ventures, we lay out some of the difficult issues below, and our thoughts toward their solution.

4.1 Technical Considerations

While technology has indeed reached a level where multimedia interactivity is feasible, not all users have state-of-the-art networks, nor do they all have the same software on their computers. A major technical difficulty lies in incorporating multimedia features that are robust, quickly downloadable, and accessible to the largest number of readers. Download times are less of a problem on university campuses with direct network connections, but readers reaching multimedia articles through modems will not have the patience to wait for sound or video files of any significant size. This problem will eventually be solved by faster network connections and even fully-networked communities. For now we are trying to minimize the problem by

- making multimedia features available but unobtrusive, with small, clearly-marked hyperlinks set off to the side or embedded in images;
- when possible, streaming in files rather than requiring that they be downloaded first;
- compressing files as much as possible without losing quality; and
- alerting readers where plug-ins are needed and directing them to appropriate download sites.

Making multimedia accessible to the largest number of readers entails adopting industry standards -- or at least current favorites -- in browsers and production software. We are currently using standard *html*, Macromedia Director, Shockwave, Javscript, and occasionally Perl and CGI scripts. We have chosen the *.wav* format for sound files. At present, we use the *.avi* format for screen capture movies instead of QuickTime movies (in spite of the fact that *.avi* is essentially designed for the PC-platform) because it produces smaller files. We are planning eventually to use streaming technology, such as RealVideo. We would like to use Dynamic HTML (*dhtml*), which facilitates the definition of "styles" and richly-formatted journal pages. However, since *dhtml* is a feature of the newest browser implementations, pages formatted with *dhtml* would be lost on many readers with older browsers. One solution to the lack-of-standardization problem is to dynamically detect a reader's platform and browser and display journal pages in the appropriate format accordingly. This entails making multiple versions of articles -- a labor-intensive solution that we hesitate to adopt.

4.2 Editorial and Production Considerations

Our first problem in getting this project off the ground is one faced by all upstart journals, but exacerbated by the fact that we are an electronic publication -- that is, attracting submissions of articles. The legitimacy of electronic publications has not yet been established in the academic community, and where there is no promise of credit toward tenure and promotion, there is little motivation to publish. This is the Catch 22 of today's electronic publication. No one will submit high quality work (wasting a publication that might see print in some more prestigious journal) until someone submits high quality work. We remain confident, however, that the current keen interest in computer-enhanced learning, the quality of our production, a careful peer-review process, and the recognition that multimedia journals are an idea whose time has come will continue to attract articles to our publication over time.

Another big challenge lies in sorting out the writing, editing, and production tasks related to an article's publication. To what extent is the multimedia production the responsibility of the author? If scholarly publication is to take this new multimedia form, do scholars now have to be technical wizards as well? The problem should be less pronounced in a journal where the subject matter so closely matches the manner of presentation, as is the case with *IMEJ*. Since some authors will be describing software that they have developed, they may have created a product which is inherently interactive and multimedia and which can be plugged almost directly into a Web page. Others, however, may be using commercial software in the context of a novel lesson plan, or software that is not Web-based and must be presented in the form of figures, audio, video, screen cam movies, or simulations.

Other practical issues to be settled are a reasonable policy for updates, revisions, and responses to articles, as well as a plan for archiving documents. Online publications can be more dynamic than printed journals, since changes can be made so easily to electronic documents. But for research purposes, it seems that each article must exist in some definitive final version, available to readers indefinitely. What commitment is an electronic journal making to both the readers and authors when an article is published? What happens to these articles if the journal folds? Our plan is to allow changes to an article only until the article's issue is made public. Any later changes or corrections would have to be in the form of addenda. Articles will remain online indefinitely after publication. We do not anticipate that disk space will be a problem at current rates.

We plan for our journal staff to work in collaboration with authors to translate their work into the *IMEJ* format. This is quite a different thing than the usual "Guidelines for Authors" that require authors to produce their articles in a camera-ready format. The need for collaboration between authors and editorial/production staff may very well be the biggest obstacle to a proliferation of multimedia journals. It remains to be seen if this collaborative model is a viable one for journal production, or if industry standards and general computer-competence among scholars will make Technical Guidelines for Authors and the author's own multimedia production possible.

However this may play out, it is clear that multimedia publication is inevitable, and we believe that it will find a useful place in scholarly publication. It will serve some purposes better than others, and is especially suitable where concepts can be visualized, demonstrations can supplement explanations, 3-D images are explicative, voices can humanize a topic, or music underscores the text. Our intention is not to replace text with graphics, sound, and animation, but to augment text in publication; not to turn the computer into a television for passive viewing, but to do something quite the opposite -- drawing the reader into exploring a subject interactively. This is an inevitable next step in publication, a step toward engagement and collaboration in scholarly communication.

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Support Services For A Training Network[1]

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Abstract: This document presents the services and facilities offered by a developed training network. Due to the network characteristics it can be considered as an Intranet where, over some basic Internet services, there are other value added services which conform an integrated environment from the user point of view. The description of the services will be done through the User Interface via which the users have access to them.

Introduction

One of the objectives of the TRaining Educators through Networks and Distributed Systems (TRENDS) project was the establishment of an European Teachers' Training Network aiming to train 2400 teachers throughout Europe [Tsakarissianos 1997]. This network consists is of six main nodes called Training Centres (TC). The TCs are placed in the countries belonging to the TRENDS consortium (one TC in one Country): France, Greece, Italy, Portugal, Spain and United Kingdom and they are connected among them via Internet. Twenty schools are connected directly to each Training Centre, but they also have access to all the TCs via Internet.

The TRENDS network integrates Information and Communication Technologies (ICTs) related services into a common environment available for the TRENDS users (secondary school teachers). The purpose of establishing the TRENDS network is to create a forum where users will become familiar with the facilities and services provided by the ICTs, in order to apply them in the development of their work (teaching and learning process).

System Architecture

Starting from the analysis of the users' needs the network nodes architecture was designed [Cabrera 1997]. The nodes follow the client/server model: the server is placed at the TCs and the clients are located in the schools from where the teachers have access to the whole network. In both, the client side and the server side, it can be distinguished two levels:

- The basic level that consists of a set of existing tools providing basic network services which are widely spread in the Internet community. These tools provide the following services:
  - Electronic mail service.
  - The WWW service.
  - FTP service.
  - News service.
  - Directory service.
- The system level. This level comprises a set of services, denominated *System services,* to achieve an integrated environment when accessing (client) and providing (server) the services of the Network. First of all, a user has to register him/herself as a TRENDS user in the network (registration service). Then he/she will be able to enter the network (authentication) and will be allowed to have access to the remaining services (authorisation). Through the User Interface the user is able to reach the information of the network and to

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perform different actions over it, depending on the kind of information and on the type of user he/she is (registration and modification service).

The remaining of this paper presents the services and facilities offered by the TRENDS network. Due to the network characteristics it can be considered as an Intranet where, over some basic Internet services, there are other value added services which conform an integrated environment from the user point of view. The description of the services will be done showing the User Interface through which the users have access to them.

Network Data Organisation

As aforementioned, one of the basic services supported by the TRENDS network is the *Directory Service*. This service conforms the data structure of the network. The distinct elements that compose the network are registered in the directory structure in order to be used either by any other network services or by the final users. The directories comprised in the network are:

- **Management Directory**. The Management Directory is responsible for storing the access information of every TRENDS user. This directory is the key to enter the network.
- **Information Directories**. These directories contain descriptive information.
  - *TRENDS users directory,* (yellow pages) containing information about the TRENDS users.
  - *TRENDS centres directory,* containing information about the schools connected to the network .
  - *TRENDS lessons directory,* containing information about the lessons stored in the network.
  - *TRENDS distribution lists directory,* containing the TRENDS distribution mailing lists.
  - *TRENDS fora directory*. This directory contains the description of the fora that can be held at the network. Depending on the service supporting the fora they can be:
    - *Chat fora* for the chat service.
    - *News fora* for the news service
    - *Collaborative fora* for the collaborative services.

The users' interaction with the information contained in the directories is controlled by the *System services.*

Registration in the TRENDS Network

The first action that has to be performed is the user registration. Users have to register in the Training Centre to which their school is connected. The registration is made via an HTML form which collects the data needed for this operation. This service automatically detects the country from where it has been invoked and displays the information in the appropriate language. The detection is performed via DNS and, in case that the country was not determined, the data will be displayed in the default language: English.

There are a set of fields that are mandatory, that is, they must be filled to perform the registration, otherwise the operation will fail. These fields are *name*, *surname*, *centre* where the user belongs to and *Client Package Installation Path* in order to integrate with the client software. The other fields are informative ones: *category* of the user, *URL* related to the user, *e-mail* address, *telephone*, *fax*, and *address*.

Once the user is registered, a login/password is associated to him/her. This information conforms the key to access to the network. The login string is composed with the first letter of the user's name concatenated with the surname. For example if the user has filled:

Name: **juan** *Surname*: **perez** his login will be: **jperez**.

The password is the same character string as the login, but if the length of the string is over eight characters it will be truncated to eight characters. The left ones are ignored. This password should be a provisional one and it should be changed for other more suitable.

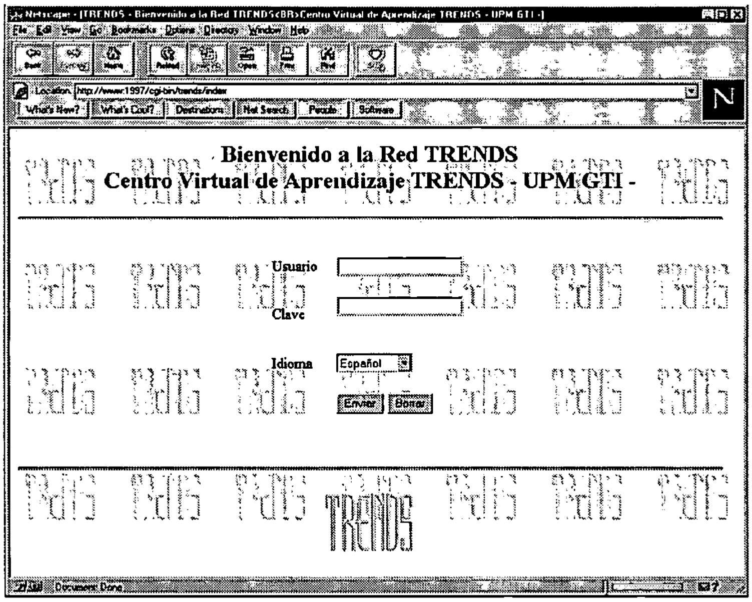

Figure 1: Welcome Page

Accessing the Training Network Services

Each Training Centre supports a set of services (the basic and the system ones) capable of being accessed by any potential user through Internet. However, the TRENDS network has a mechanism to restrict the access to only the TRENDS users (those who are registered in). The control access is performed by the system services (authentication and authorisation services) making use of the access control mechanisms of the basic servers.

Before having access to the network services, the users have to be authenticated as TRENDS users. This operation is performed by the Training Centre where they have been registered in since the user's data are stored there. When the user connects to the Training Centre, the HTML page showed in [**Fig 1]** appears. As it happened when displaying the registration form, the TC automatically detects the country where this service has been invoked (via DNS) and displays the information in the appropriate language The fields present in this form are:

- **User**: The user's login assigned by the registration service.
- **Password.** The user's password. The first time the user enters TRENDS network his/her password is that assigned by the registration service.
- **Language**. The language in which the information will be displayed. It can be chosen among English, French, Greek, Italian, Portuguese and Spanish.

Once the user has been authenticated by the correspondent TC, the authorisation process starts. The first step is to allow the access to the local basic network services modifying the server access files. Depending on the service, the authorisation is either IP based or user based. Then the TC broadcasts the user's information to the other TCs to make them allow this user to have access to their servers.

This process leaves a trace of all the logins in a log file, so the access to the network can be monitored. This information joined to the server log files can be used to elaborate statistics of the services' use, to be applied to tasks such as optimising the network working for instance, or doing somekind of network accounting.

Figure 2: System services access controls

System Services Interface

The User Interface designed to access to the system services is based on HTML technology. It consists of an HTML page with two frames:

- The first one is fixed and contains the controls (TC toolbar) to manage the user interaction with part of the system services (see **[Fig 2]**). The Toolbar is developed in Java and allows to invoke different services pressing on the icons it contains.
- The second frame shows the forms and pages associated to the different services and it changes depending on the service selected. It can also display the information of any of the links contained in those pages, such as the lessons registered in the network.

Language Selection

The labels and messages that compose the user interface can be displayed in any of the languages of the countries that belong to the TRENDS consortium: English, Spanish, Italian, Greek, Portuguese and French. Although the TC automatically detects the user's language, it is possible to change the language in which the information is displayed. The control that allows to select among those languages is shown in **[Fig 3]**. It contains six icons representing the flags of each country. Clicking on the correspondent flag the language is changed.

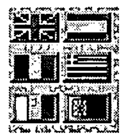

Figure 3: Language Selection Controls

Searching Directory Service

It is possible to look for information contained in the different TRENDS directories. The search facility is able either to retrieve just a listing of all the entries stored in one directory or to retrieve a specific entry/ies using keywords. Depending on the directory the user wants to seek, the user should click one of the following icons.

-  To search entries in the Users, Centres, Lessons, Fora and Distribution Lists Directory respectively.

Then the correspondent HTML form will appear (see **[Fig 4]**).

Register and Update Directory Service

Users can either register new elements (centres, lessons, fora, etc) that have been incorporated to the network, or modify, and even remove the information contained in the directories that it is no longer valid. To control all these operations, it has been created what has been denominated the person responsible for the element registered in. Whenever a new element is registered in a user is associated to it. Only that responsible user would be able to modify or to remove that element from the directory. The icons that lead to the registration or update of the directories are:

- To update entries in the Users Directory, Centres Directory, Lessons Directory, Fora Directory, Distribution Lists Directory respectively.

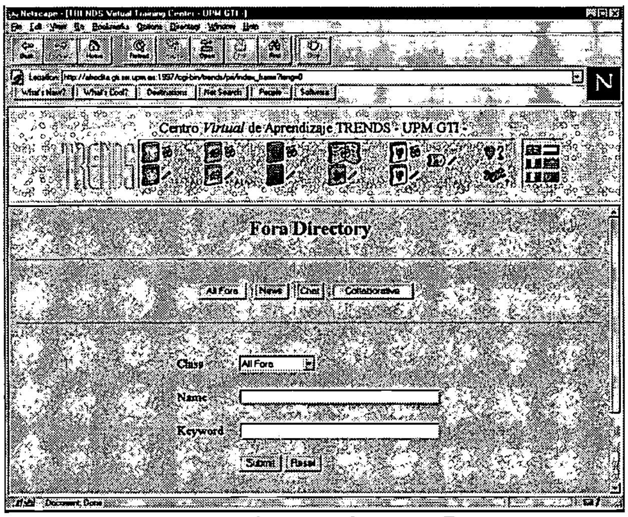

Figure 4:Searching in the Fora Directory

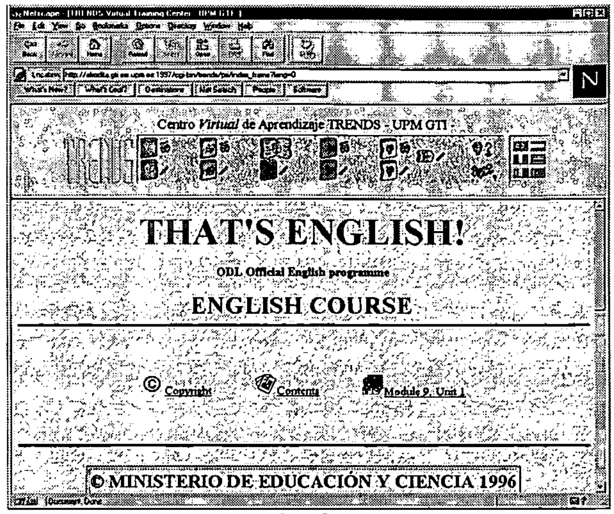

Figure 5:Example of TRENDS Lesson

Distribution Lists Management

Another task performed by the System services is the management of the distribution lists. These are the only elements whose creation and deletion is automatically performed when they are registered and removed from the directory. In other cases, the directory entry is just a link to the already existing element (e.g. lessons). Besides, the subscription and unsubscription processes are also managed by the system services. The user can subscribe to any of the existing lists of the network or unsubscribe from it invoking the service represented by the appropriate icon:

-  To subscribe/unsubscribe to/from an existing distribution list.

Notification Service

This service cannot be invoked directly using the toolbar. After the registration of a new element in the network, it is possible to notify it to part of the TRENDS users by mean of the distribution lists. This service automatically generates a default message indicating the registration of the new element, and allows to select to which lists the message is going to be sent. The notification service is in charge of generating the mail message and sending it to all the users that belong to the selected distribution lists.

Evaluation Service

In the network, there is a profile associated to each TRENDS user. This profile reflects the "Educational level" that the user has got. This level may vary depending on the results of an evaluation process. With the evaluation service it is possible to modify the TRENDS user profile. The change of the user profile must be performed by a privileged user: the *Evaluator* user. It is the only authorised user allowed to change the user profile.

The form that allows to perform this operation appears clicking:

-  To invoke the evaluation service

The fields of this form contain the Evaluator Password, the login of the user whose profile wants to be changed and the new profile value.

Frequently Asked Questions

There is a set of HTML files that contain the FAQs relative to some topics. The links to these files are comprised in the HTML page displayed when clicking the button:

-  To access to the FAQ files
- The links to the files are: **Internet, World Wide Web, e-mail, FTP, News, Chat, Collaborative** .

Web Navigation

The System services page allows to navigate through the WWW. The toolbar is always present allowing to invoke any of the services at any moment by just clicking the correspondent icon. On the other side, the other frame supports a full document navigation, that is, it can display any HTML document referred by a link. For example, if there is an HTML lesson available it could be possible to navigate in it, keeping direct access to the System services (see **[Fig 5]**).

Conclusions

The TRENDS network can be considered as a some kind of Intranet. It is intended to contain a set of elements, related to some extent mainly to educational environment, whose access is going to be restricted to just the TRENDS users. To support the access and to deal with the management of the elements the *System services* have been developed.

From the TRENDS user side, this added services are accessible via the user interface showed in the paper. This user interface is based entirely in WWW technology getting benefit from all the facilities and services it provides.

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Student Portfolio Analysis for Decision Support of Web-Based Classroom Teacher by Data Cube Technology

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Abstract: As learners use Web-based distance learning system over years, large amounts of learning logs are generated. An instructor needs analysis tools to manage the logs and discover unusual patterns within them to help improve instruction. However, logs of a Web server can not server as learners' portfolios to satisfy the requirements of analysis tools properly. To resolve this problem, a data cube model is proposed to store learning logs for analysis. We also depict the method of using query language to retrieve information from database to construct the data cube. Furthermore, user friendly operators for manipulating a data cube can retrieve the statistical information from a data cube. Although statistical tools for managing Web logs exist, none specifically address the needs of a distance learning instructor. The paper uses data cubes and database technology as fundament of analysis tools to satisfy a distance learning instructor's requirements for managing and analyzing learning logs.

I. Introduction

"Educators are managers. They manage students, resources and time to create the most valuable learning experience possible." [Thomson, Cooke, & Greer 1997] Traditionally, an instructor manages students by paper records. Paper records include students' name, sex, age, major, courses, grades, homework, project works, behaviors, etc.. Those paper records are called *students' portfolios* [Paulson et al. 1991; Crouch, & Fontaine 1994]. Many educators think that learners' portfolios are very important for assessing learning performance [Gillespie, Ford, Gillespie, & Leavell 1996]. At the same time, learners' portfolios are also required for a distance learning instructor to evaluate a learner's learning performance in a distance learning environment. However, to reconstruct learners' portfolios, a distance learning instructor must make great efforts to organize learners' behavior records in a distance learning environment.

To manage a distance learning environment, an instructor need to explore the teaching strategies and their effects on learners with different characteristics. For instance, an instructor may want to know the answers of questions such as 'Are male learners more active than female learners in the debate learning activity?', 'What is the ratio of learners that using the on-line discussion in midnight?', 'Will learners get higher grades if they enjoy answering questoions in the distance learning environment?', and etc.. However, a distance learning instructor is not easy to verify those hypotheses from the huge amount of learning records. Thus, there should be summary reports to abstract information relating to an instructor's various questions. Thereafter, a distance learning instructor can know the relationship among strategies, student portfolios, and student characteristics.

The basic requirements for evaluating students' behaviors in a distance learning environment are learners' behavior records, statistical description of records, and pedagogical meanings of records. A distance learning instructor needs feedback from learners' behaviors to manage and improve the distance learning environment. For instance, an instructor may want to know what a learner did before he/she asked. However, the logs of a Web server are huge and without structure so that it is very difficult to get the required information. Besides, the logs do not record some information for a distance learning instructor to make decision. To benefit the Web's potential, a distance learning instructor must have tools to reconstruct learners' behaviors from the Web logs and to analysis learners' behaviors records for observing the relationship among strategies, student portfolios, and student characteristics and making decisions for scaffolding student learning. To sum up, the major difficulties to construct evaluation mechanism in current Web-based distance learning systems are as the following:

First, an instructor of a Web-based distance learning system has the difficulty of observing learners' behaviors because Web system do not record enough information for analysis. If an instructor wants to observe learners' behaviors in a Web-based distance learning system, the instructor needs to know 'who has ever read a specific document?', 'how many times a learner reads a specific document?', 'what a learner did after he/she read a specific document?', and so on. Existing system can not answer those questions by retrieving information from the large amount of logs because there is not proper repository format to keep logs for evaluation. For instance, the logs of existing Web-server are sorted in time sequence order. A distance learning instructor can not get all information about a specific learner easily. These issues are referred as the *recording and repository* problem.

Second, an instructor does not have an effective tool to find pedagogical meanings from logs of a Web-based distance learning system. Some works attempted to manage logs of a Web server, for instance AccessWatch, Analog, Gwstat, and WebStat. Those works devised mechanisms for generating various statistic results from the logs to help the server administrator improving the server efficiency. Thus, the server administrator can modify the hypertext structure of the server to reduce the network traffic. However, that kind of statistic results can not satisfy the requirements of a distance learning instructor. An instructor requires the statistical results of various aspects of learners' behaviors in a distance learning environment, such as average duration, frequency of asking question, interaction pattern, etc.. These issues are called *statistical and analysis* problem.

Third, to diagnose a learner's behaviors, an instructor must make a great effort to find the similar behavior patterns in the large volume of learners' records. Diagnosing learners' behavior patterns is a complex work for a distance learning instructor in a distance learning environment because a pattern may be composed of many dimensions. Although learners' behavior records were properly recorded and analyzed, an instructor can not easily figure out the pedagogical meanings of the relationships among strategies, student portfolios, and student characteristics. As the saying said 'a picture is worth a thousand words', an instructor needs an efficient mean of illustrating complex data relationships. This issue may be called the *behavior pattern visualization* problem.

In other words, an instructor must make great efforts to trace the historical records of group behaviors before making decisions. This paper proposes a data cube framework to solve the *recording and repository, statistical and analysis, and visualizing* problems. The point here is that the instructor does not have to remember, or be bothered with intricate, yet meaningless, information; he can remain focused on the validation task at hand. Hence, the instructor will fast and accurately react to learners' statuses by the supports of data cube technology.

I. A group discussion example

It is assumed that an instructor would like to observe and evaluate learners' discussion behavior in the group discussion from the portfolios. Portfolios indicate that every discussion article will contain additional messages. For instance, the additional messages of every discussion article include the type of a discussion article, the date of a discussion article, who and when post a discussion article, and so on. The discussion articles of the group discussion must contain the information such as "who is the owner of an article?", "when was an article posted?", "what is an article talking about?", etc.. For example, learners' portfolios might have a table *NODE* to represent the discussion article. There are four attributes in the *NODE* table. First, the *NODE* table uses the *Node(N)* attribute to indicate what an article was talking. Second, the *NODE* table uses the *Date(D)* attribute to imply when an article was posted. Third, the *NODE* table uses the *Learner_ID(L)* attribute to denote who posted the article. Fourth, the *NODE* table uses the *Group_ID(G)* attribute to point which group the owner of an article belongs to. The instructor may want to observe the relations among the attributes, that are N, D, L, and G, by asking the following questions.

- Sum of nodes by L (1)
  For every learner, list how many discussion articles posted by the learner.
- Sum of nodes by G (2)
  For every group, list how many discussion articles posted by the group.
- Sum of nodes by month of D, G (3)
  For every month, list how many discussion articles posted by every group.

Thereafter, a distance learning instructor may want to observe the relations between learning performance and group discussion. Suppose there is a table *GRADE* recording learners' learning performances of paper tests. The *GRADE* table uses attributes *Learner_ID(L), Test_ID(T), Date(D), Score(S)* to indicate the learner, the name of the test, the date of the test, the learner's score of the test, respectively. In other words, the *GRADE* table records the learners' score of every test and the date of every test. Furthermore, an instructor wants to know whether learners' behaviors in a group discussion correspond with learners' score. For instance, an instructor may want to know whether a learner with high score is more active than a learner with low score. Moreover, an instructor may want to know whether learners are more active before a test than normal. The following expressions show the requiring information.

- Sum of nodes by GRADE.S, GRADE.T (4)

For every test, list the total number of discussion articles proposed by learners with the same score.

- Average of nodes by GRADE.T, GRADE.D - D < 10 (5)

For every test, find the average number of discussion articles posted during ten days before a test.

Furthermore, the pedagogical statistics can help an instructor to predicate learners' behaviors. Hence, an instructor can improve the teaching strategies by verifying some hypothesis. For instance, an instructor may want to verify the following hypothesis:

- The citation number of a discussion article is positive to its length. (6)
- Learners are more active in the group discussion near the date of a test. (7)

A distance learning instructor can not already know what is the observed relations between attributes to make decision before recording learners' behaviors. Hence, an instructor needs a functionality supporting multiple aggregates among attributes to answer those questions. The data cube technology can be used to compute all possible combinations of a list of attributes [Gray, Bosworth, Layman, & Pirahesh 1996]. In the data cube technology, a multidimensional cube is expressed as:

```
SELECT     T, D, L, S, G, Sum(N)
FROM       group discussion articles
CUBE-BY    T, D, L, S, G
```

This query will result in the combination of T, D, L, S, G, TD, TL, TS, TG, DL, DS, DG, LS, LG, SG, TDL, TDS, TDG, TLS, TLG, TSG, etc.. Furthermore, an instructor can use multidimensional analysis tools to find the results of TD, TS, and L, that are the answers of the illustrative example. [Fig. 1] illustrates how an instructor manages the discussion environment by the support of data cube technology.

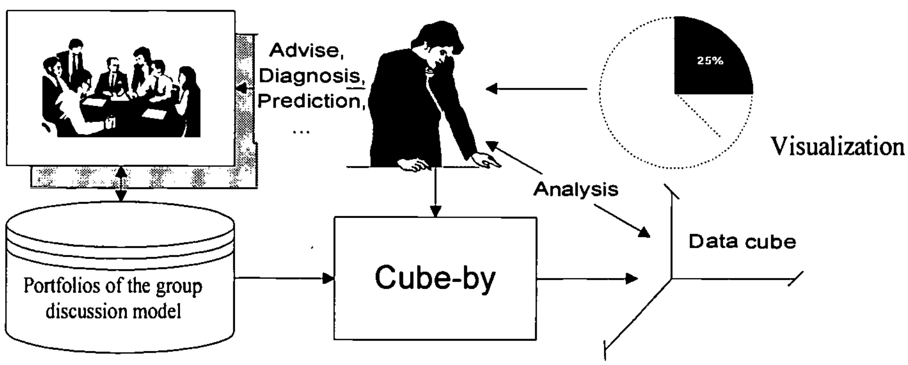

Figure 1: Manage the group discussion records by data cube technology.

To solve the *recording and repository* problem, a database is necessary to store learners' records and provide a query interface for learners' records. One of the famous query interface is the Structure Query Language (SQL). The data retrieved by SQL is called raw data because the SQL can not easily retrieve records with complex relations. For instance, the SQL can easily solve the problems of (1), (2), and (3), but the problems of (4) and (5) need complex SQL expressions. Hence, the SQL is not suitable for most instructors. Furthermore, the SQL can not express the problems of (6) and (7) because most commercial relational databases use tabular style to store learners' records. However, an instructor often needs to analyze the relations among tables. The data cube can create calculated measures by specifying mathematical formulas. Measures are created from tables or other measures. For instance, the measure "active" of (7) is calculated by subtracting a prior period average number of discussion articles from the average number of the period near a test. The measure can create another measure with the percentage style when divided by the average number of the prior period. Consequently, the cube repository can provide an intuitive expression to represent the relations among tables.

Researches make efforts to investigate how a teaching strategies affects learners' behaviors in a distance learning system [Wissick et al. 1995]. Those researches provide guidelines for a distance learning instructor using feasible teaching strategies to promote learning outcomes of a distance learning system on Internet. However, an instructor requires to know how the teaching strategies affect learners after he/she applied the teaching strategies under some conditions. A distance learning instructor may want to trace into various detail level of learners' behavior records to comprehend the causes and effect for the summary information. For instance, assume that a distance instructor wants to on-line observer how strategies encourage students participate the group discussion. Suppose that a distance learning instructor uses four strategies to encourage students participating the group discussion. *Strategy I* indicates the stage for all learners to practice posting and discussing freely. *Strategy II* denotes the stage that the instructor announced learners' ranks of post amount of each week. *Strategy III* shows the stage to announce the list of learners who have never contributed to the group discussion, neither presenting questions nor sharing answers. *Strategy IV* indicates the state that a distance learning instructor assigned a suitable question to a learner and constrained the learner to solve the question before the deadline. A distance learning instructor can on-line monitor how the strategies effect learners by a cube with LEARNER, NODES, TIME, and STRATEGY axis. That cube can be view as two-dimensional spreadsheet with sum of NODES, and STRATEGY axis with flexible period definitions, see [Tab. 1].

A distance learning instructor may want to observer the relation between students' grades and the posted discussion articles. A distance learning instructor can on-line analyze the relation by dividing students into three groups according their grades of a test. A distance learning instructor then drills down on the group dimension, displaying the number of articles posted for every group. Consequently, an instructor can figure out how the [Tab. 1] was generated. In contrast to the drill down operation, an instructor can get a summary table, that is [Tab. 1], by rolling up from [Tab. 2]. Next, the instructor adds subtotals for every strategy in [Tab. 2]. Finally, the instructor requests results are shown in statistic style, that is the average number of discussion articles posted per day and their standard deviation (SD). [Tab. 3] indicates the concluded results to satisfy an instructor's requirements. Furthermore, a distance learning instructor may need to visualize the results as [Fig. 2]. Note that [Tab. 3] is part of the results of our experience. [Ou, Chen, and Liu 1997]

Strategy	Strategy I	Strategy II	Strategy III	Strategy IV
Articles Posted	33	103	133	345
Period(Days)	21	30	30	40

Table 1: Summary of discussion articles posted after each strategy.

Strategy	Strategy I				Strategy II				Strategy III				Strategy IV			
Group	I	II	III	Σ	I	II	III	Σ	I	II	III	Σ	I	II	III	Σ
Articles Posted	18	10	5	33	42	38	23	103	48	46	39	133	163	130	52	345
Period(Days)		21				30				30				40		

Table 2: Subtotal by strategy.

Strategy	Strategy I			Strategy II			Strategy III			Strategy IV		
Group	I	II	III	I	II	III	I	II	III	I	II	III
Articles Posted/Day	0.9	0.5	0.2	1.4	1.3	0.8	1.6	1.5	1.3	4.1	3.3	1.3
SD.		0.3			0.3			0.1			1.2	

Table 3: Show the results in statistic style.

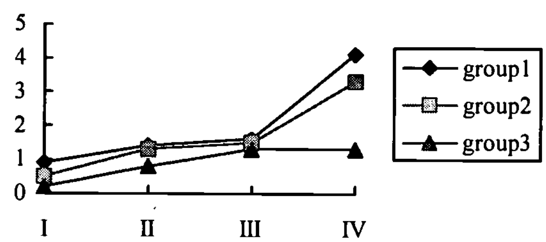

Figure 2: The visualization of the results.

The data cube technology provides several operators, including *roll-up, drill-down, cross-tabulation, pivot, flexible period definitions, sub-total,* etc., to manipulate the cube repository [Mattison 1996]. A distance learning instructor can dynamically explore learners' portfolios at any level of detail by *roll-up*, and *drill-down*. The *cross-tabulation* operator enables an instructor to dynamically create, save, and monitor relations among tables. To get a summary report with proper layout, a distance learning instructor can use the *pivot* operator to dynamically cast and recast dimensions. The *flexible period definitions* support a distance learning instructor to define the period of a teaching strategy, including noncontiguous periods, period ranges, period calculations, and period variables, such as "recent". A distance learning instructor can easily analyze learners' portfolios by multidimensional operators on a data cube without learning complex SQL expressions. Furthermore, the results of the multidimensional analysis can be shown as a graphic style for an instructor to find learners' behavior pattern. To sum up, the cube technology can satisfy a distance learning instructor's requirements because it can overcome the difficulties for observing relations between teaching strategies and learning behavior.

I. System Architecture

To observe learners' behaviors, the system should first completely record how the learners create and access discussion articles. The reason is that most distance learning system can not know the information about how a learner reads the discussion article, such as the duration, times of review, actions while reading the discussion article and etc.. Then, the cube technology must be integrated to manage learners' behavior records. Finally, a distance learning instructor can use multidimensional analysis to observer how learners' behaviors change after applying a teaching strategy.

There are three components for using data cube technology to providing that functionality. First, a relational database and a recording sub system are responsible for accumulating learners' logs. This part is used to store raw data about learners' behaviors is recording. Second, a cube repository and cube operators are implemented by complex SQL expressions. This part describes the derived data type for query and the processes of constructing cube repository and operators. Third, a method is depict for mapping SQL into multidimensional operators and a distance learning instructor can analysis student portfolios by the multidimensional operators. A distance learning instructor can also verify his/her hypothesis by the multidimensional operators.

[Fig. 3] illustrates the system framework of integrating data cube technology with a distance learning environment. The left part of the leader is the client for learners. The right part of the leader is the server. They are connected via network. The gray parts are our implementations; the other parts use existing software to support the framework, for instance WWW server, and database. The major part of the client is a browser for client agent, user action area, and WWW query interface. The server includes WWW server, WWW document, log agent, database, query process, and CGI interface. The log agent is responsible for receiving, checking, and recording messages from log client. There are three phases in the recording process, that is entry, learners' actions after enter the system, and exit. The entry phase will ask learner entering user name and password. Then, the client agent uses the identification code to access all the other WWW pages. Hence, the log agent can record learners' behaviors after entering the system. When learners exit the system, the client agent will notify the log agent. Then, the log agent will transfer learner's behavior records as a complete transaction.

To construct a cube from database, the query processor should use GROUP BY operators in SQL expressions to retrieve data for every dimension. The GROUP BY operator can get data that have the same value of some attributes. For instance, an instructor may want to know everything about a specific node. If we have the dimension that groups only by NODE, we only need scan the dimension and output the answer. We can also answer the question about relations between learners and a specific node by the dimension that groups by USER and NODE. In the first level, the query processor will group the information by (USER), (NODE), or (LOG). Hence, a distance learning instructor can easily use the multidimensional operators to get the required information about a learner, a discussion article, or a period. In the second level, the query processor will join the information of the first level. For instance, the (NODE, LOG) step will report the access records of a discussion article and when a discussion article was created. The process continues until the highest level. Consequently, a distance learning instructor can analyze portfolios starting from a summary table, indicating a discussion article, its creator, and creating time. Then, a distance learning instructor can get any detail level of learners' portfolios.

A distance learning instructor can use *roll-up, drill-down, cross-tabulation, pivot, flexible period definitions,* and *sub-total* operators to manipulate the cube of learners' records. Multidimensional operators should be able to directly access standard relational database without the need to extract and place data in a proprietary multidimensional environment. Hence, there are two interfaces to access data cube. First, a distance learning instructor can send multidimensional analyzing operators to query processor directly through any application. Second, a distance learning instructor can send multidimensional analyzing operators to CGI interface, that will transfer it to query processor, through a WWW browser. The query processor will translate multidimensional analyzing operators to SQL expressions because the infrastructure of the recording component is a database. After the query processor gets the summary results of the SQL expression, the CGI program or application can generate a picture to show the summary information. Many papers depict how to implement the multidimensional analyzing operators by SQL expressions. Those works make effort to improve the efficiency of the cube operators because a cube operation will cause a huge amount of calculation. Some commercial products also add the cube operators for reports, for instance Microsoft™ SQL Server 6.5. Hence, we do not describe how to implement the cube operator in details.

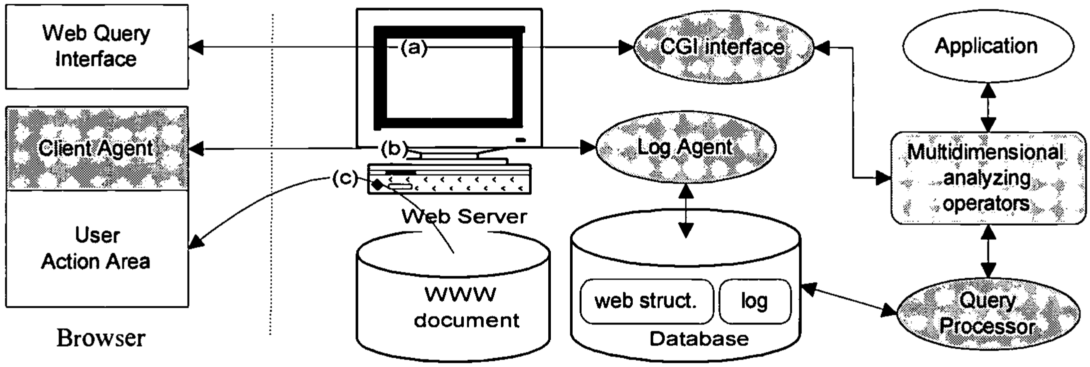

Figure 3: System framework.

I. Conclusion

This paper identifies a distance learning instructor's requirements for managing and analyzing learning logs. However, existing tools for managing and analyzing system logs do not consider the pedagogical purpose. Consequently, a data cube model is proposed to reserve the pedagogical meanings of learning logs. Based on the data cube of learning logs, a distance learning instructor can observe learners' behaviors from various perspectives, called multidimensional analysis. This paper also introduces the data cube technology and the method of constructing a cube by a relational database. The guideline and experience for implementation are depicted by a group discussion example. Hence, a distance learning instructor can transfer existing tools and get the advantages of a cube with little efforts. Most important of all, a distance learning instructor can expose the pedagogical meanings in the large amounts of learning logs to support decision making.

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'Savoirs collège' an Attempt to Create a Suitable Toolbox for the Secondary Schools

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Abstract: To accompany the reform of the first cycle of secondary teaching the french Ministry of Education and the Cndp create 'Savoir collège' a set of resources and services dedicated to the teachers. Taking into account that learning is also available from new digital educational supports the concept brings together for the first time in France Internet, CD-Rom, and television. 'Savoir collège' aims to give to the teachers the professionnal tools to facilitate thier practices, to raise the use of technologies in the classroom, and to stimulate the educational multimedia market which is gestating in France.

The situation may be unique, but the question addressed seems far more general. In France, a single public organisation takes care of the largest part of the overall production of educational resources dedicated to the teachers of the primary and the secondary schools. Cndp -ie. the national center for educational resource publishing- issues its manuals on evergreen materials as such as books and weekly news papers. Also, it taps new digital medias like CD-rom and Internet, and has been largely involved in the television field production, for years, even managing a near video on demand (N.V.O.D.) channel on cable. A large multimedia publisher, indeed.

The revolution there, wasn't the proactivity necessary for a 2,000 people organisation like Cndp and its network, spread throughout the country, to assume the right move on the right new 'technology hype', and to do so on time. By the way, Cndp launched its web site very much ahead compared to the other french educational agencies. The big news was to integrate the television programmes, the web and CD-rom publishing released by Cndp under one banner 'Savoirs collège'. One can say that Internet permits the convergence of different -but complementary- medias to serve the good cause of facilitating and improving teaching practices. A goal that Cndp has assigned itself since the Ministry of Education added instructional technology design, 'ingénierie éducative' in french, to its set of missions (see Chaptal 1994, Chaptal & Briantais 1996, Chaptal 1997).

This thinking arises from the reform of the first cycle of secondary teaching known in France as 'le collège', and the renewal of its teaching programmes. Coming from the classical approach at CNDP concerning the possible contributions of pictures, and the changes that this implies for TV transmissions broadcast on 'La Cinquième', the educational channel in which CNDP is the principal partner, the thinking rapidly took account of the fact that, in the near future, learning will also be available from new digital educational supports (see Becker 1994, Fulton 1996, Glenman 1996, Riley 1996). It followed that, from now on, a more global approach was essential which rejected the idea of competition between one support and another, but, on the contrary, use should be made of their complementarity.

The concept that arose from this was called the 'Savoirs collège' and was developed in collaboration with the national Ministry of Education, and with the support of France Telecom. It brought together the Internet, CD-Rom and television with the more traditional supports, so as to offer to educational teams a body of educational resources, products and services from CNDP which were organised in a coherent manner.

We tried to take into account the lessons of the past experiments (see Saettler 1990, Fulton 1993, Becker 1994, Cuban 1986) because we believe that those who forget the past condemn themselves to committ the same mistakes. We keep in mind that technology is still of limited use in our schools and that one of the major reasons responsible for this situation is probably that teachers are already under pressure to fulfil all their 'ordinary' educational objectives (e.g. complying with the curriculum, establishing a true pedagogical relationship with their students, managing classrooms within the rigid framework of the 55 minutes sequences, responding to parent and administration demands, etc.) and that technology appears too often as an additionnal burden of complexity, imposed on them in a top down process (see Cuban 1986, OTA 1995, Cuban 1996, Fisher & al 1996, Fulton 1996, Cuban 1997, Oppenheimer 1997).

We consider that teachers are the gatekeepers for technology use at school. To put technology at students' reach and then to modify progressively the educational process, teachers have to be persuaded by the advantages it offers. Therefore, it is of decisive importance to give them the professionnal tools, the teachers' bureautics, that can help them efficiently (see Cuban 1993, OTA 1995, Fisher & al 1996, Glennan 1996, Sandholtz & al 1997). Media are a resource, not a goal. We must help teachers to prepare their lessons and to support their own educational practices.

The driving idea behind this pilot project is to simplify teachers' life. Everyone among them is on his own to implement the new curriculum in his/her class. What resources can help them to better do their job ? How to save teachers' time and efforts when looking for information about what to do, which resources are available and how to get them ? Can technology really simplify that obstacle course ? This is the challenge of 'Savoirs Collège' which is basically a concept for documentary and pedagogic assistance.

One of the most important motive was how to best put educational resources at teacher disposal with using the emerging Internet network. In the classroom, the ideal situation would be to have over a broadly available digital network, at teacher reach, a variety of suitable tools by simply openning a unique toolbox located with the URL 'Savoirs college'. Internet techonologies are likely to offer this simplistic approach to everyone.

A Knowlegeable Mix of Television & Internet

Taking into account that one can learn from watching a video or from surfing the Internet, the concept brings together for the first time, in september 1997, in France the Internet, CD-Rom and television with some more traditional supports. Cndp created an on-line documentary and a pedagogic assistance based on the following guidelines -available off-line on a CD-Rom for those with no access to the net, still the majority of schools:

• the educational policy applied in the college claims the teachers to apropriate the new tools in their classes for teaching specific branches of instruction and general education (citizenship education, orientation education and health education),

• the development of media competence amongst the college students assumes that the teachers themselves find a simple and concrete assistance in these knowledge supports, and notably the digital networks,

• in many of the points made by the programmes, and in most of the disciplines, images have become an element which constitute the make up of knowledge, and help with its acquisition.

Two core medias, television and Internet, are mixed in a set of television programmes 'Galilée' broadcasted on La Cinquième -the french educational television channel- and in a fully integrated web service.

Galilée : A New Set of Television Programmes

The new television transmission 'Galilée', which is a co-production between La Cinquième and Cndp is concerned with an approach seeking to put images at the heart of teaching. In these new programmes, several of the training contents call for, or demand, recourse to audiovisual material which must be obtained or created. That is the objective of the 'Galilée' transmission. It brings scientific pictures, pictures from the economics and social world, pictures involving citizenship, ethical and aesthetic questions into the classroom. It allows students to see what cannot be seen in text books or generalist audiovisual programmes. Each subject is dealt with in 26 minutes from a selection of angles moving to and from between the students' familiar reality and the development of knowledge. There is an essential preoccupation running through the questions that are dealt with which integrates the transmission: the education of the citizen. For the first time, the copyright issue has been solved and teachers have the rights to record the video material directly form the television programmes.

One point is essential: the teacher must remain master of the situation. Every broadcast is produced so that the teacher can tie it in to his course: teaching guides are provided, before transmission, on the Internet and, in part, on the termly CD-Rom which is a supplement to the Téléscope review. The video cassettes and their guidance notes will be sold by the regional and departmental centers, and by mail order, two weeks after the programmes are broadcasted, using contract payments available only to scholastic establishments, with relaxation of copyright for use in classrooms.

In 1997-1998 the accent will be on the new contents for classes of the sixième and cinquième (grade 6 and 7), and for the quatrième and troisième (grade 8 and 9), for which the programmes are already partially in preparation for material that is not susceptible to later changes. From 15 September four items have been dealt with during four weekday transmissions (of half an hour duration each):

• Monday: Science and technology (how are familiar things constructed; how do the tools we use work; how is our daily food produced)

• Tuesday: Education for citizenship and for responsibility (discovering the world of work and the reality in each professional area to start pupils thinking about where they are leading; learning the basic rules about life in society and the values on which democracy is based; understanding the functioning of the human body and being responsible for one's own health)

• Thursday: French and arts (mastering the different ways of discussing; decoding the language of images; getting into the process of creation and understanding the process of production of a work of art; study a work and study more works).

• Friday: Discovering the world (reading a landscape; understanding the organization of economic activities; knowing the inhabitants of a country; understanding the interactions between different species in a given environment and identifying the constraints which that environment exercises).

A Fully Integrative Web Service

For the teachers it is a matter of giving greater emphasis to the simple use of the new supports. Whether it is about the programmes or the pedagogical organization, a teacher, a media manager or a college principal will be able to obtain information about the products and services which are on offer. Everyone will have all the useful information available, which is kept up-to-date on Cndp's Internet site (http://www.cndp.fr):

• Complete documentation on the new college. The official texts, the teaching programmes and their accompanying documentation. Library references on major themes selected from the public and private contributions by the review 'Cndp Choisir', as well as other data bases. The catalogue of written, audiovisual and multimedia products edited and distributed by the pedagogic document centres (Cndp [National], Crdp [Regional] and Cddp [Departmental])

• Specific services and productions. Information about the services and productions offered by the nearest Crdp or Cddp within the framework of the 'Savoirs collège' operation. Specialised forums for dialogue with other colleges and with Cndp. A link to other servers: educational servers at the regional level, Crdp servers and others which have been selected by Cndp for their educational interest.

• Information about the 'Galilée' transmissions. The annual programme of these new television transmissions which are coproduced with La Cinquième (mentioned above).The pedagogic guides make it easy to use them in real time in the classroom.

• A termly CD-Rom. This is a supplement to the review 'Téléscope', complementing the Internet, or for those not yet connected, which allows them to have available - at the media center of the school 'Centre de documentation et information (CDI)', for example - all this information augmented by multimedia data. This CD-Rom will be widely distributed.

• The national Cndp and Crdp reviews. They will offer access to information for those who do not yet have informatic equipment available. This is the way that an out of series Téléscope was widely distributed when schools restarted after the summer brake.

'Savoirs collège' an Attempt to Create a Suitable Toolbox for Secondary Schools

We know that it takes time for teachers to integrate technology (see Cuban 1986, Saettler 1990, Cuban 1993, Sandholtz & al 1997).

'Savoirs collège' will take part for three years in this new first cycle of secondary teaching. New products, services and experiences will come to enrich it. The mobilisation of the national network of regional and departmental centres (Crdp and Cddp) should allow 'Savoir college' to situate itself more and more within the practices of the establishments and their educational policies. Thus, while writing the article, operations are in a too early stage to advocate the success. Nervertheless, the ministry of education and Cndp are releasing some of the first evaluation results for the ED-media conference.

We can already assess some interesting indicators, even if they do not constitute a scientific evaluation. For the first three and a half months of the project (from september the 15th to december the 31st), the number of hits of our web site raised of 120 % from 8,300 to 18,300 hits per day. Of course our web site is not limited to 'Savoirs collège' but these requests represent approximately 55 % of the traffic and a global download of 70 Mo per day.

In addition to the national television broadcast, a serie of 76 videocassettes gathering the video programs of 'Galilée' has been launched on an annual subscription basis and at a low price of nearly five USD per cassette delivered every fortnight. Even though teachers have been able to record the programs free of charge when broadcasted the serie of cassettes has been subcribed for simplicity reasons.

At the beginnig of the operation, our target was to reach 10 % of all the lower secondary schools in year one. After only five months, 749 suscritions were registered representing 100 % of our objective. We now expect to reach the number of 1,000 -i.e.13 % of the schools- before the end of the school year. A survey conducted with the first 500 suscribers shows little differences between the percentage of schools which have subscribed the video and the population distribution. This means that the number and the diversity of existing local resources, which varies with the size of the city, does not seem to interfere with the choice of subscribing.

Again we must stress that we do not consider these results as clear indicators of success but merely as encouraging hints. 'Savoirs college' is an operation in progress with new releases forecasted. But one can say that benefits are already on the records. It added cohesion in the inside of the Cndp organisation which emploies diversified field specialists, associated teachers, televison producers, multimedia developpers. In the classroom, the integration of disseminated materials into a single toolbox cleared the role Cndp is able to play as an helper and a facilitator.

The main goal here is to give everyone, teachers and media workers, the ability to know about the media resources relating to their discipline or field of work. Teams in the schools should be able to discover the suitable tools which would help them with their work involving the major priorities of innovation -e.g. mastery of language, citizenship education, and education on orientation; on how to acquire methods; and on modes of adaptation of the teachers to the diversity of their pupils- and which would enrich their establishment project.

It would be quite naive to believe that this scheme would be, at the beginning, perfectly satisfying. Further developments will progressively improve it. Lack of bandwith for the schools which are hooked to the net through dial-up modems or even 64 kbps ISDN lines is a severe limitation for multimedia services delivery. To ensure the success, the access bit rates need to be enhanced. It may allow to play video on-line for preview and/or asynchronous use. Also, an accurate research engine assiociated to a validated data base is needed to ease teachers work. 'EducaSources' is the name of the one under construction in partnership between Cndp and the French Ministry of Education.

'Savoirs collège' aims clearly to put information and communication technologies at the service of teachers. Cndp hopes to raise the utilisation of these technologies in the classroom and to stimulate the educational multimedia market which is gestating in France.

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All URLs are subject to change. They were valid at the date this article was written.

Promoting Motivation and Eliminating Disorientation fir Web Based Courses by a Multi-user Game

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Abstract

Elementary school students have difficulty in using link and may be disoriented when studying web-based courseware. Moreover, they may not be interested in reading courseware. In this paper, we devised a methodology to promote the learning motivation and to prevent navigation disorientation by using a multi-user game that integrated with web-based courseware. Experiments of our implemented game show that the game does improve the motivation of the students in practicing and learning. At the same time, the students do not have the problem of disorientation in using the game. Analysis and discussion for the effect of the motivation factors of the game is also presented. This information provides guidelines for designing instructional game script.

Introduction

World Wide Web is very popular and easy accessed so that a lot of teachers put their teaching materials on the web. However, students need to know how to use links. Moreover, the student should keep in mind the structure and access paths of the courseware to prevent disorientation. This may be not difficult for university or senior high school students. It may be not easy for K-9 students [Corrina et al., 1996]. On the other hand, K-9 students do not have difficulty in playing computer games. The students can soon figure out the script structure of the game and know how to play it and navigate in the game script. Besides, those students can sit and play games for a long period of time. On the contrary, it is not easy to keep them concentrate on the courseware for a short time if no interesting things is embedded in the courseware.

It may be a good idea that we integrate a computer game with learning materials. Since students likes to play a game, the students may have more motivation to learn. The students may be more willing and persistent to learn. At the same time, if we design the game script based on the learning hierarchy and flow of the courseware, the student may not be disoriented in learning. By showing the structure of the game script, which is easy to be comprehended by the students, the students will always know where he/she is and where he/she should go next.

Before the computer network becomes so popular today, most of the games are single user games. In a single user game, the player always fights with simulated enemies generated by the game program. Usually, the simulated enemies use a same strategy in a same situation. Hence, once the player overcomes a problem in a game. That part becomes no interesting for her/him. Besides, students may abandon if they are not able to play the game well in the beginning.

Owing to the popular of the computer network, games can be designed as multi-user games. A multi-user game provides an environment for players to fight with real persons or to compete and cooperate with other players. Even for same scenery, players still face an unknown situation because real persons will change their strategies. Thus, a multi-user game becomes a social environment and can keep on being interested in for players. Moreover, if a player/student has orientation problem, other player can assist the players that are in trouble when the game has the facilities and encourage players to do so. Therefore, we can embed learning materials into a multi-user computer game to improve the motivation of the students. And, the student can learn in a social environment.

The primary reason of embedding learning materials into a multi-user computer game is to promote the learning motivation of the students. Lepper and Malone [Malone and Lepper,1981] investigated what makes a computer game fun. They [Lepper, 1988] [Malone and Lepper, 1987] [Stipdk ,1993] found that motivation factors can be divided into two groups: intrinsic motivation and extrinsic motivation. The motivation factors of a single user game are mostly related to intrinsic motivation. The intrinsic motivation factors includes: challenge, curiosity, engagement, autonomy and fantasy.

When Lepper and Malone studied computer games, most computer games are only single user games. Therefore, the factors considered in what make computer games fun are related to intrinsic motivation. However, in a multi-user game, extrinsic motivati on factors should be included. The extrinsic includes: competition, collaboration, and recognition.

Another reason for developing a multi-user instructional game is that a multi-user game has the possibility of building a situated learning environment. The game simulates a social environment that students can learn and practice the learning materials in a real situation. Lave and Wenger [Lave and Wenger,1991] presented their idea and proposed elements about situated learning. We list the some ideas of Lave's situated learning: Community of practice, Periphery, full participation, identity, Opportunity, learn to talk, not learn from talk, and access.

In this paper, we describe a multi-user instructional game that can motivate and guide students to learn and practice courseware on the web. This game demonstrates a way to integrate games, internet communication facilities, courseware in the web, and database techniques together for assisting learning. Thus we can promote the learning motivation of the students and prevent the students from disorientation in navigating the courseware. Besides, experiments are done to analyze the effect of the motivation
factors in the game.

Related Systems

Many ideas of our multi-user game come from Multi-User Dungeon MUD games. A MUD game is a text base game. In a MUD game, there are (1) levels of players and (2) communication tool such as talk and chat room. Each level in MUD has different privileges. Thus, it forms a player community. Because it is a text base game, it provides users imagination possibilities. However, it is not suitable for elementary school students. We adopt its ideas to form a community of practice.

WebQuest [Corrina et al., 1996] is a web based instructional game. The students ramble about in the game to find related information to pass a scene. When facing with problems, the students can invoke a web browser to find the answer. The students can design their own game. Experiment shows that the students more like to design a game than to play the game. They did not try to build a community of practice in the game.

Game Script and Learning Materials

selection of the style of the game

The first thing of developing a instructional game is to design a game script and put learning materials into the game. Since a learning material always has a learning hierarchy [Gange, 1968], the game script should follows the learning hierarchy. Therefore, we decide to implement our game as a role playing for the following reasons. First, role-playing games are the most popular games in Taiwan and this style of games allows player to explore and think. Second, a role playing game always has a hierarchical script structure. Thus, it is easy to design the game script according to the learning hierarchy so navigation disorientation can be eliminated. Third, a multi-user role playing game can form an environment to serve as a community of practice.

Arranging the game script according to the learning hierarchy to prevent disorientation

Figure-1 is a learning hierarchy for arithmetic skills. Each box represents a subskill. The arrow line represents the legal learning flow. The bar line represents an *and* join. A student should learn all the subskills connected to the bar line.

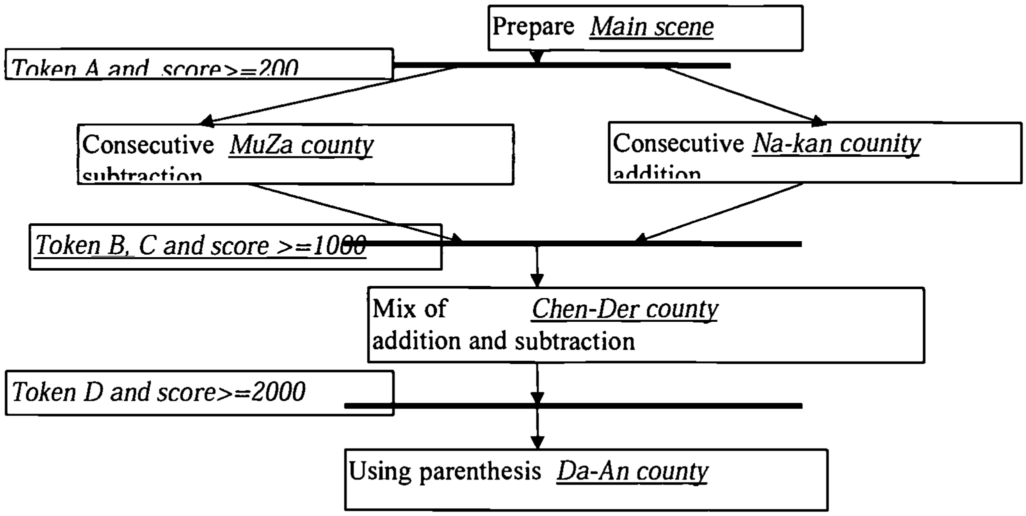

Figure-1 Learning hierarchy and game structure

We can design a hierarchy of script scenery based on the learning hierarchy as shown in Figure-1. The text in *italic* form is of the game script. Each learning element or box is a scene or an act. In the scene, the background is a place in Taipei city with roles in it which give hints, asking question, and lecturing through page in world wide web. The player is trying to get scores and the token by studying courseware or practicing exercises.

Players should get enough score or token in order to get into another act or scene. The condition of passing is stored in the bar line in the above figure. The players are free to go to any scene if they hold enough tokens and scores. Since the game script is designed based on the learning hierarchy and flows, the players will learn and practice accordingly. There are different level of roles in the game to form a Periphery community of practice.

The game is designed based on client-server architecture. The clients side, which the student or teacher faces, handles the user interaction and graphic display. The client also communicates with the server so that other players' information can be shown in the game. Also, it also sends user's behavior back to the server side. Interesting reader can download it from http://db.csie.ncu.edu.tw/~sunny/myssgi.html (in Chinese). The server contains a game server and an educational database. The game server handles the communication among players. The educational database is to record the behavior of the students.

The game also provides a mechanism for players to query the whole scene hierarchy as shown in Figure-2. Thus, the players can know where they are and where they can go. Besides, the mechanism also shows all the players in the game and the location of each player.

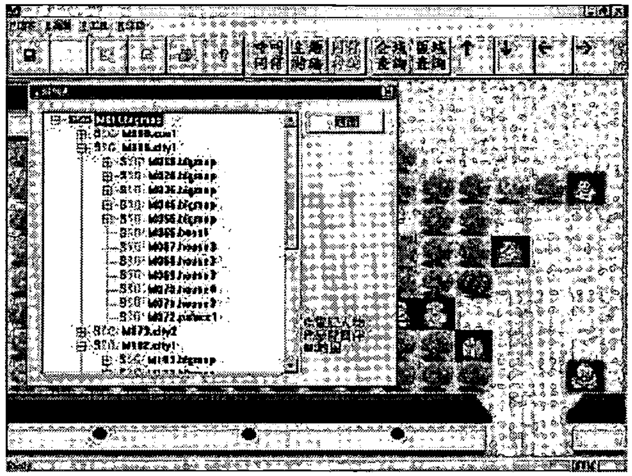

Figure-2 querying the script structure and information of other players

Building a Situated Learning Environment to Promote Learning Motivation and to Prevent Disorientation

To form a situated learning environment, we must do the following things: (1) to build a community of practice, (2) to build a set of communication tool, and (3) to encourage collaborive and cooperative working.

To build a community of practice, the game will assign each player different levels of role with different privilege. The player can query information of other members in the game. Besides, the game also provides apprentice mode to let higher level role guide lower level one in playing.

In the community of practice, members of the community should be able to communicate. Therefore, we build a set of communication tools. The communication tools includes (1) querying players status, (2) calling learning companion, (3) testing a learning companion, (4) asking a learning companion to teach, (5) getting other players as an apprentice, (6) 1-1 talking, (7) discussion room, and (8) broadcast (shout). The game script is designed to encourage collaborive and cooperative working.

Experiment and Discussion

Totally, eight classes students had used this game. Six classes (NGCAI) students play our instructional game and fill the test questions. Two classes (NGCAI) students only read courseware, do practice, and answering question which are exactly the same as embedded in our game without the game elements. After reading the learning materials, they are asked to fill the same test questions. The period for each class experiment is two hours.

For the two classes which only read materials and do practices, most of them quitted in two to three minutes. They also do not know what to do next. However, for the six classes, which play the game, most of them, played two hours. They would like to play the game even after two hours. This shows that the game elements do promote the learner's motivation. Moreover, the students do not have problem of disorientation.

The following are the records the student actions taken in the game which are stored in the database.

Play Action	Count	Percent(%)
send message (shout)	57	1.44
calling to participate chat room	264	6.68
talk in chat room	172	4.35
apprenticeship mode	61	1.54
talk in apprenticeship mode	65	1.64
get good	1037	26.24

ask question to another	100	2.53
comparison for self & another	1401	35.45
CAI presented	36	0.91
virtual people hint	759	19.21

Table-1 action statistics of students playing the game

From the above statistics, the most frequent events of a player is trying to know this/her and comparing with others. This shows immediate competition can improve the student's motivation. The second frequent actions taken are getting good and virtual person hint. These actions are the main script of the game. They are all embedded with a practice. This shows that a game can attract students to do practices.

Students like to talk to others. It may be a new experience for the students to talk in a computer game. The students may just want to talk with others by computer. In the beginning, the game asks the name of the player. The students were excited when they saw their names shown in the game.

Because the test period is limited to two hours, not many students achieve the level for shouting and calling for chat room. However, the students achieved the level still like to call for a chat room talking. In the table-1, there are 57 times and 61 times for shouting and apprenticeship mode. It illustrated that recognized by others and controlling others are fun for students even though without rewarding for that action. Most students asked questions (65 ask out of 61 apprenticeship) for their teacher in apprenticeship mode. It does provide a way to help low performance students. Table-1 shows that the students seldom read CAI courses in WWW. The major reason is that (1) students are eager to pass each scene, they are reluctant to read the courses because it is slow for passing the scene, and (2) students more like to ask other players directly because it is more efficient.

The following table is to test whether the game can promote the motivation of students as they may expected. The test sheet is designed based on Likert Scale and t test. Each question has four degrees for each : very agree, agree, disagree, and very disagree. The elements are categorized based on the motivation factors.

Rank	Item	NGCAI	SSIG	Change(+:enhance)
1	Fantasy	42.41	66.67	+24.26
2	Cognition	53.01	68.19	+15.18
3	Curiosity	56.70	71.74	+15.04
4	Control	55.54	69.86	+14.32
6	Cooperation	54.82	67.36	+12.54
5	Competition	57.34	70.49	+13.15
7	Challenge	58.71	70.83	+12.12
	Reliability	0.86	0.83	

Table-2 comparison of motivation factors

From the above table, it shows that our game meets the expectation of the students. After the students played the game, all motivation factors are improved. The rank in table-2 shows the ordering of degree of motivation improvement of our game. The first three significant factors are fantasy, cognition, and curiosity. Table-1 also shows that the students feel that the most interesting factors of the game are (1) challenge, (2) competition, and (3) curiosity. After they played the game, the most interesting factors become: (1) curiosity, (2) challenge, and (3) competition. This shows that the most interesting factors of a role playing game are (1) curiosity and (2) challenge. Although the students are very concerned about other players' score that are shown in table-1, the major driving force of keeping working on games is curiosity and challenge.

	high	low	hi-low
Curiosity	66.58	70.25	+3.67
Control	68.91	71.60	+2.69

Challenge	70.92	71.00	+0.08
Fantasy	65.76	66.00	+0.24
Competition	70.29	71.01	+0.72
Cooperation	64.86	68.82	+3.96
Cognition	66.09	69.60	+3.51

Table-3 Comparison of every Motivation item between high and low achievement(1/3) on SSIG

In table-3, we compare the motivation factors for high achievement students and low achievement students. The second column shows the motivation scores of the top one-third students in the class based on the arithmetic test score. The third column is the score of bottom one-third students. The result shows that low achievement students like the game more in every part of the game. It is easier to explain that low achievement students likes cooperation more because they usually need help in answering the questions. About cognition and control item, it may be that lower part students have less chance to be recognized. The problems and game script structure may be easier for them to capture for high achievement students so that the curiosity score for them is lower.

Conclusion

We devised a method to promote learning motivation and prevent navigation disorientation of the students by using a multi-user game that integrates web-based courseware. Effects of motivation factors are also investigated. Experiment shows a game can promote the student motivation to do practice. Moreover, most students do not have the problem of disorientation by using the game. However, to promote students to read courseware by using a game is not easy. More work left to be done to investigate how to use a game to improve the motivation of reading courseware.

Investigation also shows that low achievement students are more likely to be attracted by a multi-user game. The element of cooperation in a multi-user game is important for lower achievement students. A learning game should be designed to meet different level of students. Thus, high achievement students can feel interesting and low achievement student do not feel upset.

Communicate through computer by Chinese typing is difficult for elementary students. Further work should be done to make communication on computer easier.

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Design Guidelines for Teaching about Design Guidelines for Educational WWW Sites

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Abstract: Learning to be a designer of educational media now involves a new set of skills and insights: in addition to traditional topics such as designing video products and designing computer-based tutorials, students must also learn about designing WWW-based sites for learning-related purposes. What and how do we teach them? What are guidelines for the design of WWW-based sites for learning-related purposes? And, what are guidelines for teaching about such guidelines? In this paper, we describe how we use a mixture of WWW-based functionalities and new didactics to teach educational-technology students about the design of WWW-based learning environments. We identify the set of design guidelines that we teach, and show some of the ways in which we have designed our own WWW-based course to improve the way in which we teach our students about these design guidelines. We conclude on a meta-level: What are design guidelines for teaching about design guidelines for WWW-based learning environments?

1. What is our Content in Courses about the Design of Educational WWW Environments?

Our first task is one of content: what do we want to teach our students about the design of WWW-based learning environments? Designing and producing educationally effective WWW environments involves the integration of technical considerations and skills, user-interface design, instructional design, and management and organisational aspects. Thus many perspectives have to be addressed in courses in which students are being trained to become accomplished designers of WWW environments. One of the major strengths of WWW-based environments is their elasticity: an environment can be designed as a communication center, an information center, a collaboration center, a dissemination and publication center, and a presentation center, and combinations of all of these. A site can emphasize its hyperlinking capabilities, or it can emphasize its communication and information-organization capabilities. Thus trying to teach students about good design of WWW-based environments is challenging because the subject matter is so broad. We have chosen to focus on a set of design guidelines that have applicability across this broad variety of application forms for WWW-based learning environments. By design guidelines, we mean a 'statement of good practice', expressed as concisely as possible, ideally, so that it can be remembered. 'Keep it simple' is an example of a simple-sounding but complex-to-apply design guideline.

Many different authors are now publishing lists of design guidelines. For example, [Madhumita & Kumar 1995] have written about design guidelines for instructional design, [Park & Hannafin 1993] have published guidelines about interactive multimedia, and [Wilson & Jonassen 1989] have discussed guidelines for hypertext and instructional design. A small number are now beginning to focus on guidelines for WWW-based courses (see for example, [Eekma & Collis 1996]. Sometimes sets of design guidelines are built upon design guidelines for earlier media, such as for computer-based learning products or educational multimedia. Typically design guidelines can be grouped in clusters relating to presentation aspects, to content aspects, and to instructional-approach aspects, as well as aspects specific to the sorts of media involved (i.e., for video, audio, printed materials, hyperlinked multimedia databases, WWW sites, etc.).

Based on a number of years of investigation, we have developed a set of 21 design guidelines for educational WWW sites appropriate for use with our first-year students. Ten of this are shown in [Fig. 1], organized according to level of abstraction. These guidelines are continually evolving; we fully acknowledge their incompleteness and occasional overlap. The complete set can be seen at the URL in [Fig. 1].

Netscape: All Guidelines at Once

Location: http://www.to.utwente.nl/ism/ism1-97/wwwproj/studyctr/AllInOne.htm

Topic	Simple	Intermediate	Advanced
General	-	-	6. The WWW is a learning environment that can be made flexible. Use this fact. 9. Keep it simple 10. Be consistent
Content	4. The reader should be able to get in contact with persons, when appropriate, directly through the WWW page.	5. Design your web page not only for one way transmission of information. The www is also a good tool for communication. So, try to incorporate some means of communication such as a discussion room.	1. The content of a site should be appropriate for its intended users. "Appropriate" relates to not only the material itself, but also the way in which it is expressed.
Navigation	13. Place navigational buttons on the same location on the screen throughout a program, so that the user can always find them in the same place. 18. Do not confuse the user by putting more than 7 (navigational) icons on a page. The	2. Make sure the users have a good overview of the structure of a site, so that they can easily find their way to what they want.	16. The user automatically generates a mental model of a Web site. The user should be helped to make this model a structured one, by adding functional and graphic continuity between the various components and subsections of the Web site.

Figure 1: Design guidelines used as content for a course in which first-year educational-technology students learn about the design of educational WWW sites [Collis, Verhagen, & Gervedink Nijhuis, 1996, 1997]

But although it has not been too difficult to find lists of criteria for the design of WWW environments, and to translate those into design guidelines for educational WWW sites, in our own ongoing search of references we have not found any design guidelines for the meta-level: design guidelines for teaching about design guidelines... How do we teach about design guidelines for WWW environments to first-year students? In this report we will show our approach.

2. Teaching About Design Guidelines for Educational WWW Environments

The course "ISM-1" is a required subject for first-year students in the Faculty of Educational Science and Technology at the University of Twente ("ISM" are the initials of the department in this faculty that specializes in educational media). Approximately 70 students are enrolled, and the course lasts the entire academic year, divided over three trimesters. During each trimester, the students work in groups to design and produce different types of educational media products, for different purposes. These products include desktop-published print materials, educational videos, and WWW environments that include JavaScript-based interactivity and multimedia resources made by the students themselves (for example, Quicktime movies made by the students and integrated into educationally oriented WWW sites, where questions and answers about the message of the movies are presented via different JavaScript constructions). WWW environments are part of each of the product sets during each trimester, so the students develop in their skill and experience in designing and producing such environments over the year. The course is organized about five traditional lectures per trimester, and these group projects. (For a full description, see [Collis, Verhagen, Gervedink Nijhuis, & Meeuwsen, 1996]. The entire course is supported by an integrated and complex WWW environment, about which much has been written (see for example, [Collis, Andernach, & Van Diepen, 1997]. The course can be visited at http://www.to.utwente.nl/ism/ism1-97/home.htm.

Our main strategy for teaching about the design guidelines is to use them as the way to integrate the theory and the practical aspects of the course. The design guidelines are developed week by week, in our study materials, used to shape the way students look at and evaluate WWW sites made by others, and used as the criteria for the students' own design work. In addition, and perhaps most powerful in terms of student motivation, the design guidelines developed in the theory part of the course are the basis for the mark given to the students when evaluating the WWW sites they produce themselves in the projects. [Fig. 2] shows a typical study page for a design guideline, including a link to an external site that illustrates the guideline in practice.

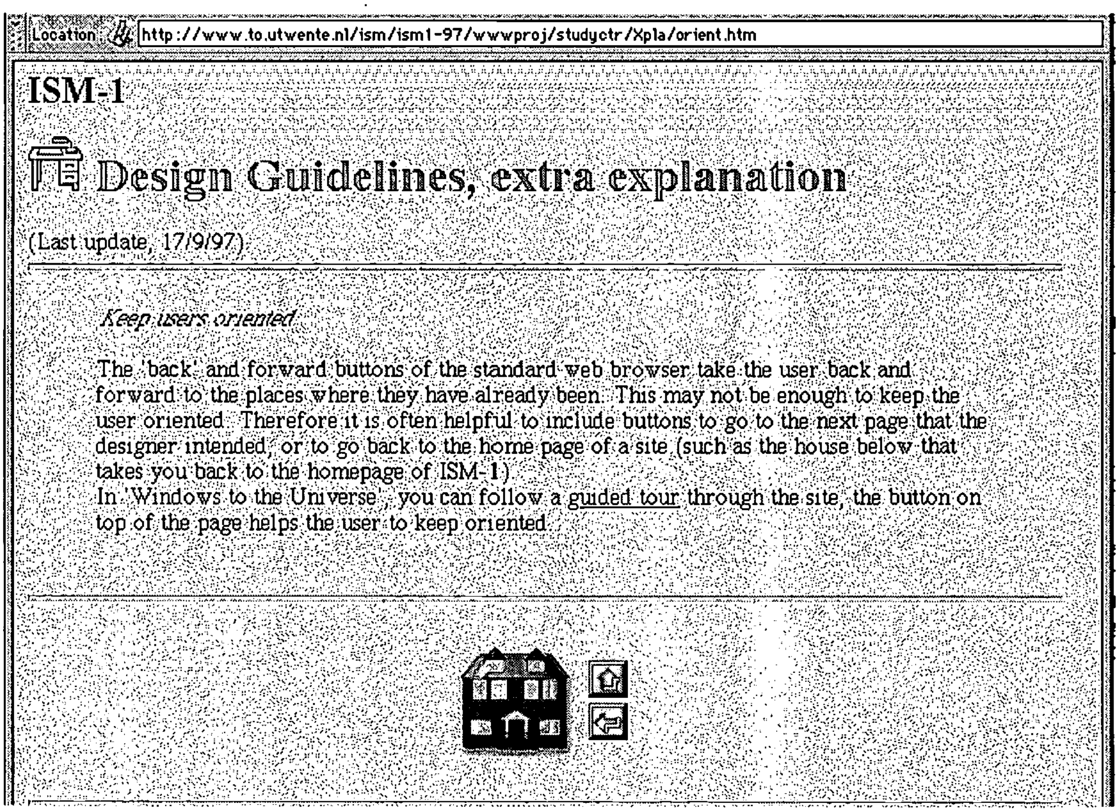

Figure 2: An example of study material relating to a particular design guideline.

[Fig. 3] Shows one of the on-line exercises that students do after each week's study about design guidelines.

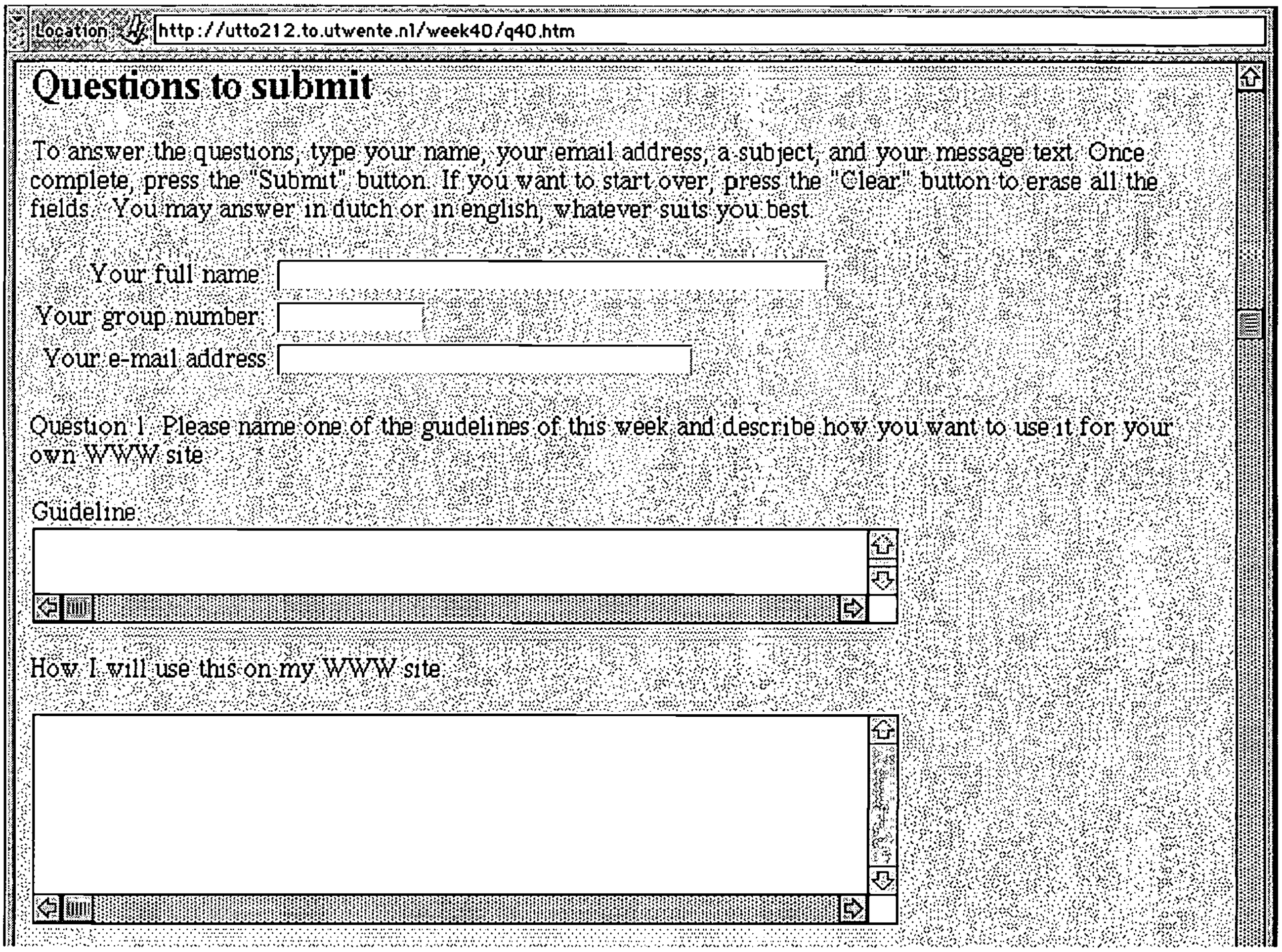

Figure 3: A typical on line exercise.

Parallel to this, the students apply the design guidelines in their own work. They do this by using them as the criteria by which they evaluate their own group's site, the criteria for peer review of the sites of the other groups, as criteria for the on-going and final evaluations of their sites by the course team, and as the basis of the final presentation and reflection that they must do about their work. [Fig. 4] shows a part of the results of self-evaluation.

Our site is a good example of:

10: Place navigational buttons on the same location on the screen throughout a program, so that the user can always find them in the same place.

Because:
De knoppen staan steeds op een rij onderaan de pagina en zijn dus altijd op dezelfde plek terug te vinden.

13: The user automatically generates a mental model of the web site......

Because:
Door de pagina's allemaal dezelfde kleur als de knoppen te geven weet de gebruiker waar hij/zij zit. De pagina's zijn ook op soortgelijke wijze vorm gegeven wat het geheel ook consistent m akt, zodat er gemakkelijker een mentaal beeld te vormen is.

Figure 4: A part of the results of self-evaluation in which guidelines are used.

3. Issues Relating to Teaching about Design Guidelines

Although we have made significant progress in developing our instructional strategies for teaching first-year students about design guidelines for educational WWW environments, we are still concerned about a number of aspects and are carrying out research to investigate further how to design WWW environments to better support good teaching and learning about design guidelines for WWW-based learning resources [Winnips 1997]. Key among these concerns are:

1. How can our content in terms of the choice and wording of the design guidelines be improved?
2. How can we measure the students' growth in understanding about these design guidelines? (The students have indicated that the guidelines are so clear and sensible, that they can come to "know them" without much effort. How do we indicate levels of wisdom and insight in terms of applying a guideline such as "Keep it simple?" to the design of a WWW environment?
3. How can we measure the impact of our own teaching strategies on this growth? In particular, how can we design and use our course WWW site as a powerful learning environment relating to these design guidelines?
4. How can we most effectively scaffold [Jonassen 1996] the students in the application of the design guidelines? How can scaffolding procedures be designed as part of our WWW-based course environment? How can we measure the impact of the different forms of scaffolding we are trying to use in our course?
5. Looking at the problem from the course designers' perspective: how do we design a WWW-based resource to help students learn design guidelines for WWW-based resources?
6. Finally, from an instructor's perspective, what are design guidelines for teaching about design guidelines with the support of WWW environments?

We conclude this paper with a brief reflection on the last question.

4. A Preliminary List of Guidelines for Teaching about Guidelines for WWW-Based Learning Materials

Based on our experiences with three years' of the ISM-1 course and the use of a WWW-based course environment as well as design guidelines in those three cycles, we offer the following provisional set of design guidelines for others who wish to teach their students about design guidelines for WWW-based learning resources:

- Provide many different ways to apply the guidelines, ranging from using them to categorise external sites, to criteria for evaluating the students' own work.
- Repeatedly give opportunities for articulating the design guidelines, using them to explain one's opinion about a WWW site [Vermunt 1992], ranging from memorising to creating one's own guideline (reflecting).
- Scaffold the explanation and examples, providing detailed comments to begin and also less-detailed points; scaffold the pedagogy, from explicit exercises to implicit appreciation.
- Find a measure of student progress, and collect data to show improvement.

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NetTest: A General Purpose Web-Based Assessment and Teaching Tool

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Abstract: With the advent of computers, multimedia learning systems, and the Internet, technology use in education has increased tremendously. As electronic delivery of educational material increases, the need for an electronic means to assess learning also increases. This paper describes NetTest, an Internet-based tool which can be used for multiple forms of assessment of knowledge or competencies. An important feature of NetTest is the breadth of question categories that it can deliver. In addition to multiple choice and true/false questions; matching, sequencing, fill-in-the-blank, graphics, essay, and performance-based questions are allowed. Along with a variety of question types, NetTest has extensive authoring, management, and security features. Since NetTest is Java-based, it can be accessed from any system with a Java-enabled browser. While NetTest was initially designed as an assessment tool, extensions to NetTest enable it to function for both assessment and teaching. Using author-enabled feedback, NetTest can teach as well as assess.

1. NetTest: An Assessment Tool

NetTest consists of four elements: a test taking/delivery system (TTDS); a test management system (TMS); a test authoring system (TAS); and a user interface. The TTDS controls user and author access to the test and statistical databases. This element also provides the multiple levels of security in NetTest that are critical for use in an educational environment. The TMS provides the means by which a manager or instructor controls access to the system and generates reports on student progress, performance, etc. NetTest's TAS allows instructors to create and edit tests for inclusion in the test database. The foundation for NetTest is a set of databases which contain student, test, and performance data. The test database contains all of the tests for NetTest. The student database contains student information for log on security, class status, test results, etc. The performance database contains information about overall test performance, question correct/incorrect rates, etc. The user interface runs under the student's Java-enabled browser. It is the means by which one navigates in NetTest and issues commands.

2. Test Taking/Delivery

NetTest is a Java-based Web-enabled system and hence, through the Internet, someone with a Java-enabled browser can access and use NetTest. Currently, because of browser incompatibilities, NetTest only runs under Netscape 4.0 or higher. The TTDS interfaces to the student and test manager components to assemble and deliver a test to a student. In order to access NetTest, a user must have a valid username and password.

Once a user selects a test, NetTest extracts from the database for that test a subset of the questions in the database. In building the test database for a particular subject, an author categorizes questions into sections. Typically, a section consists of a set of questions designed to measure a particular competency or skill level. At the time of authoring, one must also specify the number of questions to be selected from a section. For diversity among tests on a subject, the author should generate considerably more questions for a section than the number to be selected for an individual test. Using a possibly different number for each section, the system randomly selects questions from the database. These questions are then combined to form a single test. The order of the questions in the test is also randomized and for multiple answer questions such as multiple choice, the order of the choices is randomized.

At the highest level, NetTest allows for two general categories of tests; *secured* and *not-secured*, and three general categories of questions: *pre-test, required,* and *general*. A secured test is one which not only requires that the student be logged on with a valid username and password, but that a program manager also have generated a request for a test for this student. Normally, this means that the student has identified him/herself to the manager by showing a valid picture id. For the not-secured test, the student only needs to log onto the system and select the desired test.

NetTest's three question categories allow for testing of initial knowledge of the subject (*pre-test*); specific knowledge (*required*), and/or general subject knowledge (*general*).Using pre-test questions, it is possible to develop an initial knowledge or background test for a subject. In such a case, when a student enters NetTest and selects a test for a subject, they can choose to take a pre-test or a general test. If pre-test is selected, the system randomizes and delivers all of the pre-test questions for that subject. The author has the option to require or not require a pre-test. However, once taken, a pre-rest cannot be re-taken.

When a student chooses to take a general or standard test, all required questions are selected, and then, based on the author-set section quantities, other questions are selected to produce a complete test.

2.1 Test Security

NetTest has several levels or types of security. They are: *Log On*, every user must log on with a valid username and password; *Secured Test*, a secured test can only be taken after a user has logged on, and a program manager has unlocked that specific test; *Class Requirement*, only a student registered for a particular class (or some other identification) is allowed to take such a test; *IP Address*, a test will be delivered only to the machine(s) with specified IP address(es); and *Time Stamp*, a test can only be taken on a specific day(s) at a specific time(s). These security levels are not mutually exclusive. For example, a test can be secured so that it is only delivered to systems with certain IP addresses, on a particular day, to students registered for a particular class.

2.2 Question Categories

Seven different categories of questions are currently allowed in NetTest. The categories or types are: *true/false, multiple choice* (one or more correct answers), *sequencing* (place the shown steps in proper order), *fill-in-the-blank* (up to 10 variations or spellings can be scanned and accepted), *matching* (match items in column A with those in column B), *essay*, and *performance-based*. Except for performance-based questions, all questions, regardless of type, have the same user interface. In addition to text-based questions, it is possible to have a graphic associated with each of the first six question categories. Figures 1 and 2 are examples of two such questions; namely, multiple choice and essay.

When a student exits a test, the questions in the test are automatically graded, except essay and performance-based questions. The student is also notified of their score, and the student and test result databases are updated. If enabled, the instructor will be notified (by e-mail) that the student has completed the test, the score they received, and the time the test was taken. Finally, also if author enabled, NetTest will give the student feedback as to the results for specific questions. It is its multi-level or extended feedback capability that represents one of NetTest's most important capabilities. Rather than simply telling the student whether or not they have answered a question correctly, and possibly, what the correct answer is, NetTest can present a variety of additional information to assist the student to understand the answer. Such information may be textual, graphic, bibliographic, links to other web sites, and/or video/audio information such as specific feedback recorded by the instructor. For a class, this feedback could at least include references to the text where the tested material is presented. Answer feedback can also be set to be given only after a particular date/time. In this way the instructor can control security for question answers.

2.3 Essay Questions

Essay questions represent a special question category that the system is not able to automatically grade. When a student completes a test containing an essay question(s), the essay question answers, i.e. the student's written responses, are stored in a secured database and an e-mail message is sent to the author assigned address of the grader. At their convenience, the grader can then enter NetTest and call up the student's answer to read and grade. Once grading is complete, the grader assigned scores for these questions are used to update the student's total score, and the student is also notified by e-mail of their score. In addition to assigning a score, through the NetTest interface, the grader can add comments to the student's essay to give additional feedback. Hence, when the question is graded, the student receives not only a score, but an annotated evaluation of their essay. These comments will be in addition to the more generic feedback that can be included as with other types of questions, i.e. locations in the text where the subject matter for the questions is discussed, etc.

While not another question category, bundled essay questions are also allowed. In bundling, the author develops 2-4 sets of essay questions. For such questions, NetTest will randomly select one question from each set and then deliver all to the student as a single essay question with the instruction that they are to answer only one of the set in the essay answer window.

2.4 Performance-based Questions

Like essay questions, performance-based (PB) questions are a special category. Upon completion of a test, the results for these questions are also transmitted to an author-specified site for grading. PB questions represent a powerful extension to standard CBT systems. A PB test is a set of PB questions associated with a particular software tool or product. In order to execute a PB test, it is necessary that the host system have a copy of the specific software on which performance is to be measured. For a PB test, a screen as in figure 3 will be displayed. Normally PB questions are used in conjunction with a specific software product. For example, if an instructor wished to test competency in the use of a word processor such as MS Word, they could do so most effectively using a PB test.

A PB test has three components: an environment, an initial state, and a sequence of PB questions. The environment is the software product on which the PB test is given. This product may be a standard commercial software product such as Corel's WordPerfect, or it may be more special purpose such as a chemistry laboratory simulation tool. The initial state for a PB test is typically an initial file. For a document processing PB test, the initial state might be an initial document file on which students are to make changes, additions, corrections, etc. The PB questions are those operations that the student is to perform. Answering such questions results in a change of the system's state. As an example, for a spreadsheet PB test, there might be a PB question such as *set the format of cell B12 to currency.* Figure 3 shows the user interface for a PB test. The top portion of the screen is the actual product, and the bottom portion is a set of PB questions. When *DONE* NetTest transmits the system's final state, in this case the modified file, to an author assigned location for grading. This form of question also allows for a much more flexible assessment of competency. In this environment, when versions of a software product change, PB questions need not change. This is because PB questions are couched in terms of the performance of a particular task not in terms of how that task is performed. A question such as "What are the keystrokes needed to ...", is not version independent.

The random selection process is also slightly different for PB tests. Normally, an author will create several PB tests with associated initial state and PB questions. At time of test initiation, the system randomly selects and delivers from this database a single PB test with its associated PB questions.

3. Test management system

NetTest's test management system controls access to the test, user, and statistics databases. The functionality of this part of NetTest is accessed through the various user interfaces.

3.1 Test Database

The test database is simply a database of tests, where a test is a set of test questions categorized by section. Ownership for a test is assigned to the author of the test. A test owner can give that privilege to other authors to allow for more than one person to edit a test. However, the more common security level is read/copy access. With this level of security, an individual can copy another's test; rename it, and then proceed to edit it under their own authorship. Once a test is authored, an owner can revisit the test to edit, add, or delete questions.

3.2 User Database

In the user database is stored user information, such as user type, class registration (if they are a student), current status, i.e. tests passed to date, etc.

3.3 Statistics Database

This database stores most of the data used in the generation of test results. For example , in addition to data about test taking results, a record is maintained for every question in every test indicating the number of times it was answered correctly and the number of times incorrectly.

4. Test Authoring System

The test authoring system is that portion of NetTest that allows an instructor to create or edit a test for inclusion in the test database. The process of entering or editing tests is performed in a template fill-in environment and hence is relatively straightforward. Figure 4 is an example of such a template for a multiple choice question.

5. User Interface

Depending on the type and operating mode of the user, there are three user environments or interfaces. Specifically, a student interface, an author interface, and a program manager interface. As shown in the preceding figures, the interface is a windows-like environment with most operations performed in a point-and-click mode. Where specific input is needed, it is generally template fill-in.

Program managers are responsible for security, test management, and report generation. Instructors can also perform report certain generation operations. Like the other interfaces, the program manager interface is a point-and-click environment. Program manager functions include creating or deleting student, manager, and/or instructor accounts; generating a report on the passing rate for a selected test(s); unlocking a secured test for a student; etc. There are also different levels of security for program managers. For example, a program manager can be given only test unlock privileges, in which case they cannot edit or remove accounts, etc.

Two of the most useful reports generated by NetTest are question pass rates (QPR) and student performance (SP). The QPR report lists all questions in a given test and the frequency with which they were answered correctly and incorrectly. Such a report is useful for question and test validity analyses. The SP report is much like a grade list. In fact, such a report can be saved to disk in spreadsheet format for use and editing by an instructor. Another important feature of NetTest is that all databases are SQL format. This means that with proper security clearance, someone can access this database to generate their own report(s). Currently NetTest uses MS/SQL and JDBMS for its database system. In the near future we will port it to an Oracle SQL environment.

Summary

While work on NetTest is on-going, it should also be recognized that NetTest is a real product. It is the goal of the multimedia research group at Utah State University to continue to expand the capabilities of NetTest, and to find applications for NetTest which will test and verify its utility. The authors believe that NetTest is one of the more powerful assessment tools currently available and as such, are working to establish relationships with potential users of NetTest.

When an instructor authors a test, if they spend the additional time needed to include resources for feedback, we believe NetTest can be an effective teaching as well as an assessment tool. The PB assessment capability of NetTest means that it can assess competency in the use of specific software tools such as word processing or spreadsheet programs. Furthermore, this capability means that when NetTest is integrated with specialized software, e.g., a laboratory simulation tool, it can be used for assessment in laboratory-based classes such biology, chemistry, or physics. Currently NetTest is being used for challenge examinations in US History and Economics. Beginning Fall, 1998, with the opening of USU's computer-based testing facility, NetTest will be used for campus-wide testing of computer literacy.

Acknowledgments

Funding in part for this work was supplied by the National Science Foundation and by the Fund for the Improvement of Post Secondary Education (FIPSE/DOE).

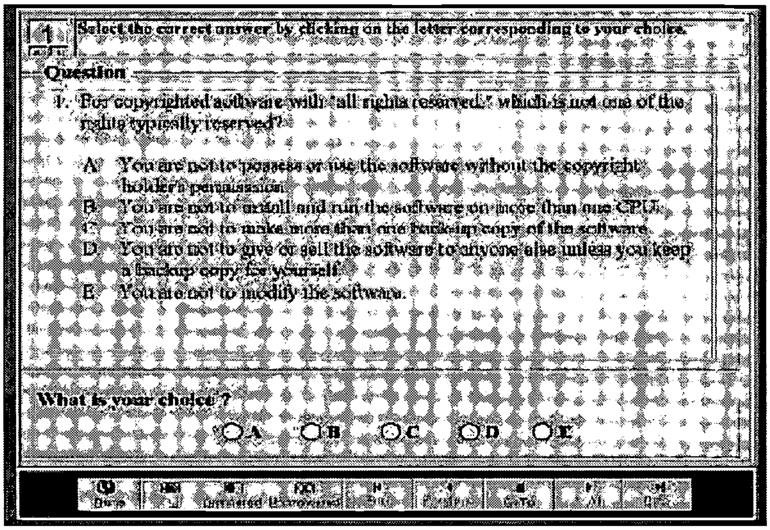

Figure 1: Multiple Choice Question

Figure 2: Essay Question

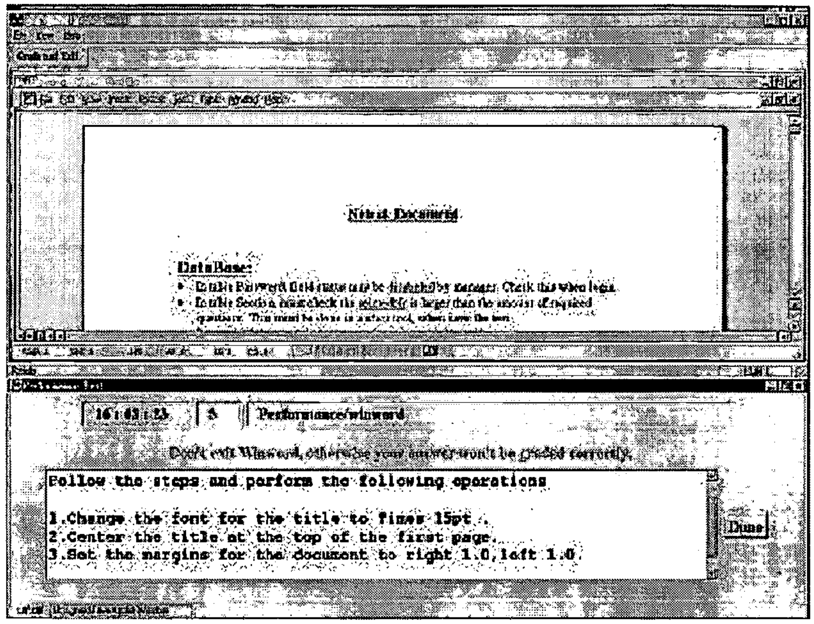

Figure 3: Performance Based Test Example

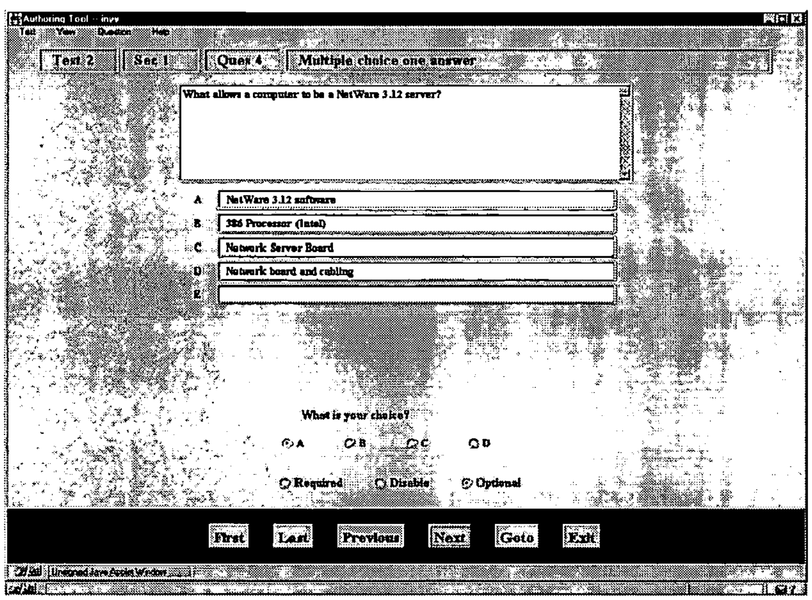

Figure 4:

Authoring Template for Multiple Choice Question

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Dynamic Content
A New Model for Collaborative Learning Environments for Language and Culture Studies

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Abstract: This paper investigates the potential of dynamic content structures in non-linear educational media. On the basis of a Web-based, collaborative hypermedia learning environment for German Culture and Language Studies, titled "Berliner sehen"[1], the presenters will explain the concept of dynamic content and the resulting new forms of student interactions. Authentic personal life stories in "Berliner sehen" in conjunction with a rich archive of relevant current and historical documents encourage students not only to explore the lives of Berlin residents and the multiple stories they tell about their neighbor-hoods, past and current events, places and people but also provides students with the capability to reconfigure at will the media contexts to create their own "mini-stories" and "mini-documentaries".

The Project

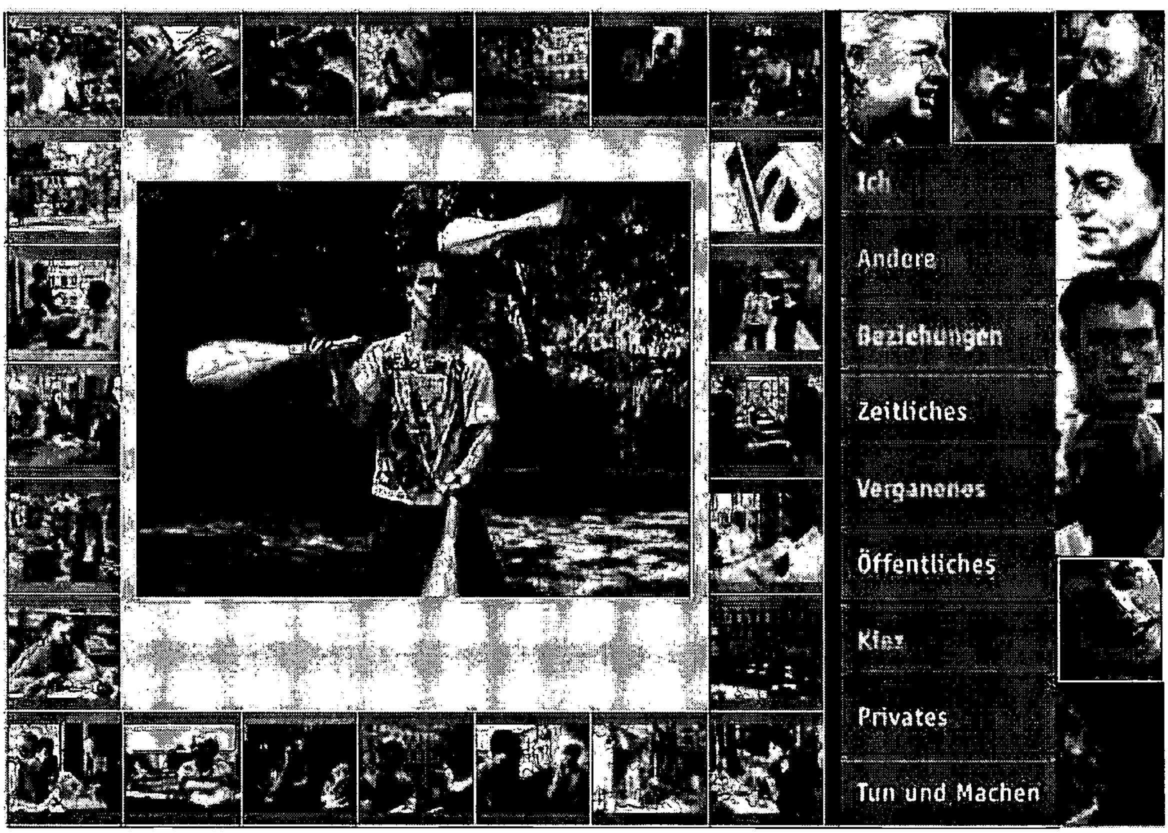
The *Berliner sehen* project combines an interactive narrative approach with the genre of an interactive documentary to form a new hybrid: a collaborative hypermedia learning environment. Experimentation shows that this new hybrid genre provides students with a variety of ways to explore notions of culture through language from multiple points of view. Non-linear modes of accessing the material in *Berliner sehen* are supported by a narrative structure that is based on individuals' life stories told by residents of both parts of the formerly divided city of Berlin.

The core video material, filmed specifically for the project, depicts nearly 50 residents of Berlin from all walks of life and in a variety of conversational constellations. Eight Berliners and their intersecting life stories in neighborhoods in east and west Berlin provide a common narrative structure in their conversations with family members, friends, neighbors, and colleagues. In these natural, non-scripted conversations and discussions the residents bring up a broad array of private, social, political, current and historical issues that pertain to their personal perspectives on cultural change as east meets west. One of the recurring themes is the changing face of the re-unified city that can be seen in city redevelopment projects and the process of gentrification. The hypermedia archives contain supporting documentary materials that provide a particular focus on such overarching themes in the core video material.

Pedagogically, we proceed from a model that combines the learning of culture through narratives and encourages students to investigate authentic contexts of language discourse. We do not follow a conventional top-down approach that would describe, explain or synthesize information about the culture in a thematic framework. The core video of conversations among Berlin residents provides the students with an insider's perspective on life stories as they are embedded in the larger social context and cultural history of the city. The insider's perspective is doubled by the specific cultural context of life in Berlin today, a city in which two German cultures confront each other. West Berliners and East Berliners each provide us with an insider's perspective to their respective German cultures as well as an outsider's perspective to each other's culture. By juxtaposing these perspectives students gain a unique position from which they learn about culture through the words and the original stories of the people who live in that culture.

The structure of the core video is based on principles of hypermedia rather than a linear or hierarchical structure. In such a structure there are multiple points of entry rather than a specific beginning or ending point. This structure allows for the units of content to be re-configured according to the user's perspective rather than limiting the user to a fixed configuration. Since the order in which a user views a particular segment of the video material is not pre-determined, each segment of the video has meaning as a separate autonomous unit and at the same time can easily be linked to other segments in a meaningful way. The narrative structure of the eight individual life stories of the Berlin residents provides a key relationship that connects all of the video segments. Narrative structure as a principle of hypermedia design serves here to orient the user without imposing a linear structure on the documentary.

The prototype of an interface component of "Berliner sehen" depicts the dynamically reconfigurable workspace with the so-called perspectives on the right. While in browsing mode, students can select any combination of persons and notions to display a permutation of media documents that provide a context for study:



Screen Shot of "Berliner sehen", © 1997 MIT

The Concept

The concept of dynamic content builds upon the original idea of Hypertext, as it was first described by Vannevar Bush in "As we may think"[i] [Bush1945] and later by Theodor Nelson in "Literary Machines"[ii].[Nelson 1987] Bush argues that our current methods of storage and retrieval of information are inadequate:

> "Our ineptitude in getting at the record is largely caused by the artificiality of systems of indexing. When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (when it is) by tracing it down from subclass to subclass. It can be in only one place, unless duplicates are used; one has to have rules as to which path will locate it, and the rules are cumbersome. Having found one item, moreover, one has to emerge from the system and re-enter on a new path." [Bush1945, 106]

According to Bush, the storage and the manipulation of data are operations that can easily be automated. Retrieving data, however, is a highly creative process that requires new approaches for it to be automated. Existing techniques of retrieving information, he argues further, heavily rely on relatively inflexible systems of artificial content structures that have no equivalent in human thinking.

> "The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. It has other characteristics, of course; trails that are not frequently followed are prone to fade, items are not fully permanent, memory is transitory. Yet the speed of action, the intricacy of trails, the detail of mental pictures, is awe-inspiring beyond all else nature. Man can not hope fully to duplicate this mental process artificially, but he certainly ought to be able to learn from it." [Bush1945, 106]

As a solution to the problem, Bush developed the concept for the so-called MEMEX, the memory expander, which - in 1945 - was a mechanical device. A closer look at how a user can interact with documents, already provides useful insights to the basic design principles for a system of dynamic content:

> "The owner of the memex, let us say, is interested in the origin and the properties of the bow and arrow. Specifically he is studying why the short Turkish bow was apparently superior to the English long bow in the skirmishes of the Crusades. He has dozens of possible pertinent books and articles in his memex. First he runs through an encyclopedia, finds an interesting but sketchy article, leaves it projected. Next, in a history, he finds another pertinent item, and ties the two together. Thus he goes, building a trail of many items. Occasionally he inserts a comment of his own, either linking it into the main trail or joining it by a side trail to a particular item. When it becomes evident that the elastic properties of available materials had a great deal to do with the bow, he branches off on a side trail which takes him through textbooks of elasticity and tables of physical constants. He inserts a page of longhand analysis of his own. Thus he builds a trail of his interest through the maze of materials available to him." [Bush1945, 107]

Systems that connect media documents through fixed links, e.g. the WorldWideWeb, share merely the connectivity feature of hypertext. The model of dynamic content on the other hand replaces fixed links with reconfigurable dynamic links. This paradigm permits a flexible and individualized approach to retrieving information without restricting the user by fixed ordering schemes. In conjunction with a provision for collecting materials, systems of dynamic content offer students a rich learning tool that fosters high-level thinking skills such as hypothesizing, application, analysis, synthesis, and evaluation. It further promotes cross disciplinary interactive approaches that enhance motivation by allowing users to influence the outcome, to follow divergent paths, and to experiment with different interpretations of the material. A dynamic learning environment for cultural studies such as "Berliner sehen" lets student access the otherwise 'hidden layers' of a foreign culture by juxtaposing cross-cultural content and personal perspectives.

The integrated networking capabilities of "Berliner sehen" provide students with a collaborative workspace that can be shared flexibly across Intranets and the Internet. Whether students are in one location or in several culturally different regions, they can collaborate to reconfigure the core material in ways that reflect their respective views of specific cultural notions. Students offer 'their' interpretations of the "Berliner sehen" materials by publicizing them to the network. This approach permits learners unique insights in the process of culturally dependent interpretation.

The Technology

"Berliner sehen" as a model for a dynamic content system is built on top of a complex database structure written in Java. The content of the core archive consists of more than thousand video clips in MPEG-1 format as well as thousands of historical and personal photos and documents. The *Berliner sehen* archives, including all texts, images, audio and video, are stored in a hybrid local/ networked fashion. The core video material and other copyrighted documents will be distributed in a variety of formats: on high-density DVD-ROMs, via an INTERNET-2 connection, and on multiple CD-ROMs for upload to an Intranet server; depending on the institutional set up, all other material collections are stored locally, on Intranet servers, or can be accessed through the central project server at MIT. Developed in the Java programming language combined with the QuickTime media format, this approach takes advantage of the latest developments in media technology, without compromising the potential for distribution on a variety of low-cost computer platforms. *Berliner sehen* is constructed as an open system that allows students not only to expand the archives but also to collaborate on the construction of new collections that can be made available to other users over networks.

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[1] More information on the project: http://web.mit.edu/fll/www/projects/BerlinerSehen.html

[Bush 1945] Bush, Vannevar (1945(As We May Think. *The Atlantic Monthly*, vol. 176, July 1945, 101-108
[Nelson 1987] Nelson, Theodor H. (1987): *Literary Machines, Edition 87.1*

A Coordinated Browsing System

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Abstract: Java is enabling Web applications to be richer and more interactive. It is now becoming feasible to build collaborative Web applications. This work focuses on a synchronous class of collaborative applications. A coordinated browsing system was built, which allows a group of users to "surf" the Web together (where users have the capability to be geographically distributed, possibly working on different platforms). In this environment when a user in the group loads a new document from a site, the same document gets loaded on all the other users' Web browsers. The proposed coordinated browsing system works on any platform that supports a graphical Web browser with Java capability. Advantages are two fold: in our approach it is not necessary for every user in the group to have the same browser, nor do we modify the browser.

1. INTRODUCTION

The World Wide Web is growing exponentially, thus, making it an attractive framework for a wide variety of applications. Today the World Wide Web is the most cost-effective way to share information among geographically dispersed users. The graphical Web browser's ease of use makes internationally distributed multimedia information accessible to anyone with access to the Internet. The Web seamlessly connects disparate hardware platforms running different operating system in diverse locations. With the advent of Java technology, Web applications can now support collaboration.

The focus of this work is to develop a synchronous class of Web based Java collaborative applications. More specifically, we are looking at coordinated browsing (*co-browsing*) which allows a group of users to "surf" the web together (where users have the capability to be geographically distributed, possibly working on different platforms). When a user in the group loads a new document from a site, the same document gets loaded on all other users' Web browsers. Coordinated Web browsing, along with audio support, can be used effectively in many situations to increase productivity. Some example scenarios in a teaching environment are:

1. *Group of students*: Courses that are project oriented might require students to collectively research or explore information on the Web. For example, a group of students may be working together to write a report on the subject of computer security. For this, students may decide to research the material together to identify papers that they can use for writing the report.

2. *Group of students and an instructor*: When an instructor holds a recitation session with a group of students to explain or elaborate on some concepts discussed earlier in the class, an instructor may find it useful to use different media, such as animation and video available in a digital library, to explain a breadth-first search algorithm.

3. *An instructor and a student*: When a student wishes to interact with the instructor about a specific question, the instructor may find it appropriate to co-browse material from the lecture for that course.

Recently, many collaborative Web applications have been developed [Bhatia 97, Chen 97, Hoshi 92, Maly 97a, Maly 97b, Toye 94, Rees 93, Beca 97, Davis 97]. Most of these approaches either require modification of the browser or are based on the X Window System protocol. However, these approaches do not lend themselves easily to a group of users working on multiple platforms (such as Unix, Windows NT, MacOS, and Windows95) concurrently.

This paper describes an approach that works on any platform that supports a graphical Web browser with Java capability. Most new Web browsers, such as the Netscape and Microsoft Internet Explorer, have this capability. Also, in this approach it is not necessary for every user in the group to have the same browser. It is feasible for some users in the group to use Netscape while others use Microsoft Internet Explorer. Another advantage of this approach is that it does not modify the browser. Coordinated browsing can be integrated with audio to enable users to speak while browsing. However, this paper will only discuss the coordinated browsing architecture and its implementation.

The rest of the paper is organized as follows: Section 2 presents the architecture of the coordinated browsing system, Section 3 discusses the design and implementation issues faced, Section 4 describes the current prototype, and in Section 5 Conclusions and future work are detailed.

2. CO-BROWSING SYSTEM ARCHITECTURE

When a user in the group loads a document from a site in a co-browsing session, the same documents is loaded on all the other users' Web browsers. The main attribute that makes co-browsing possible is its ability to intercept a Web browser's request for a document and communicate it to other browsers in the session. The other browsers, on receiving this information, download the same document. We use a modified proxy server to intercept requests from various Web browsers in a co-browsing session. A Web browser, once configured to use a proxy server, sends the complete URL request to the proxy server. The proxy server, in turn, opens a connection to the requested URL Web server, makes the HTTP request, and then sends back the result to the Web browser. Traditionally, a proxy server has been used to provide Web services across a firewall, or to locally cache remote documents to reduce network traffic. Java applet technology has been employed to enable Web browsers in a session to receive information about document requests. Web browsers in a co-browsing session always have an applet running to receive these request updates. In addition, software is also needed which will keep track of the active Web browsers in a session. This software will communicate with the applets. Methods are also needed to allow a Web browser to join a co-browsing session.

The following is a description of the co-browsing architecture for a single group of client browsers. This system will be referred to as "the single-group architecture." The number of clients supported by a single-group architecture is determined by the hardware and software characteristics of the machines involved. A discussion on how the single-group architecture can be extended into a hierarchy of groups to support large number of users will follow. The objective of the overall design is to achieve cross-platform support, and to allow for the use of standard web browsers and servers (without modification).

Single-group Architecture

The single-group architecture along with its various components and how they interact is shown in Figure 1. The co-browsing architecture consists of (i) a Central Proxy Server (CPS), and (ii) a Central Registration Service (CRS) that consists of a standard Web Server (WS) and a Registration Server (RS). In this section we look at the functional description of these modules and how they interact to support a co-browsing session. In the next section we discuss the design and implementation issues for these modules.

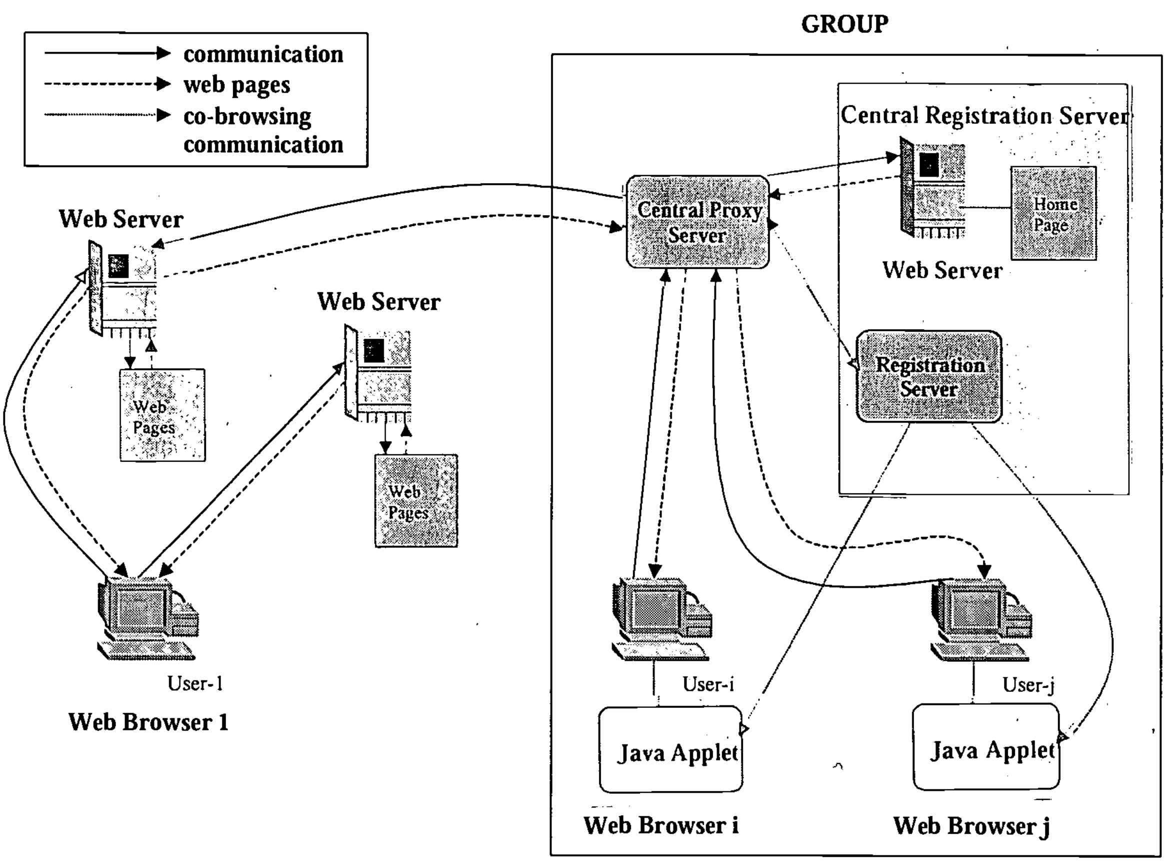

Figure 1: Single-group architecture for co-browsing system.

To help illustrate the working of the co-browsing architecture the following example describes a situation where a new user joins an ongoing co-browsing session of two users. To keep this explanation simple, certain assumptions have been made: the user in a co-browsing session only download simple HTML documents without any embedded images, the user never clicks a link with its target set to "main". These issues, along with their impact on the overall co-browsing architecture design, will be discussed in the next section.

Step 1. The new user downloads a registration document served by the CRS-WS [Fig. 2]. This document has information about the existing users in the group. Once the user selects to join the group, she receives a two-frame web page. One frame of this web page is visually hidden from the user and contains an embedded applet along with a parameter containing the URL of the current document being viewed (http://www.some.site/doc0.html) by the group. The browser downloads the applet and runs it. First, the applet registers itself with the RS. Note, due to security restriction of Java applets, the RS and WS have to be on the same host. The Java applet security environment does not allow applets to communicate to any host other than the host from where it is was downloaded. The applet registration process involves informing the RS it is active and the port number at which it will be listening. Upon receiving this information, the RS updates its table of active Web browsers in the session [Fig. 3]. Second, the Java applet downloads the current document being viewed by the group into its second frame. Recall that the URL of the current document is passed by the RS as one of the parameters to the embedded applet. The Java applet remains active until the user leaves the co-browsing session. Since all new documents are loaded into the second frame, the embedded applet remains active. However, the applet will stop running if a new document is loaded in the main window. This issue will be discussed in the next section.

Step 2. User-1 clicks on a link that points to the URL "http://www.some.site/doc1.html". User-1's browser sends the request to the proxy server, which performs the following two functions :

(i) it makes a connection with the host "www.some.site", gets the document "doc1.html", and sends it back to User-1's browser. It also caches the document for further distribution.

(ii) it passes the requested URL along with the requested Web browser information to the RS.

Step 3. The RS on receiving information from the CPS, sends the URL "http://www.some.site/doc1.html" to the applets running on User-2 and User-3's Web browsers. Note that the RS does not send the URL information to the browser that originated the request. The applets, upon receiving the URL information, issue a request to their respective browsers to load the new document in the second frame.

Step 4. User-2 and User-3's Web browsers send the request for "http://www.some.site/doc1.html" to the CPS. The CPS serves these requests from its cache. These requests are not forwarded to the RS.

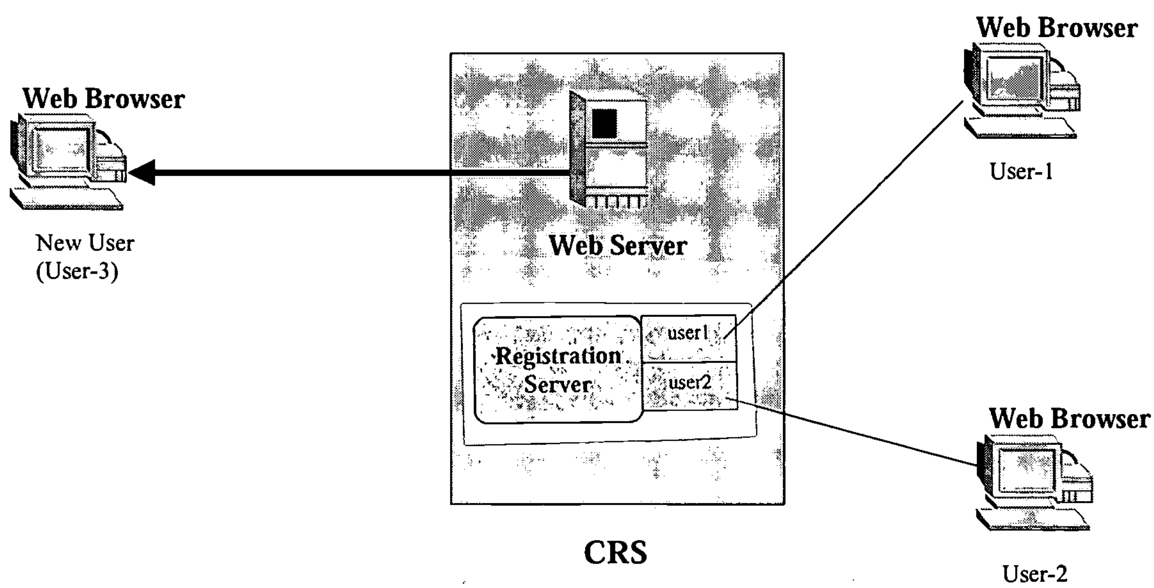

Figure 2: A new user requests the registration document for joining a co-browsing session.

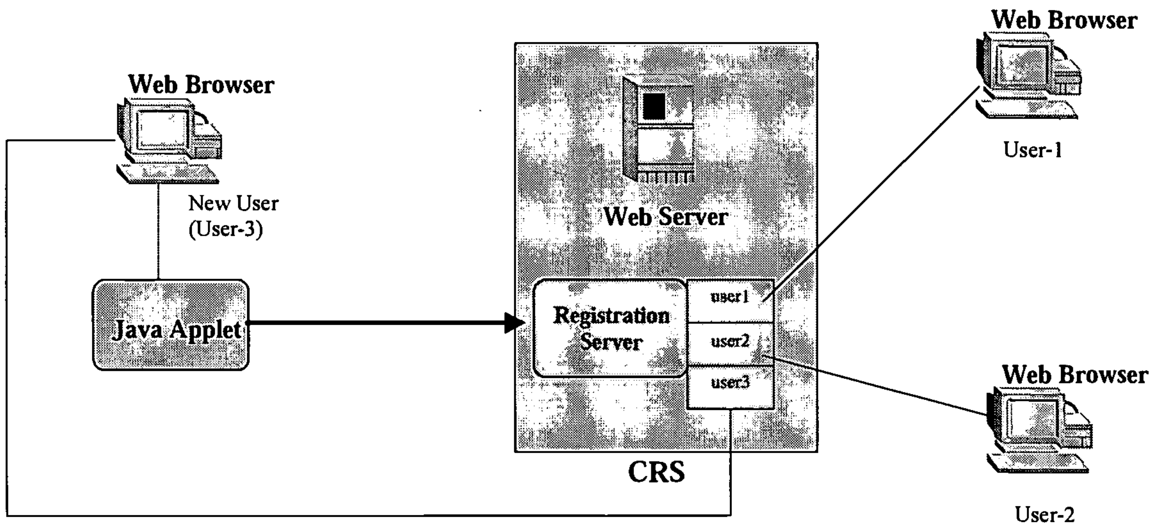

Figure 3: An applet registers with the registration server. The Registration server updates its table of active Web browsers in the co-browsing session.

3. DESIGN AND IMPLEMENTATION ISSUES

To build a working co-browsing system, the following design and implementation issues must be addressed:

- What happens if a user in a co-browsing session loads a complex HTML document that requires multiple HTTP requests by the browser?
- What happens if multiple users in a session concurrently try to load different documents?
- What happens if a user clicks on a link with its target set to the main browser window?
- What happens if one of the browsers is on a slow machine or on a slow network connection?

For a full discussion of these issues, please refer to [Davis 97].

4. PROTOTYPE

The current prototype implements a single group architecture. The prototype system was designed using the Java 1.0 development kit and is currently being updated to Java 1.1 in order to take advantage of any performance increases and additional features the new JDK might offer. Java is the language of choice for the Central Proxy Server and Central Registration Sever because it is platform independent. The detailed implementation of the Central Registration Server, and the Central Proxy Server are discussed in [Davis 97].

5. CONCLUSION

This paper proposes a co-browsing architecture that allows a group of users to "surf" the web together. The proposed architecture works with any graphical Web browser that supports Java applets. The users may potentially be geographically separated and working on different platforms. The system was demonstrated by building a singe group architecture that is able to support a co-browsing session for 100 users at any given time. The possibility of implementing a scalable hierarchical-group architecture is speculation at this time.

Features such as asynchronous support are planned for the future. Students and teachers will be able to create a scripted tour of several Internet sites and register this tour with the proxy server. Users can then access a series of pre-scripted WWW locations. Support for page annotations will also be included for the pages placed in a tour. Providing a means for asynchronous use will facilitate the creation of reusable courseware materials. It also allows greater flexibility for large groups of students working together whose respective time constraints (work, parenting, etc.) would otherwise prohibit traditional collaborative methods. Once the complete Java Media APIs are available, audio will also be supported with the co-browsing architecture. This feature will enable co-browsing participants to have simultaneous audio and web browsing potentials.

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University Strategy and the World Wide Web - An Empirical Analysis

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Abstract: World Wide Web (WWW) "home pages" are now ubiquitous for universities around the world. A university home page is the first place that many stakeholders will be visit for research on the university or for information on a variety of topics. It was hypothesised that the size and nature of universities and their investment in the staffing of WWW sites will determine the level of output of WWW sites. A WWW-based survey was conducted of Webmanagers at all universities in Australia. A response rate of 80% was achieved. The number of services provided, the number of pages made available and the number of pages that are changed on a regular basis were alternative measures of output. The hypothesised relationship between size and nature and output was not supported. There was limited support for the hypothesised relationship between staffing levels and output.

Introduction

This paper introduces an empirical analysis of the strategic development of the World Wide Web (WWW) by university management in the Australian context. The WWW has wrought major changes in the manner which universities communicate with students, faculty, and the wider community. Many universities worldwide and certainly every university in Australia have at least one WWW server and a "home page". The services provided by these sites range from relatively simple introductions to the institution to large and highly complex, multimedia institutional encyclopaedia. The home page has, in a very few years, become a core element of University public relations, information management and dissemination and to a lesser extent a snapshot of its teaching, learning and research activities.

Yet the development of the WWW in the university setting has been the subject of very little research. The research, which has been conducted, has been largely descriptive of the issues that have arisen within a single institution. An extensive literature search has not disclosed any published research that investigates the development or management of the WWW across a large panel of universities. The research described in this paper was designed to fill this gap in the educational technology research literature. The research also analyses the factors that explain the size, complexity and state of the university web sites. The remainder of this paper proceeds as follows. The next section sets out the background to the study and introduces the survey that is at the heart of this research. The following two sections analyse the model and the results of the survey. A summary and conclusion follow these sections. The necessity for and direction of further research in this area is explored.

The Study

An important development in information technology (IT) provision in universities recent years has been the arrival of the WWW site. For many external parties, such as journalists, potential students and academics from other institutions, the university WWW site is now the first and often only source of information. Faculty, staff and students also use the WWW site for administrative, teaching and learning purposes. It would be unthinkable in the late 1990s for a university of any size whatsoever not to have a WWW "home page".

University WWW sites varies in scale and complexity. Some provide little more than a quick snapshot of the university. Others are highly complex including information on current events, university handbooks, staff and student contact databases and interfaces to administrative applications. The management of WWW in universities is not a typical IT function as it involves elements of IT, public and alumni relations, student administration as well as input from faculties or schools and individual faculty and students.

At the same time as the WWW has arrived in the university, central university IT facilities are experiencing very rapid increases in demand for resources [McClure, Smith, & Sitko, 1997, Ellis & Debreceny, 1997a, Debreceny & Ellis, In Press]. IT managers feel that they are almost under siege as new classes of users demand a wide variety of services. As [McClure, Smith, & Sitko, 1997] note "a decade ago, fewer than 20 percent of our faculty, staff and students were active consumers of technology services and support. Today, almost all of them are, at least to some degree. ... The educational potential of the Web alone has unleashed a firestorm of support demands, not to mention escalating printing costs in public labs." (p 2). Problems for central IT management include upgrading of computer networks, provision of adequate on-campus laboratories and off-campus connectivity [See CAUSE, 1997].

Despite the ubiquity of the WWW in the university sector, there is surprisingly little research on the management of the WWW. The literature has been descriptive in nature. It has either centered on the experiences of a single institution [Quinn, 1995, Hensarling, 1995, Callum, 1996] or has described the impact of the WWW on a particular class of university administrator [for example, Ryan, 1996, Meer & Fravel, 1996]. [Goldenfarb, 1995] provided a useful analysis of the critical success factors which determine the adoption of a WWW-based CWIS. An extensive literature search in traditional journals, relevant conferences such as ED-MEDIA and ASCILITE and on the WWW has uncovered no research, which has investigated the development or management of university WWW sites from a cross-institutional perspective. This research was designed to overcome at least in part this apparent gap in the research literature on educational and administrative information technologies.

The objective of this research was twofold. First, it was desired to build an understanding of the role and the challenges facing the university Webmanager. The second objective was to complete a profile of the output of the university WWW site, the tools used to build and maintain the site and the management strategies. An important element of the study is to gain an appreciation of the concerns and the plans of the Webmanager and of his or her team.

The Model

The dependent variable in this study is the level of output of services. Three measures of output were adopted. The first measure is the level of services provided. The survey sought information on the range of services provided as shown in Figure 1. For each service, the respondents were asked whether these services were provided by central Web services under the control of the Webmanager, by another server on campus or not at all. A score of two was allocated if the central web server was used for the service. A score of one was given if another university server provided the service[1]. There was, of course, no score if the service was not provided. The second measure of output was the number of pages on the central Web site. The third measure was the number of pages that were updated on a weekly basis.

[1] A number of combinations of scores were tested in the reported models shown below. The results were essentially invariant to changes in relative scores.

Campus Maps	Phone book	Staff email	University publications
Commercial Services	Press releases	Student email addresses	Web servers
Coming events	Promotional Material	Student information	
Degree listing	Prospective student guide	Teaching and Learning resources	
Library Catalogue	Research	University Handbook	

Figure 1: Potential Services Provided

Three independent variables were adopted. The first independent variable was the size of the institution. Size should predict the level of service provided by the central Web site. The range of stakeholders (students, faculty, staff, prospective students, parents, employers etc.) for universities is not dependent on scale. While a larger university would have more student, teaching, administrative and research activities than a smaller university it is not a linear relationship. The cost of bringing information on these activities to the WWW has, however, a high fixed cost component and a relatively low variable cost component. For example, the cost of establishing a database of faculty research activities may involve several person months as well as server and networks resources. Once the service is established and integrated into the university's business processes, the marginal cost of adding research information to the new WWW database is low. Almost certainly, it will be lower than for the equivalent printed report. A larger university will, we predicted, have more stakeholders to absorb the fixed cost of development. It is hypothesised that the size of university is a determining factor in predicting the level of output of WWW services.

The second independent variable was the nature of the institution. Universities were categorised as regional or metropolitan and ex-Colleges of Advanced Education (CAE) and "traditional" university. The latter classification reflects the historical origins of universities in Australia. Prior to the late 1980s, a number of higher education institutions in Australia were "Colleges of Advanced Education" or "Institutes of Technology". These institutions primarily had a teaching and learning mission. Following the creation of the so-called "Unified National System", these institutions either merged with the then existing universities or became universities in their own right. The student population of the ex-CAEs is more heterogeneous than those of the traditional universities. For example, they have relatively high proportions of part-time, adult and distance students. It was predicted that the ex-CAEs would be more likely to use the Web for communication purposes as their heterogeneous student populations can be more effectively reached via the WWW.

A third independent variable was the staffing levels within the central WWW services. It is with the staffing of the WWW unit, that universities explicate their priorities. The level of staffing is a second order variable.

Survey Results

The survey was distributed and the results collected over the WWW in August and September 1997. There were 33 useable responses to the survey, from a population of 41[2] universities. Analyses of different aspects of the survey results have been published in [Ellis & Debreceny, 1997b] and [Debreceny & Ellis, 1997]. The distribution of respondents by size[3] and type of institution is shown in Table 1:

2 One university in the survey is managed as a federated institution. The campuses have a high degree of autonomy. Each campus was treated as a separate institution for the purposes of this study.

3 Size is measured by thousands of Equivalent Full Time Student Units (EFTSUs)

		Size of University (EFTSUs)						
		0-5	5-10	10-15	15-20	20-25	> 25	Total
Type of University	Metropolitan ex-CAE	0	1	1	1	2	0	5
	Metropolitan University	2	4	3	3	3	3	18
	Regional ex-CAE	0	1	1	1	0	0	3
	Regional University	2	2	2	1	0	0	7
Total		4	8	7	6	5	3	33

Table 1: Size (000s of EFTSUs) and Type of Universities

Model Results

There is insufficient space in this paper to provide a complete suite of results for the predicted relationships. A selected subset of the results is reported. Both parametric and nonparametric statistical techniques were used to analyse the results[4]. Table 2 shows the crosstabs for the quartiles of services provided against the size of the institution.

		Size of University (000s of EFTSUs)						
		0-5	5-10	10-15	15-20	20-25	> 25	Total
Services (Weighting 1)	1.00	2	2	3		1	1	9
	2.00	2	1	2	1	1	1	8
	3.00		5		3	2	1	11
	4.00			2	2	1		5
Total		4	8	7	6	5	3	33

Table 2 Crosstabs - Services Provided by Size of University

There was no statistical support for the hypothesised direction[5]. Larger universities did not provide a greater range of services than those provided by smaller universities. As Table 2 indicates, some of the smaller universities (for example, those in the 5-10k EFTSU range) are providing a wide range of services. Not one of the three largest universities was in the fourth quartile and one was in the first quartile. A similar pattern was found for the number of pages on the central web site, as shown in Table 3. Two of the largest universities provided less than 100 pages of content. This is a trivial amount of content for such large institutions. Conversely, some of the smaller institutions were providing large quantities of information on the WWW. One of the universities in the group of 10-15k EFTSUs provides more than 20,000 pages of information with more than 200 of those pages changing on a weekly basis. The patterns that are disclosed in Table 2 were repeated when the nature of universities was investigated. The number of pages was somewhat different however. Regional institutions, even smaller regional institutions, are providing more pages than their larger metropolitan siblings are. This may be a function of the stronger distance education element at regional institutions.

4 While the number of observations is small (33), it constitutes a very high proportion of the population.

5 Employing both the Kruskal-Wallis non-parametric test and the Chi-square measure on Crosstabs.

		Size of University (000s of EFTSUs)						
		0-5	5-10	10-15	15-20	20-25	> 25	Total
Number of Pages	1-50		2	1				3
	51-100	1	2	2	1		2	8
	101-150	1	1					2
	151-200			1		1		2
	250+	2	3	3	5	3	1	17
Total		4	8	7	6	4	3	32

Table 3: Crosstabs - Pages Provided by Size of University

The level of staffing provided a more interesting pattern. There was a high degree of variability in the level of staffing allocated to development and maintenance of the WWW site. Table 4 shows the equivalent full time staffing on WWW duties, by size of institution. It can be seen that even large institutions operated their central WWW site with the equivalent of less than one quarter of a person's time.

		Size of University (000 of EFTSUs)						
		0-5	5-10	10-15	15-20	20-25	> 25	Total
Total Staff on Web Duties	0-0.3	1	1	2	1	3	1	9
	0.3-0.85	1	3	1		1		6
	.85-1.15	2	1	3	2			8
	> 1.15		3	1	3	1	2	10
Total		4	8	7	6	5	3	33

Table 4: Staffing Levels

The Kruskal-Wallis non-parametric test of ranks (mean ranks) for the effect of staffing on output is shown in Table 5. No pattern can be discerned for services provided, but statistically significant relationships existed for both pages on site and pages changed weekly.

	Total Staff (Quartiles)			
	0-0.3	0.3-0.85	.85-1.15	> 1.15
Services (Weight ing 1)	18.78	19.83	15.69	14.75
Pages on site[a]	20.06	6.30	17.13	17.90
Pages changed weekly[b]	18.00	10.25	15.31	21.50

a. Significant at $p < 0.05$

b. Significant at $p < 0.10$

Table 5: Effect of Staffing Levels on Services and Pages Provided

Conclusion

Only limited support for the hypotheses on WWW provision, set out above, could be found in the analysis of the survey results of 80% of Australia's universities. It was hypothesised, for example, that size of university would be positively correlated with WWW output. To the contrary, a number of the smaller and medium sized universities had a substantial WWW presence. Some of the larger universities had a minimal presence. The level of staffing did however provide some predictive power. Perhaps more interesting, however, was the relatively low levels of staffing within most central university WWW functions. This is, perhaps, an indication that the WWW has not yet become a focus for university management.

This is the first large-scale survey on central WWW provision within the University sector. The research should be complemented by similar studies in other countries and by small scale and case study research which provides more detailed cross-institutional comparisons.

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A REVIEW AND ANALYSIS OF TOOLS FOR LEARNING PROGRAMMING

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Abstract:
Many tools have been designed, prototyped or implemented for students' use in the acquisition of programming skills. We present a concise review and analysis of twenty-five systems developed to teach problem solving and programming. These systems are classified in three categories: programming environments, intelligent tutoring systems, and intelligent programming environments. A discussion of deficiencies and weaknesses of these system is also included.

PROGRAMMING ENVIRONMENTS

Programming environments are systems used by programmers to develop and test programs They are used by novices and experts, individuals and teams of programmers, and provide a range of functionalities. Traditional programming environments consist of tools that can be used in program construction, compilation, testing and debugging: editors, language compilers, pre-coded function libraries, linking loaders, parsers, tracers and debuggers. More current systems also include syntax-directed editors, code indentation, graphical user interface tools, dynamic compilation capabilities, powerful library systems and possibly code generators. This section examines only those environments developed primarily for teaching programming. An explanation of each reviewed system follows.

Pict [Glinert and Tanimoto 1984] is intended for Pascal programs that will be represented graphically. Pict is a *purely* iconic graphical environment and consists primarily of an editor where programming is done by selecting atoms, which are pre-written functions such as input, output, looping control, etc. that are represented/displayed as icons. The atoms are selected with a joystick and arranged in a flow-chart-like manner on the screen: with Pict, the keyboard is not used. The program syntax representation can be formed, and the user can observe the execution. The system detects syntactical errors, but does not assist in planning the solution.

PECAN [Reiss 1985], a language independent system, provides the student with multiple views of a program including representations of the program, its semantics, and its execution. PECAN consists of three main components: (1) a basic level support module that includes the command manager which provides the user interface, a general purpose parser, and an incremental compiler that consists of a control module and several special purpose modules which interpret semantic actions; (2) a mid-level service module that includes PLUM, a data structure support that provides data manipulation and database management, event management, and data structure monitoring and ASPEN, which provides program representation via abstract syntax trees; and (3) a higher level module that includes the various program views.

SCHEMACODE [Robillard 1986] addresses the issues of documenting source code and understanding flow control. The problem with documentation is that it is not systematic because it is not part of the programming language, and it is usually done after the program is completed (bottom up instead of top down). SCHEMACODE consists of two main components: (1) a schematic editor, where the programmer constructs the problem solution in Schematic Pseudo Code (SPC) and (2) code generation module, where the system generates the program source code in either FORTRAN IV, FORTRAN 77, PASCAL, dBase III, COBOL, or C.

The DSP system [Olsen 1988] is intended to encourage algorithmic thinking and to support modular programming. The DSP system is highly visual and allows for selecting, moving or copying predefined templates to avoid syntactical errors. The DSP system is designed to combine the advantages of application generators and traditional programming languages. Programs can be generated in Ada, Modula II, or Pascal. The DSP system consists of five main components: (1) a visual high level language, including a set of templates; (2) a language sensitive editor where program construction is done by combining icons; (3) a module base encompassing a predefined set of generic definitions and routines represented in target language syntax, which can be extended by the teacher; (4) a generator for translating DSP code to the target programming language; and (5) a visual runtime system, which executes DSP programs and displays content of data structures and variables.

Amethyst [Myers, Chandhok, and Sareen 1988] is part of a family of programming environments designed for novice programmers. It was developed on an Apple Macintosh, written in object Pascal, and stands for A MacGNOME Environment That Helps You See Types. The goal is to teach introductory programming through visualization. Amethyst provides data visualization and graphical displays to help the student understand program functions and conceptualize the data structure. Amethyst consists primarily of a sophisticated editor that can represent the syntax for a specified program in different views such as outline, tree decomposition, and linear.

The University of Washington Illustrating Compiler (UWPI) [Henry, Whaley, and Forstall 1990] was developed to use program illustration or visualization to help students learn basic programming concepts. UWPI illustrates the data structures for simple program written in a subset of Pascal. A program illustrator works by watching for *events* through *hookpoints*, which are inserted into the program. UWPI inserts these hookpoints automatically. UWPI consists of two main components: (1) a conventional compiler/interpreter including an analyzer, interpreter and runtime-state parts and (2) an extended compiler core including an inferencer, two illustrators, layout tools and a renderer. The inferencer searches for the abstract data types within the code, chooses a layout plan, and passes the plan to the data illustrator, which, in turn, creates and updates the illustration.

BACCII's [Calloni and Bagert 1994] premise is that the best way to learn programming is by developing algorithms using icons, independently of syntax details. Students develop algorithmic flowcharts using icons selected from a menu without any regard to the programming language syntax. ASCII format code is automatically generated for Pascal, C, FORTRAN and BASIC. The current version enforces top-down design methodology and an object-oriented version is being considered. BACCII consists of two main components: (1) the iconic algorithm development module, which allows the students create solution logic by combining icons and (2) the code generation system allowing the students to convert the iconic algorithm into language syntax.

ASA [Guimaraes, de Lucena, and Cavalcanti 1994] is an environment designed to teach algorithms at the introductory level. It supports code executión, animated tutorials, and a program construction facility. ASA consists of two main components: (1) the lessons model, which presents information in tutorial form with animation of concepts and algorithms and (2) the constructor, which consists of a flowchart editor and an interpreter allowing for algorithms to be formed using menus and icons, and to be represented graphically using flowcharts. The student can also visualize the algorithm in pseudocode, Pascal, C, or Clipper.

SUPPORT [Zelkowitz, Kowalchack, Itkin, and Herman 1989] is a PC-based system intended for programming using a subset of Pascal. The goal is to create a self-sufficient system that does not require the student to deal with the operating system or even be exposed to language features that are beyond the scope of the first course. SUPPORT consists of three main components: (1) a syntax-directed editor to build the program; (2) a Pascal interpreter to execute the programs; and (3) a user interface module, which uses windows to communicate with the user.

STRUEDI [Kohne and Weber 1987] is a LISP STRUcture EDItor for novice programmers. The basic idea behind STRUEDI is to allow the student to select predefined language constructs from a menu in order to build the program. STRUEDI maintains control of syntax, provides for understandable presentation of code, and helps the student understand syntax and semantics by offering explanations. The number of predefined constructs is limited to those taught in a first year LISP course. However, the instructor can modify the number. STRUEDI consists of primarily of a sophisticated syntax-directed editor and a collection of predefined language-constructs that are selected from a menu.

Example-based Programming System (EBPS) [Neal 1989] combines the concepts of syntax-directed editors and software reuse. It was observed that novice programmers had problems with the terminology used in currently available syntax-directed editors. It was also noticed that programmers use previously written code, either from textbooks or their own code, when writing programs. The idea for this system is to use pre-written examples to aid the programmer. EBPS consists of two main components: (1) a syntax-directed editor and (2) an example library. The syntax-directed editor is supported with an editing and an example window. Example programs can be viewed, edited, or copied into the editing window.

Software Design Laboratory (SODA) [Hohmann, Guzdial, and Soloway 1992] is based on a software design model, and provides a "workspace" for each stage of the process. The system was developed to help students overcome serious difficulties in identifying problem modularization during the design process, and to integrate those modules in the proper order to form a solution to the problem. Its primary goal is to support the software design process. SODA consists of three main components: (1) a problem decomposition module, which provides reference to existing program solution techniques; (2) a composition module, which support the students in integrating solution parts; and (3) a debugging module to facilitate solution verification.

MEMO-II [Forcheri and Molfino 1994] was developed to address shortcomings in earlier tutoring systems developed specifically for learning particular languages and paradigms, and systems that promote learning programming methodologies, but do not aid students in solving problems. MEMO II consists of three major components: (1) a specification acquisition module used to build solution specifications using an editor and a verifier; (2) a reasoning mechanism, which proves the specification base; and (3) a direct implementation module that allow students to automatically translate specifications into code.

INTELLIGENT TUTORING SYSTEMS

Artificial intelligence techniques are employed in some tutoring systems to provide more sophisticated support for students learning programming. Such systems are referred to as intelligent tutoring systems and allow access to tutoring and testing material on language syntax. These systems offer adaptive instruction to individual learner needs and are able to analyze student responses and determine correctness; guide and interact with students; and provide feedback and advice. An explanation of each reviewed system follows.

The BASIC Instructional Program (BIP) [Barr, Beard and Atkinson 1976] is an independent, self-contained instructional course for learning the BASIC programming language. BIP was intended for students with no prior computer knowledge as a tutor or a supplement for learning computer literacy. BIP consists of five main components: (1) an enhanced BASIC interpreter which also collects knowledge about student performance and presents errors in a more readable fashion; (2) a database of 100 programming problems of varying difficulty; (3) a HINT feature which provides text help and text-based "graphical" problem solving hints; (4) the Curriculum Information Network (CIN), which through a series of error counters and self-reported student ability information will select problems for the student based upon skill set; and (5) a BASIC language student manual.

Goal-Restricted Environment for Tutoring and Educational Research on Programming (GREATERP), better known as the LISP Tutor [Anderson and Reiser 1985], combines a psychological theory of skill acquisition with artificial intelligence to create a teaching device for the LISP language. It was developed on the assumption that private tutoring is much more effective than classroom training. The tutor is intended for beginning LISP programmers in introductory courses, is written in LISP and runs on VAX systems. The LISP Tutor consists of three main components: (1) the domain expert, which writes LISP functions from problem specifications; (2) the bug catalog, which holds possible divergence from the ideal "*expert behavior*"; and (3) the tutoring module, which consists of an expert system used for instruction.

PROUST, a tutoring system for Pascal programs [Johnson and Soloway 1985], was developed with a two-fold goal: to provide students with their own "programming expert", and to create a "pedagogical expert" that could interact effectively with students. PROUST consists of three main components: (1) a module to address the location and content of the bugs in a program; (2) a module to determine what the student intends to do with the code; and (3) a module, the most important, to identify misconceptions a student may have that explain the presence of bugs in the program.

The ACT Programming Tutor (APT) [Corbett and Anderson 1993] is a cognition-based tutor. The APT tutor is designed as a programming environment to help students complete short programming assignments, and based on an *ideal student model* using production rules as its knowledge base. The knowledge base currently supports LISP and Prolog syntax. APT consists of two main components: (1) the tutor interface, which presents the exercises for the students to solve and (2) the cognitive model, which consists of a set of rules for writing LISP code.

INTELLIGENT PROGRAMMING ENVIRONMENT

Intelligent programming environments combine the features of intelligent tutoring systems such as adaptive instruction, monitoring and assessment of students' progress, and feedback and advice with tools that are used in the program development process. In addition to the domain knowledge base, the student model, and the tutoring agent, intelligent programming environments provide access to traditional programming environments utilities such as syntax editors, compilers and debuggers. An explanation of each reviewed system follows.

Bridge [Bonar and Cunningham 1988] is a "complete tutorial environment" for the beginning programmer. In addition to finding student errors, it also understands partially completed programs and student intentions for their code. The tutor is able to understand natural language specifications to problems and the syntactical solution.

Bridge consists of three main components: (1) solution specification module, which allows the students to formulate their ideas in English; (2) plan specification module, which teaches the students programming skills and allows them to translate from informal specifications to plan specifications; and (3) the syntax module, where students build the programming language code for the solution.

Graphical Instruction in LISP (GIL) [Reiser, Ranney, Lovett, and Kimberg 1989] was developed to construct explanations based on its knowledge of the problem and the solution and to use visual representations to aid the student in writing simple LISP programs. GIL consists of four main components: (1) a problem solver, which uses a knowledge base of reasoning rules and plans; (2) an explainer, which follows the problem solver's logic and explains its own reasoning; (3) a response manager, which responds to program errors, errors which are legal LISP expressions, but are not useful to the program, non-confirming strategies, and specific hint requests; and (4) a graphical interface, which allows students to build programs by connecting objects representing different program constructs into a graph instead of using LISP's traditional text form.

Intelligent Tutor, Environment and Manual for Introductory Programming (ITEM/IP) [Brusilovsky 1992] is an integrated intelligent tutor an programming environment for teaching the mini-language Turingal [Brusilovsky 1991], designed for this system's use. ITEM/IP was developed as an example of a system that provides functionality by integrating an electronic manual, a tutor, and a programming/learning environment. ITEM/IP consists of three main components: (1) the programming laboratory as an integrated editor/debugger; (2) the information kernel, which contains the student history); and (3) the pedagogical module, which controls teaching operations such as when to move on or repeat a lesson.

DISCOVER [Ramadhan and du Boulay 1993] is an intelligent tutor and programming environment designed to teach beginning programming. DISCOVER combines visualization and traditional programming environment features with intelligent tutoring. It consists of two main components: (1) the free phase module, which allows the students to construct programs on their own with no feedback from the system other than memory visualization and (2) the guided phase module, where students learn from a set of problems under the guidance of an "*intelligent programming expert.*"

Episodic Learning Model Programming Environment (ELM-PE) [Weber 1993] is a cognition based intelligent programming environment designed for teaching the LISP language. ELM-PE is an example-based system designed to support students learning LISP through the use of analogies. ELM-PE consists of five main components: (1) a syntax-based structure editor, designed to reduce syntax errors by filling in LISP statement slots with appropriate insertions, allowing only valid LISP syntax to be constructed; (2) example-based programming tutor to teach LISP whose code may be modified and copied into the student's own programs; (3) a stepper module allowing the student to visualize the flow of data during the execution of the program, which can be stepped through line by line and stopped anywhere to allow the student to see mistakes made; (4) error messages delivery and explanation module; and (5) a cognitive diagnostic module based on the ELM theory.

Capra [Verdejo, Fernandez, and Urretavizcaya 1993] supports planning and implementation and combines features of programming environments and tutoring systems. The system helps the student understand and write elementary programs and provides tutoring based on students' knowledge. There are three steps to a programming solution: problem abstraction, relationship to a class of solutions, and refinement to produce a final answer as designed and stored in the system's knowledge base. Capra consists of three main components: (1) the tutor module, which presents the students with exercises to check concept comprehension; (2) the knowledge based debugger, which monitors students problem-solving activities; and (3) the interface module, which manages the system's multi-window interface.

INTELLITUTOR [Ueno 1994] is another example of an integrated intelligent programming environment that consists of three main components: (1) GUIDE, (2) ALPUS, and (3) TUTOR. GUIDE is a knowledge-based editor which assists the student in writing programs with built-in syntax knowledge. ALPUS is the portion of the system which attempts to "understand" the student's intentions based on an "*algorithmic structure*" knowledge base that contains possible solutions. It analyzes buggy statements and detects logical errors. It then "guesses" the intentions of the student and offers advice for fixing errors. The TUTOR subsystem receives information from GUIDE and ALPUS to build a model of the current user's abilities. TUTOR can then present the appropriate knowledge to the student to facilitate learning. The system does not, however, consider the student's knowledge level.

ANALYSIS OF REVIEWED SYSTEMS

Most of these tools are basically environments for coding and testing. Some of the tools support a broader, but still incomplete, aspect of the problem solving and program development process. A major shortcoming is an intense emphasis on syntax. The student is led directly into the implementation stage, without any allusion to the problem solving activities. Research results [Soloway et al., 1982; Perkins, Schwartz, and Simmons, 1988; Shackelford and Badre 1993] have consistently uncovered student difficulties with programming beyond the scope of syntax. Despite this, the overwhelming majority of the tools continue to solely address the implementation stage of the software process. Even the tools that do not solely focus on the coding task devote a disproportionate amount of attention to this activity compared to other software process activities. The inadequacy of the user interface has also been criticized. Students must typically spend considerable time learning how to use the system, creating the need for tutorial support to overcome basic operational difficulties. With these systems, student dissatisfaction with the user interface is frequent [Eisenstadt, Price, and Domingue 1993]. Rules-and-Errors Knowledge Bases, such as those used in intelligent systems, are also problematic since they evaluate student programs based on comparison with stored "*ideal solutions.*" A knowledge base of solutions, errors and rules is maintained for comparison and verification. Such a knowledge base is intrinsically incomplete because it is impossible to include a pattern for every solution and a complete list of errors [Haga and Kojima 1993]. Because the solution knowledge base is incomplete, students will inevitably propose correct solutions deemed invalid by the system [Sleeman and Brown 1982]. The simplicity of their examples is another concern regarding the problem solving approach of intelligent systems. As observed, this is inevitable given the limitations intrinsic to the rules-and-errors knowledge base essential to an intelligent tutoring system [Haga and Kojima 1993]. The tools actually address this incompleteness problem by the expedient of using only highly specified and simple problems for which reasonably complete knowledge bases can be developed. Thus, the very "problem simplicity" that enables the knowledge based system to behave as an expert simultaneously reduces its usefulness once the student is ready to move beyond the basics of the subject. The reliance on a limited number of teaching paradigms and simple examples makes these systems too restrictive to suit student needs, reducing their ability to provide significant experiences [Eisenstadt et al. 1993].

Evaluation of post-system deployment is an important assessment technique; however, little such evaluation has been reported. Those experiments that were done almost invariably report success and improvement in student performance but offer little supporting detail. An examination of the reported evaluations reveal a variety of problems with experimental design, including frequency of experiments, selection of course sections, number of subjects, the type of evaluation performed and the conclusions reached by the authors. To measure the impact of intelligent systems and programming environments on computer science education and the delivery of introductory courses, they must receive widespread acceptance. However, it is questionable whether these systems have been integrated into the curriculum. There is no evidence in the literature that true integration has taken place; by *integration*, we mean a system has become an important and integral part of the learning process and is regularly used by students and teachers to enhance the learning environment. Intelligent systems present the student with a simple problem containing a clear definition, specifications and constraints. The student is then *led* into finding the "*ideal solution.*" The systems monitor student activity very closely and adapt to their responses, but never relinquish control [Marco and Colina 1992; Snow and Swanson, 1992]. Therefore, students often become dependent on the system's ability to *lead* them in solving the problem. Imposition of such barriers to creativity and the acquisition of higher order thinking skills undermine student cognitive development. This is a serious drawback, considering that these are the very skills the intelligent systems propose to teach. For example, it is often the case that a problem can be solved in a variety of ways. The problem solver may also explore alternative solutions to a particular problem. Students may identify correct solutions that are judged erroneous by the system because the solution is not within its domain.

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Instructional Hypertext: Attentional Strategies and Text Representations Developed for Different Types of Learning Goals

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Abstract: This paper examines differences in attention and knowledge representations for hypertext studied with three types of learning goals: factual learning, information application (problem solving), and information integration (interrelating text content). For all goals, readers focused on target content (content required for the goals), selecting this information most often and spending more time on this than other content. However, Fact readers focused attention more exclusively on target content than other readers. Integration readers selected target content as often as Fact readers, but spent less time on this content, suggesting a broader study focus. They also attended to organizational information about the units provided on a content map for information selection. Application readers were less systematic in their study strategies, and focused less on target content than the other groups. Attentional differences were reflected in text recall, with Fact and Integration readers recalling more target content, and Application readers remembering more introductory information.

1. Introduction

Instructional hypertexts provide an advantage over traditional textbooks in facilitating goal-directed text study. Because readers have some degree of control over the order, pacing, and content of their instructional material, they can focus on and organize relevant content to meet the requirements of their learning goal. [Dee-Lucas 1996b] found that readers alter their hypertext study strategies in a manner consistent with their learning goal. The current paper reports additional analyses from the Dee-Lucas experiment. These analyses examined differences in attention and knowledge representations developed with different hypertext learning goals.

Dee-Lucas compared readers studying a hypertext with goals emphasizing factual learning (answering factual questions), information application (using the text content to solve problems), and information integration (interrelating different portions of the text). The results indicated that readers are flexible in developing goal-specific study strategies for hypertext. For factual learning, readers used an alphabetical topic list to select information units for study (as opposed to a structured content map providing an organization for the units), and reviewed units extensively. This suggests a focused study strategy emphasizing understanding of a subset of the text content. In contrast, information integration readers preferred to select units from a hierarchically-organized content map showing unit relationships. They also took detailed notes, and reviewed the information units often. These findings indicate a concern with understanding both unit content and between-unit relationships. Information application readers did not show a preference for the content map or topic list, and reviewed units less often. These readers appeared to rely less on the available hypertext features and possibly more on prior knowledge to guide text study.

The three groups also exhibited differences in depth of understanding for the text. Readers with the simplest goals (factual learning), were unable to use the text content for higher-level tasks (information integration and application), but readers with the most complex goals (information integration) were able to complete simpler tasks (information application and answering factual questions). This suggests that the complex goals resulted more elaborated knowledge representations for the text information [Kintsch 1988].

Although readers exhibited differences in study strategies and text comprehension with the different goals, there were no overall differences in study time or text recall. There were no differences among the three groups in total study time, the number of units selected, the number of readers selecting each unit, or the total amount of text content recalled. Thus at a global level, the different goals did not appear to influence how thoroughly readers studied the text or the amount of content they retained.

This paper reports analyses of qualitative differences in attention and recall for different types of hypertext content with the three learning goals. Each hypertext unit was classified according to its relevance to the goals (i.e., target units, elaborative units, and introductory units), and the effect of learning goal on the processing and recall of these different types of information was examined. The extent to which readers used the topic list and content map to select units from each information category was compared to determine if the structural information provided by the map aided unit selection for some types of content. To investigate attentional differences due to study goal, text review and study times for each category were examined. Text recall was also analyzed to determine if attentional differences were reflected in knowledge structures developed for the content.

2. Method

The hypertext consisted of 17 content units (1, 2, and 3 screens in length) discussing the scientific measurement of length and time. Each screen had buttons for displaying the following: (1) the previously selected screen; (2) a topic list for selecting units; (3) a content map (also for selecting units); (4) the assigned learning goal (factual, information integration, or information application questions); (5) a screen for recording notes; and (6) a set of self-testing questions allowing readers to assess their understanding of the text.

Readers selected units for study by clicking on their titles on the content map or topic list. On the content map, unit titles were organized in a hierarchy indicating subordinate and superordinate relationships among units. The topic list presented the titles in alphabetical order with no information about how they were related.

The button for displaying the learning goals allowed readers to review the assigned goals at any time. The Fact goals consisted of three questions that involved paraphrasing information from the text. The Integration goals had two questions asking readers to compare and contrast different portions of the text. The Application goals consisted of three problems that required readers to use quantitative relations to derive new relations and solve problems. The learning goals for all groups dealt with the same units within the hypertext.

The participants were 60 undergraduates who had not taken any college level physics. Twenty participants were assigned to each of the three types of learning goals. Prior to studying the experimental text, all readers used a practice hypertext to familiarize themselves with the procedures for taking notes and studying the text. They then studied the experimental text with the assigned learning goals. All readers were given the assigned questions prior to text study, and could review them at any time. After they had finished studying the text, the readers completed the goal questions using their notes. They then completed the learning goals that had been given to the other two groups. They had not seen these questions prior to studying the text. Finally, they completed a free recall in which they wrote down everything they could remember. The free recalls were used to assess readers' knowledge representations. To determine what was remembered, each unit was analyzed into its component propositions, and the recalls were scored for the number of propositions recalled from each unit.

3. Results

The hypertext units were classified into three categories according to their relationship to the learning goals. Six of the content units contained *target information* required to complete the learning goals. All learning goals required information from these units, but the goals differed in how the unit content was to be used. Another six units provided *elaborative information* which modified or expanded upon the target content. This information was related to the learning goals, but was not required to complete them. Four units provided *introductory information*. This was general information relating to the topics of the target units. One unit was an introduction to the text as a whole, and thus did not fit into any of these categories. Due to its special status as the superordinate unit for the hypertext, data for this unit were not included in the analyses.

3.1 Information Selection from the Content Map vs. Topic List

[Dee-Lucas 1996b] reported that Fact readers preferred to select units from the alphabetical topic list, while Integration readers preferred the hierarchically-organized content map. Application readers exhibited no consistent pattern. These results suggest that the structural information on the content map aided unit selection for Integration readers, whereas Fact readers were able to select the content they needed by scanning titles on the topic list. To determine if readers used different access facilities to select different types of information, an analysis of variance was performed on the proportion of unit selections made from the content map and topic list for each information category.

The analyses indicated that the Fact group made more unit selections from the topic list than the content map for all information categories, although this difference only reached statistical significance for the introductory content (for target content, $p<.08$; for elaborative content, $p<.09$). This suggests that the Fact readers did not find the organizational information provided by the content map to be useful or relevant for the factual learning goals. In contrast, the Integration group made more unit selections from the content map than the topic list for all categories, with significant differences for both the target and elaborative content (for introductory content, $p<.18$). This suggests that the Integration readers may have been basing their unit selections in part on the structural relationships among the units.

There were no significant differences in the use of the content map and topic list by Applications readers. This may reflect individual differences in the degree to which readers based unit selections on prior knowledge relating to the application problems. Research with traditional texts indicates that readers rely to a greater degree on prior learning for information application tasks than for goals emphasizing text recall [Kintsch 1988].

3.2 Attentional Differences

[Dee-Lucas 1996b] reported few differences in unit review for the overall text. There were no differences in the number of readers selecting each unit, or in the number of units selected. However, Application readers reviewed the units that they selected less often than readers with the other learning goals, suggesting less thorough text processing. To determine if there were differences in the amount of attention given to different types of content, analyses were performed on the number of times each type of information was selected, and total study time for each information type.

3.2.1 Information Review

An analysis of variance on the total number of unit selections from each information category indicated a significant interaction between learning goal and information category. All readers selected target content most frequently, followed by elaborative information, and then introductory information (with significant differences between all categories). However, Fact and Integration readers selected the target content more frequently than the Application readers, with no significant differences among the groups for the other information categories, see [Fig. 1]. These findings suggest that all readers concentrated their text study on the target content, but Application readers focused on this information to a lesser degree than readers with the other goals.

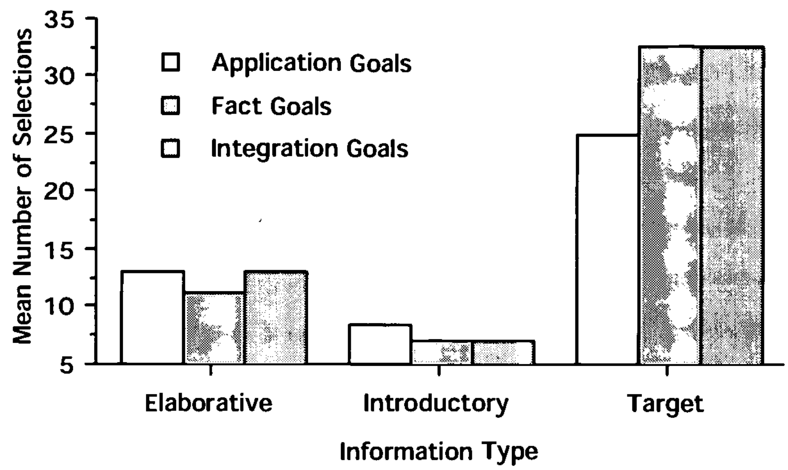

Figure 1: Mean number of unit selections made from each information category with each goal.

3.2.2 Study Time

An analysis of variance on the proportion of total study time spent on each information category also indicated a significant interaction between learning goal and information category. All groups spent more time on the target content than on the other information categories. They also spent significantly longer on elaborative than introductory content. However, Fact readers spent a significantly greater proportion of their total study time on the target content than readers in the other two groups, see [Fig. 2]. This is consistent with the unit selection data indicating that the Fact group concentrated text study on target content.

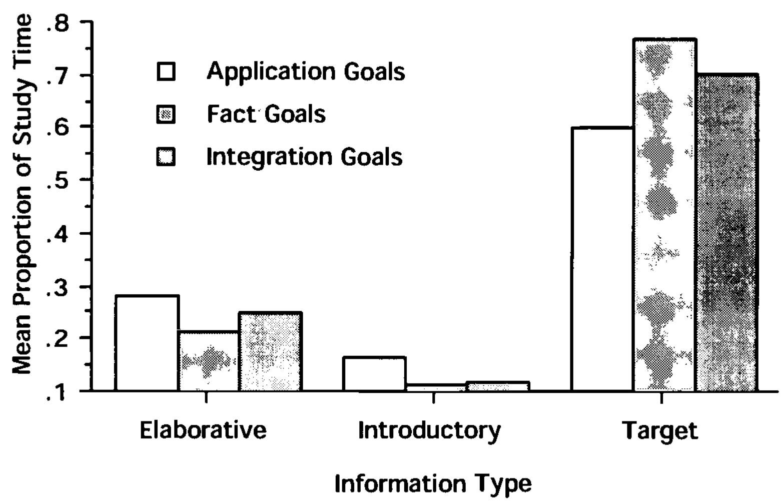

Figure 2: Mean proportion of total study time spent on each information category with each goal.

3.3 Text Recall

[Dee-Lucas 1996b] found that Integration readers were able to complete the simpler goals (fact and application) in addition to the integration goals that they had been given. This suggests that these readers developed elaborated knowledge structures incorporating a broad range of content. In contrast, Fact readers were only able to complete the fact goals, suggesting narrow knowledge structures focused on goal-related content. To more closely examine knowledge structures developed with the different goals, an analysis of variance was performed on the proportion of text recall consisting of each information type with each goal. All readers recalled significantly more target content than other information types, and more elaborative than introductory content. However, the recall of Fact and Integration readers contained proportionately more target content than recall of the Application readers. Furthermore, Application readers' recall included a significantly greater proportion of introductory content than recall of the Integration readers, see [Fig. 3]. These results suggest that Application readers focused on a wider range of information, and did not process the target content as completely as other readers.

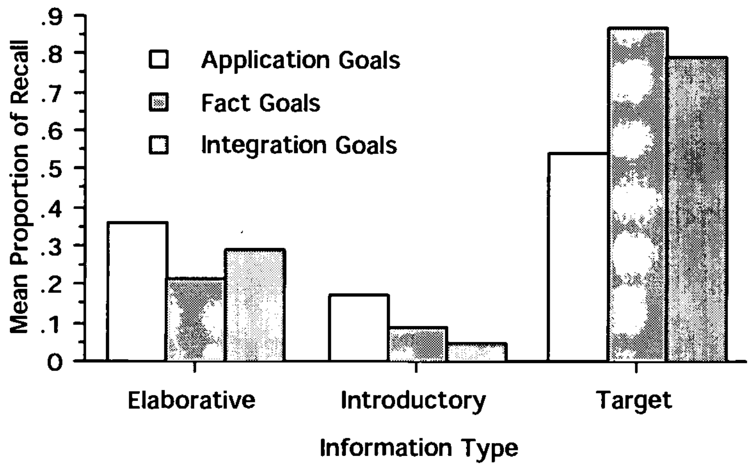

Figure 3: Mean proportion of recall consisting of elaborative, introductory, and target content for each goal.

4. Discussion

All readers focused their text study on the target content, selecting this information most often and spending proportionately more time on this than other content. All readers also processed elaborative information more thoroughly than introductory content, indicating that readers were more concerned with acquiring an in-depth understanding of target content than a general information framework. Although all groups were consistent in their study focus, there were differences due to learning goal in the thoroughness with which readers processed target content. These attentional differences were reflected in knowledge representations developed with the different goals.

4.1 Factual Learning

The factual learning goals required readers to paraphrase information from the target units. Readers needed to pay close attention to the wording and content of the text, but did not need to make inferences or go beyond what was stated. Although all readers focused text study on the target content, Fact readers processed this information more thoroughly than other readers. They selected target units more often than Application readers, and spent more of their total study time on target information than readers with integration and application goals. This was reflected in more complete recall of the target units (compared to Application readers).

One factor contributing to the focused text study with the Fact goals was readers' ability to easily identify target units. Fact readers preferred to select units from the alphabetized topic list rather than the content map, even though the content map was more informative (i.e., grouped together related units). This suggests that these readers were confident about which units contained goal-related content, and did not find the additional organizational information to be useful for unit selection, or relevant for completing the learning goals.

[Dee-Lucas 1996b] reported that Fact readers were able to answer the factual questions they had been given as goals, but were unable to complete the information integration or application questions. This indicates that these readers developed knowledge structures limited to a literal understanding of the text, with little elaboration or ties to other knowledge [Kintsch 1998]. This suggests that the repeated review and long study times for the target content were devoted to developing a complete representation (i.e., incorporating all of the target content), rather than acquiring a deeper understanding. Fact readers' preference for selecting units from the topic list also suggests that they processed the units in isolation, without trying to form an integrated text representation.

4.2 Information Integration

The Integration readers had to compare and contrast target content, generating relationships that were not explicit in the text. These readers required an understanding of the target content at a level sufficient for determining between-unit relationships. The results of the current research suggest that the Integration readers processed the target content at a deeper level than readers with the Fact goals.

Integration readers selected target content as often as Fact readers, but spent less of their total study time on target units, suggesting a broader study focus. However, Integration readers recalled the same amount of target information as Fact readers. [Dee-Lucas 1996b] reported that Integration readers made extensive use of study aids provided in the hypertext. They took more notes than Fact and Application readers, and used self-testing questions more often than Fact readers. These findings suggest that Integration readers used study strategies that went beyond repeated text review in trying to achieve a relatively deep understanding of the content. This deeper processing would have facilitated recall of the target content. Additionally, the process of interrelating the text units in generating the between-unit relations required for the integration goals would also aid in target unit recall because memory for one unit would prompt recall of related text units [Dee-Lucas 1996a].

Integration readers preferred to select units from the content map rather than topic list, indicating that these readers found the organizational information to be useful. This information may have been used to guide unit selection, and/or to interrelate units in the manner required by the integration questions.

[Dee-Lucas 1996b] found that Integration readers performed as well on the fact and application questions as readers receiving those goals in advance. Thus Integration readers mastered the content to the degree necessary to answer factual questions and apply the content to solve problems. This is consistent with the study strategy data indicating greater depth and breadth of processing with the integration goals.

4.3 Information Application

The Application readers had to use the target content to solve problems. While these readers needed to have a thorough understanding of the target information in order to determine how the content should be applied, they did not have to cover all of the target content. They could concentrate on the specific information within the target units that they needed to solve the problems. In the current research, Application readers as a group were less focused in their text study than readers with the other goals.

Application readers selected target units less often than other readers, and spent less time of their total study time on the target units than Fact readers. Text recall for this group included proportionately less target content than readers from the other groups, but more introductory content than readers with the integration goals. These findings suggest that Application readers had a broader focus to their text study than Fact and Integration readers, and concentrated less exclusively on target information.

Even though readers with the application goals focused less on target content, they performed as well on the factual learning goals as Fact and Integration readers. Application readers may have concentrated on the information within the target units that was unfamiliar, so that they were able to answer factual questions about the target content even though their recall was less complete. Application readers did not perform as well on the information integration questions as the Integration readers. The Application readers most likely organized the text content around the application problems in goal-specific structures which were not useful for comparing and contrasting the content in the manner required by the integration goals.

Unlike Fact and Integration readers, Application readers showed no consistent preference for the content map or topic list when selecting units. These readers may have relied to a greater degree on prior knowledge to guide text study. Research with traditional text indicates that readers with learning goals requiring information application use prior knowledge to develop more elaborated knowledge structures incorporating both text content and related knowledge from other sources [Kintsch 1988].

5. Conclusions

This research found that readers studying hypertext with different types of learning goals alter their processing of goal-related information (i.e., target content) and organizational information according to the goal requirements. These processing differences were reflected in both the content of readers' knowledge representations and their ability to use the information to complete other tasks [Dee-Lucas 1996b]. These results are consistent with research with traditional texts showing that readers develop knowledge structures that reflect the nature of their learning goals [Schmalhofer & Glavanov 1986]. The extent to which this process is facilitated by the flexibility of hypertext depends on the match between the study goal and capabilities for goal-directed learning provided in the hypertext [Wright & Lickorish 1990].

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Paradigm Change in Education in Conditions of Emerging New Information Technologies and Global Information Infrastructure Building

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Abstracts: Paper discusses general trends and problems of Education and Research development in conditions of emerging new technologies and Global Information Environment. New principles of Education in Information Environment are based on existing paradigm shift in modern education changing role of teacher from source to producer of information and role of students from passive information receivers to active knowledge accumulator. Possibilities of Internet for education and Research are considered. Discussed results are based on two years experience in active instructional methodology development in Kiev Polytechnic Institute.

1. New Trends and Technologies of the Information Age

Internet and Global Information Infrastructure (GII) development in the world changes the main paradigms in Education and Research and raises new tasks caused by mankind survive Information Revolution and start building Information Society which is defined as post-technological society.

The pace of revolutionary technology changes increases exponentially:

50000 years ago - primitive man started to speak and conceive discrete picture of the world operating with primitive concepts and images;

5000 years ago - literacy appeared giving first opportunity for acquiring knowledge in the form combining text and pictures

500 years ago - book-printing invented; great opportunity for knowledge acquisition and dissemination, involvement of many people into research and education

50 years ago - computer and communications give new possibility and tools for multimedia data acquisition, dissemination, processing and messages exchange

5 years ago - WWW was invented as hypermedia information presentation: information acquisition, processing, access and search in Global Information Environment.

Last mankind invention World Wide Web gives people tool for facilitation of the power of abstract thought because of WWW operates with mixed (multimedia) information very similar to real thinking process. Now WWW technology becomes basic for development of Knowledge Network operating with knowledge and information across the network and independently from the form of information presentation. The wonderful feature of the web technology is the possibility to model via its directory and hyperlink structure the model of information and knowledge presentation in the brain, as it was defined by Lev Vygotsky, Russian Psychologist: "The word (information) is its search" [Vygotsky 1995].

GII based on Internet and WWW technologies provides powerful tool for global knowledge integration.

On the background of global economy's integration companies and countries survive global competition. In the knowledge based economy of Information Age knowledge and skills become the key factor of competition. Distinctive feature of modern Knowledge Based Companies (KBCo) is continues improvement of their products by integration and attraction of knowledge and skills of developers, implementers and users via bug reporting, beta-testing and other approaches for knowledge absorption and skills involvement. The very existence of KBCo is based on constant technologies' development and change as well as on learning acquired skills.

Such picture of the world wide economy differentiation is not fatal but stress on the main factor of success in the modern world economy - the knowledge and skills that should be supported by lifelong learning and training. IT and GII were the main facilitator of forming Information Society and they are main base for doing in the knowledge based society.

In global information environment developing countries or countries with emerging technologies are suffering in general from the high technologies changing pace that does not correspond to the national economy development pace. These processes lead to forming "slow" and "agile" nations in respect to technology innovation and implementation [Kennedy 1993].

Complete globality of modern IT and possibility for its instantaneous dissemination via GII allows to make technological leap-frog for developing nations and countries with emerging technologies. But such trends should demand special concern and national policy in education and training areas.

2. Education in Global Information Environment

Education should respond on global challenges of forming Information Society in providing necessary background for successful people living in this new knowledge based formation:

- forming base knowledge and motivation for constant improvement of knowledge and skills
- forming moral principles of coexistence in open IS accepting of majority of truths and inadmissibility of harmful impact because of global impact of any actions in global information environment
- setting up of life-long learning motivation
- free access for learning materials and training materials.

On other side, IT provide efficient tools in education for tight interaction with external environment and facilitation of knowledge acquisition owing to global access to information (and knowledge) and possibility to increase number of experiments during learning.

The education area is becoming now the place where many technologies meet, converge and are tested by real practice and coexistence. Education area is becoming important part of general companies' activity (notwithstanding the structural affiliation - to company or university). Education becomes a conductor and promoter of new technologies and area where new approaches and new social imperatives are forming now.

New aspects of education and research in networked information environment and IT usage are based on approaching assistance tools to the real process of abstract thought process

- facilitation and extension of abstract thought process by extension of it's information and knowledge base
- providing tools for multimedia images manipulation and processing
- replacing and supporting information processing by information/knowledge access in growing structured information environment
- increasing contributive effect of education and training

New approaches in education and training should increase the assistance-to-contributive effect, i.e., education and training organisations should become the knowledge based organisations themselves and implement KBCo corporate model. Contributive effect in IT education should shift from secondary process to productive. Changing approaches in professional education should utilise the learning process (or it's results) for creating information and knowledge base for teaching next generation of students and/or trainees.

Classroom integration into Internet will demand special approach for curriculum design and instructional methodology used that should be focused on reaching main teaching goals because of learners in such environment have real choice "to stay" in the class or escape into Internet surfing. Curricula have to take into account existence of such global information environment as Internet. Teacher must afraid that his/her students will be lost in the open global information space. Education and culture globalisation and internationalisation shall not impact on national cultures. In these circumstances, education at its initial stage has to inoculate national and cultural values to learners. (Students should accept priorities of national values in integration into the global IS). During education and further lifelong learning people should take over new global criteria (but not change values) applying and adopting them to the national values.

This approach can play constructive role even in the case of inevitable "brain drain" (physical and via teleworking) caused by growth of transnational corporations and global workforce integration and migration. In general, this process is inevitable because of objective development of transnational corporations that utilise and integrate the most important value of humankind - human intelligence. Conformity to international criteria in professionality and skills will raise common professional and knowledge level among local specialists.

Development of GII and communication infrastructure will be facilitated by

- needs of distributed knowledge based workforce access and integration
- needs for national and cultural information resources access

Rapid technology changes and economy IT-directed restructuring in Ukraine (as country with emerging technologies) raise another problem with "professionally lost" generation. Wide demand of knowledge intensive qualified workforce in IT (and programming particularly) causes problems with completed professional education. Students that have at least initial knowledge in IT and programming are absorbed by many small companies for serving their IT needs. In difficult economical situation they are forced to earn money that, in general, contradict with needs for intensive learning according to curriculum. Young people of the third-fourth years in Universities go to professional sphere without formed professional credo that could affect their potentiality to innovative qualification growth in the future. Professional consciousness should correspond to the professional knowledge to secure constant and successive professional growth and knowledge acquisition but not only skills.

3. Paradigm shift in professional education

In modern networked information environment the main paradigm of professional education is sufficiently changed in actual roles of teacher and students. Old methodology was based on concept of the classroom as the ultimate place of knowledge receiving where teacher plays the role of source and transmitter of information and knowledge and learners play the role of receivers. Teacher could learn from his/her experience. But now with rapid technologies' changes very few teachers can teach from their own experience.

The problem for education is that competition between transnational industry leaders provide increased pace of technologies development and changes. Therefore, in current conditions the main paradigm of education is changed to cooperative and contributive learning in which teacher plays role of information producer and curriculum adviser but students act as information accumulators and knowledge acquirers. They become responsible for necessary knowledge acquisition based on curriculum experience but teacher has to manage education process and set up an appropriate motivation system, in other words, teacher will teach students how to learn and set motivation frame for successful and timely curriculum performing.

Teachers in the new instructional methodology have to satisfy the following demands

- have high level of initial knowledge and necessary experience in IT
- ability to work as project teams member and curriculum manager
- ability to organise project teams work in such way that all students accept proposed conditions

- dynamically manage curriculum establishing and adoption criteria and flexible motivation principles oriented on the final results.

Students are learning in cooperative project based environment oriented on producing final results that help them to acquire knowledge in adjacent areas of common project group competence. Contributive process of education in IT should work on developing meaningful information resources increasing national presence in GII.

The real challenge for Ukraine as country with emerging technologies in Professional Education on IT and IT based courses is Constructivistic instructional methodologies incorporating active position of teacher and students in tight interaction with global information environment:

Project or Problem Based Learning (PBL) that is effective in information and knowledge rich environment with developed infrastructure [PBL-1 1997, PBL-2 1997, Lenschow 97a].

or *Cooperative and Contributive Learning (CCL)* that is PBL adopted to the conditions of emerging technologies and developing communication and information infrastructure [Demchenko-1 97a, Demchenko-1 97a].

4. Main Principles of Teaching in Networked Information Environment

Existing experience acquired during implementation of elements of PBL and CCL instructional methodology in teaching Networking Information Technologies and Services at CAD department in NTU "Kiev Polytechnic Institute" allowed to formulate the main principles of education in Global Networked Information Environment.

These principles can provide real base for establishing active position of teachers and creative role of learners.

1. The new paradigm of education in modern Networked Information Environment should be incorporated into instructional methodology development

   Learning from the Internet - Contributing to the Internet

2. *Cooperative Learning Model + students' initiative.* Using Internet/Intranet technologies Teachers and Learners can mutually benefit from implementation and mastering new technologies. Key role in exploring this principle belong to educational projects and rely on Cooperative model of course management that effectively use students initiative in mastering new technologies

3. *Contributional Learning model.* In conditions of wide use of computers and multimedia technologies among students and rapid technology changes, teachers sometimes can not have strong benefits in practical technological experience. In these circumstances they should play the role of mentors and/or managers of educational process or curricula. Teacher can propose some idea of *contributional learning* when students or student's groups work on the projects that will have real implementation in building Campus computer network, development of information resources or other Society's meaning.

4. *Integration of traditional* and *distance learning.* New networking environment provided by Internet/Intranet eliminate differences between traditional and distance learning, however, stressing on interactive on-line (IRC, conferencing) and off-line (e-mail, mailing lists) communication between teachers and students.

5. *Concept of "active position".* Complete implementation and full benefits from using Internet and New Information Technologies in Education can be reached only by using this principle that is very close to the idea of contributional learning. It is not enough to give students and teachers Internet access only. To use effectively Internet, faculties should start development of their own Internet resources and creation of its own Internet presentation.

5. Existing Experience

Pilot project on development of Educational Program and Instructional Methodology for Teaching Computer Networking and Internet Information Technologies has been started at Computer Aided Design Department in Kiev Polytechnic Institute in 1996. 17 students of the first group have successfully defended their Master theses in June 1997. All students were involved into development of complete educational course technical and information base.

The main intermediate results of pilot project realisation can be stated

1. Formulation and testing in real practice Cooperative and Contributive Learning Instructional Methodology in teaching Networking Information Technologies and Services
2. Creation and operation of educational server and development of technical base for cooperative work of tutors and students on educational and information resources development.
3. Development of training materials and information library for practical studying of Internet technologies that are used now both for students self-training and for users training courses
4. Involvement of students in pilot testing of instructional methodology, development of educational base and creation of WWW information resources of society's meaning was resulted in development of information content of two experimental servers
    - U'Pavilion - WWW Server on Historical and Cultural Heritage of Ukraine (*http://www.park.kiev.ua/*)
    - Multiling - WWW Server on Multilingual Applications in WWW/Internet (*http://www.ml.kiev.ua/*)
5. Creation of the critical mass of specialists and students involved in development of educational courses and correspondent research activities

Current experience allows to suppose that wide implementation of such instructional methodology and whole realisation of it's potentiality in local conditions will affect teaching of another IT related courses at the Department and lead to their integration on the base of Internet/intranet networking and information technologies which were found to be very effective for re-engineering educational process and developing collaborative learning models.

6. Summary

Education and research in present rapidly changed environment caused by Information Revolution and GII spreading over the world has to challenge new approaches and paradigm shift. The importance of Education, particularly professional education, is increasing now as base for successful implementation of the new technologies.

Cooperative and Contributive Learning model was found as effective approach for developing new instructional methodologies in Education in Global Information Environment.

Professional academic contacts have to be established for cooperative development and wide dissemination of the new educational courses and instructional methodologies.

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Evaluation of Educational Simulation Interface Using the Graphical Jogthrough Method: The "Network Simulator" Experience

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Abstract: This paper reports on the application of the Graphical Jogthrough method in evaluating the interface design of the "Network Simulator", a simulation program that enables users to virtually build a computer network, install hardware and software components, make the necessary settings and test the functionality of the network. Graphical Jogthrough is an expert-based interface evaluation method modified by the authors so that evaluators' ratings can produce evidence in the form of a graph presenting estimated proportion of users effectively using the interface versus the time they had to work with it in order to succeed effectiveness. The modified method along with the results of the evaluation session are presented and concluding from their experience authors argue that Graphical Jogthrough may be useful for locating interface design deficiencies in educational software and the extend of this usefulness strongly depends on two factors: the evaluators' expertise and the tasks selected for evaluation.

1. Introduction

Any simulation is a software medium that utilizes the interactive capabilities of the computer and delivers to the learners a properly structured environment where user – program interaction becomes the means for knowledge acquisition. The structure of the simulation (actions that users are allowed to perform and experiences they are guided to have) creates a cognitive world that users enter in order to acquire knowledge of the subject matter. Characteristics of interface design such as intuitiveness (use of proper metaphors) and transparency (not interfering with the learning procedure) [Roth and Chair 1997] must and can be evaluated using various methods depending on the production phase of the software.

We have designed and developed a first prototype of an educational simulation program that we call "Network Simulator". This software enables users to virtually build a computer network, install hardware and software components, make the necessary settings and test the functionality of the network For a first evaluation of the interface design we have chosen to use the Cognitive Jogthrough method since it is intended for evaluation early in the development phase, has been reported to be a valuable information source during a system design process [Aedo et al. 1996], is relatively cheap to apply and has also been applied for the evaluation of educational interfaces of a certain kind [Catenazzi et al. 1997]. Wishing to produce evidence of interface quality that would take into account the user's gradual familiarization with the interface tasks we modified the standard Jogthrough method by introducing a special graph for recording and presenting expert evaluators' ratings. We call this modified version "Graphical" Jogthrough.

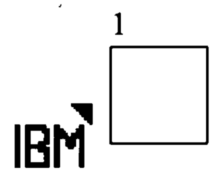
2. The Network Simulator Interface

"Network Simulator" may operate in either of two modes: (a) Stand alone as any typical simulation program or (b) in communication with "ISTOS" [Demetriadis et al. 1997], an interactive learning environment where a cognitive apprenticeship module enables users to work with Network Simulator, design their proposed network solutions and submit them to the module for further assessment.

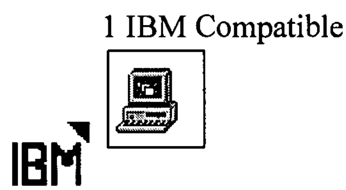
Users of Network Simulator manipulate a network much as word processor users manipulate a written document. The "New" menu command enables users to activate on the screen a specific topology or network architecture selecting from the various supported in the simulation. An activated topology is a properly structured grid consisted by a number of cells where the hardware components of the network may be placed.

User's first action is to place the appropriate nodes, communication media and active elements of the network (computing machines, printers, network cards, cables, bridges, routers etc.) and proceed later on to install the necessary software so that the initially empty grid becomes a fully functional computer network. "Network Simulator" extensively utilizes the Select – Carry – Install metaphor. Users may *select* the component they need from the toolbox, *carry* it to the desired cell and *install* it by clicking on the empty cell [Fig. 1].

Select: User is ready to select the IBM Compatible Machine icon from the component inventory



Carry: User has selected the IBM Compatible Machine (indicated by cursor), has carried it to the proper grid cell and is ready to install it



Install: User has clicked on the cell and the IBM Compatible Machine icon appears. Cursor remains in "IBM" mode denoting that an "IBM Compatible Machine" item is continued to be carried and may be installed in another cell.

Fig. 1: The *Select – Carry – Install* Metaphor used in Network Simulator

3. Interface Evaluation Using the Graphical Jogthrough Method

Walkthroughs and the Joghtrough Version

Interface evaluation of a software system is a procedure intended to identify and propose solutions for usability problems caused by the specific software design. A usability problem may be defined as "anything that interferes with user's ability to efficiently and effectively complete tasks" [Karat et al. 1992]. The main idea in expert based evaluation methods is to present the tasks supported by the interface to an interdisciplinary group of experts who will take the part of would be users and try to identify possible deficiencies in the interface design. Evaluators use an appropriately structured questionnaire to record their ratings. The original Walkthrough method [Lewis et al. 1990] is a substantially slower proceeding method since all the recording is done manually. In the Jogthrough version instead [Rowley and Rhoades 1992] a video camera is used for recording evaluators' comments and proposals, thus speeding up the pace of the session. One should have in mind that Cognitive Walkthrough is a method originally designed for the evaluation of "Walk Up and Use" interfaces [Wharton et al. 1992]. Users therefore are supposed to be basically novices or infrequent users working with relatively simpler interfaces (e.g. information kiosks). The method though has been applied to more complex interfaces [Wharton et al. 1992] in an attempt to identify needed refinements and augmentations that could turn it into a useful evaluation methodology even under these circumstances. The Jogthrough version has also been implemented for educational software evaluation [Aedo et al. 1996], the kind of software that users may gradually become familiar with through repetitive usage.

The Graphical Jogthrough Evaluation Session

We applied the Jogthrough method for the evaluation of the Network Simulator interface. Our session lasted about 4 hours. During this time length 6 tasks (and a total of 20 actions) were evaluated. Two members of the design team guided the session. The first author acted as the "Moderator", presented the tasks and actions, commented on the design principles followed and guided the conversation trying to succeed in time management so that opinion expressing and record keeping could be accomplished for all the tasks according to the pre-planned timetable. The second author played the role of the "Recorder", recording the videotape time code at moments when something interesting was brought up by the evaluators. Would be users of the simulator were described as having limited experience with the "Windows 95" environment, knowing the basics of a word processor and a spreadsheet and having introductory knowledge of basic programming languages such as BASIC and/or Pascal.

Evaluators Profile

We invited four experts to act as evaluators in the Graphical Jogthrough session:

a) Evaluator A: Multimedia Expert (Multimedia Educational Systems Analyst),
b) Evaluator B: Subject Matter Expert (Network Manager, Aristotle University of Thessaloniki),
c) Evaluator C: Multimedia Expert (Multimedia Programmer-Producer and Educator (High School Informatiqs Teacher)),
d) Evaluator D: Multimedia Expert (Multimedia Programmer and Producer).

Our evaluators were very experienced in multimedia software programming and development and one of them in the subject matter. None of them though had any special cognitive science background.

Selecting the Tasks

The tasks selected for evaluation were representative of the complete set of tasks available in Network Simulator [Fig. 2]. Each task was analyzed into a series of actions the user had to perform for completing it and these actions were defined both in terms of user goals and interface actions that had to be executed (see analysis of Task 1 in [Fig.2]). So we tried to define user goals at the granularity of individual interface actions although this is reported to cause problems in certain cases [Wharton et al. 1992]. The reason for doing this was the poor Cognitive Science background of our evaluators. Since they were unfamiliar with the method we believed it would be helpful to see user goals and interface actions tightly bound, avoiding thus getting involved in considerations that might lead to session delay and failure of completing the evaluation in the time available.

T.1.) Activate a New Network Grid
  a.1.1) Start the procedure for activating a New Network Grid(click on "New" icon on the Toolbar)
  a.1.2) Determine the general kind of Network needed (click on appropriate button on the displayed menu)
  a.1.3) Determine the specific topology or architecture to be used (click on appropriate button on the displayed submenu)
  a.1.4) Confirm the Selection (click on the "OK" button)
T.2.) Install a Computing Machine
T.3) Uninstall a Computing Machine
T.4) Install a hardware component (Network Interface Card (NIC)) on a computer
T.5) Uninstall a hardware component (NIC)
T.6) Connect a NIC to a cable

Fig.2: List of the Evaluated Tasks

Questionnaire

Evaluators were handed a booklet that contained the forms to record their ratings. The form displayed the five basic questions that the evaluators had to answer. These questions were :

(Moderator describes the action)
a) How many users will think this action is available?
b) How many users will think this action is appropriate?
c) How many users will know how to perform the action?
(Moderator executes the action)
d) Is the system response obvious? YES NO
e) How many users will think that the system reaction brings them closer to their goal?
(after presenting complete task)
f) Do you find the task useful? YES NO
If NO then how can it be modified to become useful? Comments / Opinions

The above questionnaire had to be answered for every action of each evaluated task. In a typical Jogthrough session such as those described in [Rowley and Rhoades 1992; Aedo et al. 1996] evaluators answer questions a, b, c, and e by using a simple arithmetic code: 0=very few, 1=less than half, 2=more than half, 3=nearly all, NS/NC=Doesn't Know/No answer. Their ratings therefore define a number of potential users without considering the process of user becoming experienced with the interface after repeatedly having completed the various tasks. We instead wanted to capture in the evaluators' ratings exactly this gradual increase in user understanding of the interface. For this purpose we designed an answer form appropriate for a more complex environment where users may start as novices and gradually become experienced. We asked then the evaluators to estimate the above numbers of successful users in four distinct phases of user familiarization with the interface: the first time users try to perform the task, after having performed it few (2 or 3) times, after enough (4 or 5) times and after more (>6) times [Fig.3].

All Users				
Most				
About Half				
Few				
None				
	1st time	Few times (2–3)	Enough times (4-6)	More (>6)

Fig. 3: The graph where evaluators recorded their ratings

4. Results

Ratings for the Network Simulator Interface

In [Fig. 4] evaluators' ratings are presented after they have been coded (1=None, 2=Few, 3=About Half, 4=Most, 5=All) and statistically elaborated to obtain the mean scores across all the evaluated tasks. We interpret this final graph as a kind of quality "fingerprint" displaying visually an estimate of how fast the majority of the users would be effectively working with the specific interface. The curves indicate the increase in number of users who (according to the evaluators) could successfully understand actions as available, appropriate, getting them closer to their goal or know how to perform them versus the times they would actually have to perform the tasks in order to achieve this level of understanding. A first observation is that a great number of users (~ 60%) is expected to effectively understand the availability, appropriateness and way to perform the actions even from the first time. Even more users (~ 90%) will understand the first time that system responses are getting them closer to their goals. The overall result indicates that evaluators expect the majority of users (90%) to be able to completely understand the task performance after they actually perform the tasks for a few (2 or 3) times. One can see that "Closer to Goal" curve is distinctly higher than the three others. We believe that this might be an indication of evaluators having strongly connected the user understanding of getting closer to his/her goal to the perceptual alteration of the system state (obvious when an action was executed).

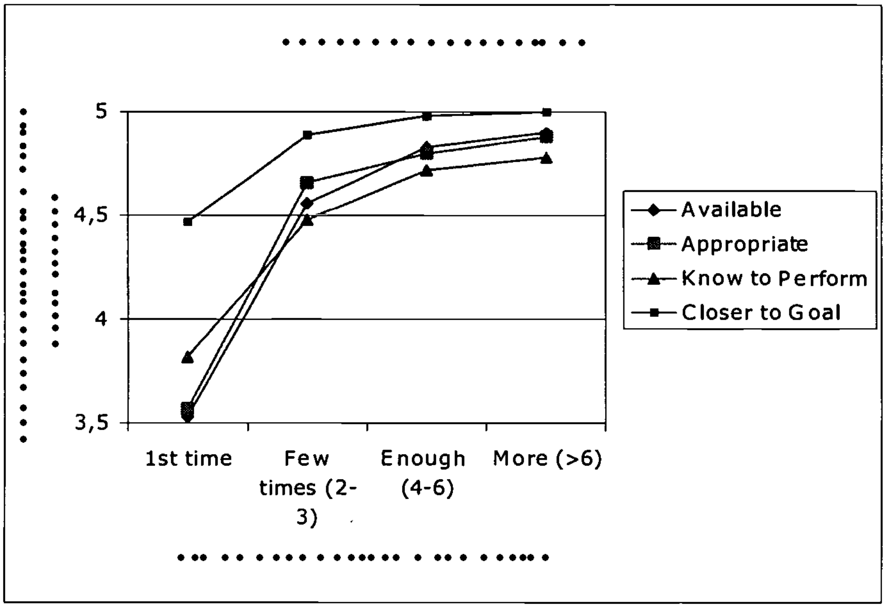


Fig. 4: Evaluators' Ratings for the Network Simulator Interface

Evaluators' Opinions and Suggestions

Evaluators made several remarks concerning many perceptual interface characteristics such as appearance of windows and buttons, buttons functionality, consistency of the alternative options in relation to the options generally supported by the operating system etc.. More important they almost always offered solutions and alternatives that the design team could later implement. The select – carry – install metaphor was generally positively commented and a suggestion was made that altered cursors (indicating carrying an item) might better be icons of the item instead of letters denoting it. There was a case where one of the evaluators proposed that selection of a specific network interface card might well be inactive when the user chooses a network topology where this card is not used and so have the interface support user's decisions by limiting the available options only to the accepted ones. This suggestion was rejected since it was in contradiction with our pedagogical approach to allow users make mistakes that in the real world would be possible to do. We believe that it is pedagogically correct not to have interface options guide user's decisions but offer constructive feedback after a user follows a path of action that may lead to unaccepted proposals.

5. Concluding Remarks and General Guidelines for Applying the Graphical Jogthrough Evaluation Method

The benefits of the method may be seen as resulting from two mutually completing sections: a quantitative one including ratings recording and a qualitative where designers listen to evaluators' remarks and comments and discuss with them .

In the quantitative section of our modified procedure the graph presented in [Fig. 3] was the main instrument for ratings recording. The use of this graph is judged as successful. After a short introduction by the moderator, evaluators were able to comfortably use it and denote their ratings by checking on the proper boxes. In the qualitative section the comments and suggestions that evaluators made helped us understand

how to apply a better design on various interface aspects. Evaluators focused more on the perceptual characteristics of the interface but this was only natural since their main background was on multimedia programming and development.
Task selecting and analysing is a point of great importance especially since the Walkthrough or Jogthrough methodology itself does not provide guidance on this point. Tasks should be representative of the overall available tasks and at the same time not too much extended and time consuming when evaluated. Analysing the evaluated tasks so that user goal granularity would be the same as interface action seemed to work alright but one should be cautious to avoid possible pitfalls [see Wharton et al. 1992], i.e. cases where actions might not be quite well mapped on user goals. We believe that our approach (having task actions described both as user goals and interface actions) helped evaluators proceed in a faster pace since they found user goals already connected to interface actions.
Concluding from our experience we argue that the Graphical Jogthrough interface evaluation method may offer useful feedback to designers provided that they clearly understand interaction between the two main factors of the session: evaluators' expertise (human factor) and selected tasks (system factor). The results (quantitative and qualitative) that the session produces are strongly biased by the characteristics of these two factors. Designers should keep in mind that the specific expertise of the evaluators will inevitably lead them to focus on certain aspects of the interface design neglecting others. It is their responsibility to identify the priority of other factors (e.g. the pedagogical approach) and reject the evaluators' proposals in case they misleadingly suggest redesign of certain interface aspects. Reflecting on the session we conducted we summarize as follows: aspects of Graphical Jogthrough that worked well include identification of perceptual interface design deficiencies, discussion with evaluators (helped us develop a more clear opinion about the way possible users might work with the interface we designed) and use of the graph we introduced in order to capture indication of novice-becoming-expert pace. Aspects to pay attention to include evaluators' background (it constitutes the human factor and will define the area of useful conclusion drawing), selecting the tasks (it is the system factor and should be a satisfactory trade off between adequate system representation and time length of the session) and designers' clear understanding of the human and system factor (it is the relationship between these two factors that defines the specific usefulness of the evaluation session).

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BLOOD CELLS REVISITED by INTERACTIVE MULTIMEDIA

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INTRODUCTION

For the student of Haematology the ability to correctly identify normal and abnormal blood cells is an essential skill. To interpret the morphological changes and variations that occur in diseases of the blood and arrive at a clinical diagnosis is very difficult and conventionally takes many hours of study using a microscope. In a haematological disease such as Chronic Myeloid Leukaemia, for example, the morphology of the white blood cells changes dramatically as precursor cells normally found only in the bone marrow enter the peripheral blood stream (see Fig. 1). At the present time the only meaningful way a student can learn to identify these cells is to have one-to-one tutorial help at the microscope.

Figure 1: Chronic Myeloid Leukemia

BACKGROUND

At Curtin University of Technology in the School of Biomedical Sciences, Haematology is taught to students enrolled in the Medical Science degree course. There are -

80 first years
60 second years
30 third years (major Haematology unit)

These students have access to only 20 microscopes and very little tutorial time. A major problem for the students was finding extra time when the microscopes were not in use, to study their blood cell morphology. It became apparent that a solution to this problem could be met by the use of the capabilities of interactive computer based multimedia

STUDENT SURVEY

Before embarking on such a project a survey of second and third year students was performed to assess the extent of the problem. Following is a summary of some of the survey questions:

Do you find the class tutors' help with cell identification satisfactory?

- YES - 56%
- NO - 44%

- Not enough time - too many students
- Too shy to ask questions
- Just wasting tutors time
- Just guess at odd cells
- Don't understand initial concepts

When you have finished assessing a blood film do you have difficulty in forming a conclusion?

- NO - 20%
- YES - 80%
  - Not enough time
  - Miss an important cell or inclusion
  - More than one abnormality
  - Can't relate abnormality to the disease

Do you have difficulty in relating and interpreting blood count results/histograms from automated cell counters, to the morphology on the blood film?

- NO - 55%
- YES - 45%

What do you perceive as the major difficulties in cell identification?

- Not enough time with tutor
- Abnormal white blood cells and precursors
- Atlas doesn't have full lineage
- Variations of normal and abnormal cells

Do you find tutorials using the video helpful?

- YES - 99%
  - Get feedback on what we were supposed to see
  - Reinforcement
  - Clarify cell morphology
  - What cells are significant
  - Much better to "see" than be told
- NO
  - One person too shy to ask questions

Although the video tutorials were deemed most useful, sometimes a period of 1 to 2 weeks elapsed before the student could get this type of feedback on their interpretation of the blood cell morphology.

INTERACTIVE MULTIMEDIA AS A SOLUTION

I. • The student would not need access to a microscope.
• The student would not need a tutor as immediate on-screen help with cell identification and access to the correct diagnosis would be available.
• The student could work at their own pace.
• Other information could be incorporated, such as a fully illustrated patient history, further laboratory test results, normal values and a glossary.

II • The students progress could be monitored either in a learning mode or in an assessment mode.

III • Initially, only one blood film per case study would be required to digitise the blood cell images onto the computer. This would be a major advantage in gaining access to rare blood cell disorders.

CURRENT METHODS OF TEACHING

Currently students are given a report sheet with a brief patient history, blood count values and a stained blood film (see Fig. 2).

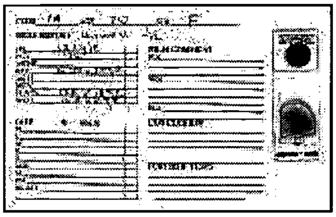

Figure 2: Report sheet and blood film

The blood film is assessed, using a microscope and the student performs a differential white blood cell count, using a "diff. counter".
This involves counting 100 white blood cells and differentiating them into their different cell types (see Fig. 3). After also examining the red blood cells and platelets the student is expected to write up a conclusion and suggest a diagnosis. This may include suggesting further laboratory tests to aid their diagnosis.

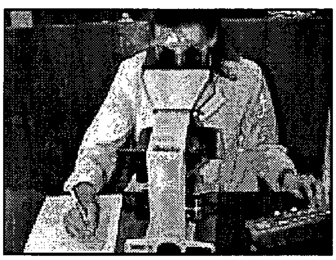

Figure 3: Using a "diff" counter at the microscope

NEW PROPOSALS USING INTERACTIVE MULTIMEDIA

It was decided to enhance the educational value of the teaching material by using realistic haematological case studies, as seen in a clinical laboratory, rather than just an "atlas" type package. At the present stage of development, the program includes the following features:

1. The patient history includes "hot text" with which the student can interact and actually see the features and clinical appearance of the patient. (See Fig. 4)

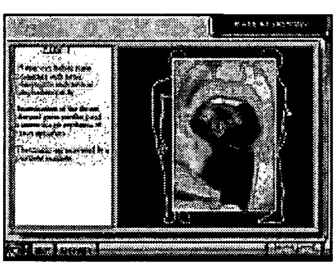

Figure 4: The Patient History screen

2. A glossary is also available on every screen for the student to access the meaning of unfamiliar terms or abbreviations. (See Fig. 5).

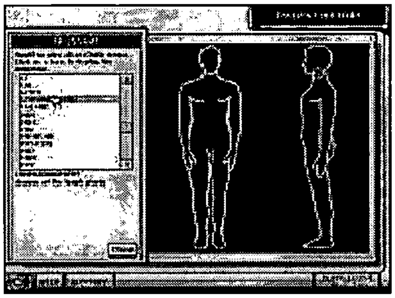

Figure 5: The Patient History screen with glossary displayed

3. Full blood count results from printouts (see Fig. 6) from automated haematology analysers (see Fig. 7) were obtained and scanned using a Umax Vista-S8 flatbed scanner. The student is then be able to interact with these results and learn to relate the appearance of the graphical representation of the cells with the microscopic appearance. (See Fig.8).

Figure 6: Printout of full blood count results

Figure 7: Haematology Analyser

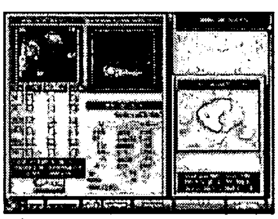

Figure 8: The White Blood Cell Results screen showing a "hot spot"

4. On appropriate screens the student has access to normal values or images of normal cells, to compare with the patient results. (See Fig. 9).

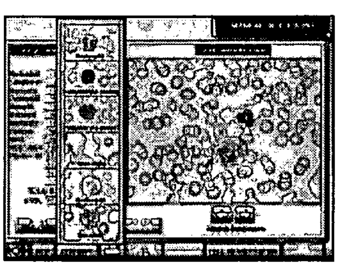

Figure 9: The Differential Count screen with normal cells displayed

5. At any stage in the white blood cell differential, if the student can not identify a cell, access to a cell identification protocol is available. (See Fig.10).

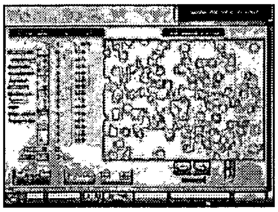
Figure 10: The Differential Count screen with access to the Cell Identification Protocol

6. The cell identification protocol has a step by step interactive approach to the identification of each white blood cell whereby the student must select specific morphological criteria to identify the cell. As on other screens, access to the correct answers is always available. (See Fig.11)

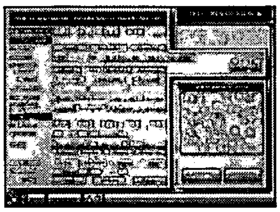
Figure 11: The Cell Identification Protocol screen

7. The correlation between the red blood cell morphology and the graphical representation from automated haematology analysers also allows for student interactivity, to enable a better understanding of these concepts (see Fig.12). Similar screens are available for platelet morphology.

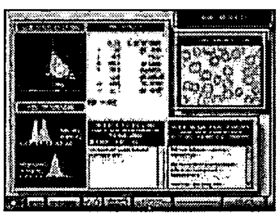
Figure 12: The Red Blood Cell Results screen with overlay of normal histograms

8. The final Case Summary (see Fig.13) correlates all the previous screen input from the student, which then enables them to reach a tentative diagnosis.

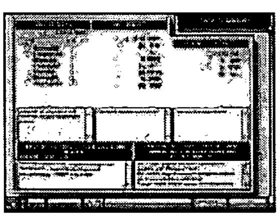
Figure 13: The Case Summary screen

9. In most haematological case studies, to come to a final diagnosis, confirmatory tests are often requested. Again by interactivity, the student has immediate access to further relevant laboratory test results for the patient (see Fig.14).

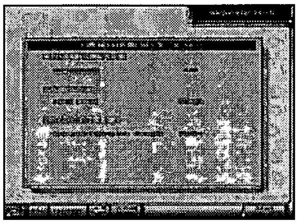
Figure 14: The Diagnostic Tests screen

10. On the final screen the student is required to reach a diagnostic conclusion (see Fig.15). At this stage the student may choose another Case Study or access a more "in-depth" review of the current case which would include references for further study by clicking on the Case Review icon (Fig. 16).

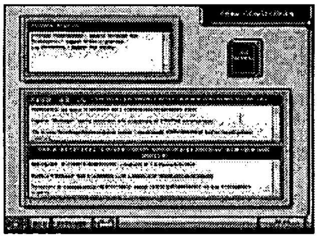
Figure 15: The Final Conclusion screen

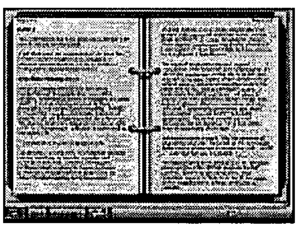
Figure 16: The Case Review screen

In summary, this is a totally new and unique approach to teaching haematology. By working at their own pace, with the high degree of screen interaction and tutorial help available at every step, students can develop their own deductive reasoning skills. They are also able to reach a conclusive diagnosis and gain confidence in their ability to correctly diagnose haematological diseases.

DEVELOPMENT

Initially 6 months was spent in designing the storyboards. It was decided to incorporate the conventional method of examining a blood film and therefore the navigation is fairly structured, with the interactivity occurring within each screen. By nature the diagnosis of any clinical disease state has to be approached in a systematic fashion. For haematological disease the following protocol is generally accepted (Dacie & Lewis, 1995) (see Fig.17).

Figure 17: Diagnosis Protocol for Haematological Disease
This format was adopted in the designing of the storyboards and formed the basis of the navigation map (see Fig.18) which can be accessed from any screen via the HELP button.

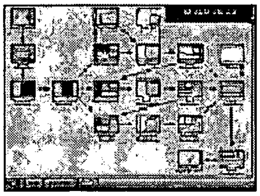

Figure 18: The Navigation Map screen, accessible from the HELP button

AUTHORING ENVIRONMENT:

The Haematology Tutorial was developed in SuperCard 2.0, an environment very similar to HyperCard, but with the addition of built-in 8-bit (256) colour and the facility to add scripts to graphic objects. The scripting language SuperTalk is a super-set of HyperTalk, and the conversion of HyperCard stacks to SuperCard stacks is provided within SuperCard. Some minor "tweaking" may be necessary with some HyperCard commands which are not directly supported in SuperCard.
The most critical aspect of this project was the requirement to display digitised images of blood cells on the computer screen equal in quality to that seen through a microscope. This meant that 16-bit colour (32768 colours) was the minimum in terms of colour quality, and that colour balance and image density had to be accurate and consistent over the 500 images captured and processed for each case study.
Early prototyping revealed that the QuickTime video format would provide the required image quality in the SuperCard environment, and at the same time allow transparent compression-decompression and rapid retrieval of the images. A decision was made to purchase a high-resolution triple-CCD video camera to ensure optimum colour fidelity and balance at a sufficient resolution. The camera was adapted to fit an Olympus BH-2 microscope, and the images were digitised through a PowerMacintosh 7100 AV computer (see Fig. 19), supplied through a local Apple University Development Fund grant.

Figure 19: Capturing the blood cell images

IMAGE PROCESSING

Images were captured in two magnifications from the microscope. The "low power" views were captured with a 60x objective and the "high power" views were captured using a 100x objective with oil immersion. The standard Macintosh AV program, VideoMonitor was used to capture the images as PAL "half-screen" (376 x 288 pixels) single frame PICT files, which were then manipulated with Adobe PhotoShop to produce a set of base images ready for conversion to QuickTime format. Images are displayed in the program in two sizes: 376 x 288 pixels and 188 x 144 pixels. The larger half-screen size is used for the differential count (see Fig.10), and for red blood cell and platelet morphology screens. The smaller size appears in other screens as a cropped area without any scaling (see Fig.11).

PROGRAM DESIGN AND STRUCTURE

The Case Study module of the Haematology Interactive Teaching program is essentially data-driven. It is designed as a series of template screens on which different images and data relating to each case study is presented to the student. The selection of the particular case study may be decided by the student or may be selected, either sequentially or randomly, by the program itself, depending on the mode required.
An important part of the design was to enable the program to be used in "author" mode to generate or modify and save case study data without the necessity for a programmer. For example, the Cell Identification screen (see Fig.11) requires the student to select characteristics describing the displayed cell, and then to check their identification. In author mode, the same screen can be used to select the correct characteristics (with alternative

selections) and save this data to the case study data file. The program may then be switched immediately to "student" mode to check the data from the student perspective.
Other screens may be used in author mode to position screen "hotspots" and link these to images (see Fig. 8), enter patient history information and data (see Fig.4), or even proceed through a complete differential count on screen (see Fig.10) and save the results in the data file. The main advantages of the author mode is that additional case studies may be created without technical programming assistance, and case study data may be verified and/or modified while the subject expert works through the program.

PROGRAMMING CONSIDERATIONS:
An initial prototype of the differential count used a database of screen coordinate hotspots for each cell in the particular frame being displayed. As the mouse was passed over the cell, the cursor changed to a "magnifying glass" icon to indicate a high-power view was available for this cell. Similarly, in the high-power view, when the mouse was waved over a cell, the cursor would change to a "question mark" icon to indicate a link to the Cell Identification protocol screen. This method was effective in terms of the interaction, but presented difficulties with the complexity and amount of data required for implementation. A further problem with this method was that the program was unable to determine in a multiple cell view, exactly which cell the student was considering when they pressed an F-Key to identify and count the cell. A possible solution was to have the student click on the particular cell first, then press an F-Key to count the cell. A cell selected in this manner could not be highlighted by an overlay of a graphic, since the QuickTime display occupied the highest layer on screen, except for the cursor.
A different approach simplified the data structures and decreased the program's response time. A small arrow was overlayed onto each multiple cell frame in the sequence to indicate to the student the current cell under consideration. Frames with multiple cells were simply duplicated and the arrow moved to a different cell in each duplicated frame. This meant that there was one frame for each cell in the blood film regardless of multiple cell views. The student could now view the frame and press an F-Key to identifiy the cell indicated by the small arrow (see Fig. 9). Pressing any F-Key also automatically advanced the view to the next frame, saving a number of keystrokes.If a higher magnification of a cell is available an "OIL objective" icon appears which the student can click on to access the image.The Review Errors procedure was also vastly simplified by this technique. In this mode, the program could easily locate incorrectly identified cells, and display these sequentially for the student to review. A displayed count-down of the number of incorrect cells left was also now possible.

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Beyond the Information Arcade™: Next Generation Collaborations for Learning and Teaching at the University of Iowa

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Abstract: Since 1992, the University of Iowa Libraries' Information Arcade has been a spring board for developing new collaborative technology-based services to support teaching, learning, and research. This paper describes next generation developments underway in applying learning technologies as well as issues and challenges, including development of media user education programs, technology training programs, and building "Arcade-like" facilities across the campus. Issues and challenges found in these new collaborative efforts will be discussed as well as "third" generation scenarios to come.

1. INTRODUCTION

In 1992 the University of Iowa Libraries opened the Information Arcade, a unique, ground-breaking facility designed to support the use of electronic resources in research, teaching, and independent learning, and founded on the philosophy of collaboration between librarians, faculty, and information technologists [Lowry, 1994]. Over the past five years the Arcade was the focus of intense worldwide attention including winning the ALA Library of the Future Award. Five years after its opening new campus-wide technology based services are being developed to support learning, teaching, and creative research. This paper describes next generation developments in advancing collaborative learning and teaching environments in the Libraries and throughout the campus, building on experiences gained from developments in the Information Arcade.

2. ADVANCING LEARNING TECHNOLOGIES THROUGH THE INFORMATION ARCADE

Progress towards integrating computer-based multimedia programs, Internet resources, and other networked information resources by teams of faculty, librarians, and information technologists is evidence of Iowa's assimilation of the "Information Arcade" philosophy at the University of Iowa – collaboration, creative risk taking, and integration of services and staff expertise to support innovation in teaching and learning throughout the curriculum.

Elements of this experience may contain useful models for other institutions seeking to create dynamic and effective learning environments. Major issues facing research library staff and other players in the university committed to the integration of learning technologies into the curriculum are also considered.

2.1 THE WHITE CITY AND MORE: REAL APPLICATIONS WITH EXCITING RESULTS

Development of a physical space such as the Information Arcade, visually and actively demonstrating action based on an education philosophy (interactive learning combined with rich connections to networked information resources), remains a critical element in the success of current initiatives and the future developments of others. Established with a $750,000 grant from the Roy J. Carver Charitable Trust of Muscatine, Iowa, the Arcade consists of an electronic classroom with 24 dual platform high end workstations and an instructor's station. Beyond the classroom are clusters of multimedia workstations and information stations. All workstations are mounted on an ethernet network allowing for superior connectivity making possible the creation of the LWIS (Libraries-Wide Information System) and the Gateway to the Internet, a specially selected collection of direct links to databases, documents, image collections, WWW home pages, and other materials arranged by subject, type of information resource, and institution (http://www.lib.uiowa.edu/) [Lowry, Soderdahl, Dewey 1996].

The creation of the Information Arcade provided a dynamic way for librarians to work directly with early innovators on campus such as English Professor Brooks Landon who taught a course, "Literature and Culture of Twentieth Century America." Central to the course was the profound implications of the 1893 World's Columbia Exposition in Chicago. When taught in the Arcade's electronic classroom, the course was transformed into a hypertext-guided tour of the fair using documents, images, and photographs. The end result is a dynamic and continually emerging database Landon calls "The White City." From the research library perspective the Information Arcade provided a focus for bringing together the expertise of librarians in information resources needed for a course such Landon's with faculty who would use the facility for developing interactive learning environments and other new approaches to their courses. What occurred was a fundamental change in the way librarians and faculty worked with students and with each other. Important for librarians, the facility provided a new way to use their expertise to integrate information resources (in all formats) into courses, along with the information seeking and problem solving skills needed to sort out and apply the vast body of information resources available to students now and in the future. And, the opportunity to experiment with emerging learning technologies and creating information resources for research and teaching with Arcade technology and staff expertise was a major advancement (even prior to widespread web use). Lofty goals but doable over a relatively short period (five years) with the existence of a splashy, high profile and expertly staffed facility, the Information Arcade, and with a strong emphasis on partnerships.

3. IF WE BUILD IT THEY WILL COME

Why were librarians at the University of Iowa so interested in learning technologies to the extent that we truly believed "if we build it they will come," a famous saying from the Iowa movie *Field of Dreams*? Obvious reasons include the fact that research libraries are already immersed in the application of technology from purchasing indexes, books, and research materials in digital formats to carrying out library operations in an online environment (processing, reference, communications). For the UI Libraries it became a major way to pursue our primary goal -- "to maintain as a top priority the development and delivery of instructional programs and materials to assist students, faculty, and staff in acquiring the skills and knowledge to achieve information literacy in order to secure information needed immediately and throughout their lives [University of Iowa Libraries 1995]." And, building the Arcade enabled us to visibly address the concern that technology, in and of itself, become the driving force of advancement in the learning and teaching process.

Stephen Ruth accurately remarked in a recent *EDUCOM Review* article that technology-based learning is not about the medium but it is all about how the technology is leveraged [Ruth 1996]. Or, as a recent Pioneer Seed Corn Company television ad noted (Iowa has plenty of corn producers) we are seeking "Technology that Yields." Thus, librarians' role in working with faculty to incorporate research skills within courses in new and dynamic ways, and with networked information resources, is a natural progression of the more traditional roles of simply housing and providing access to library materials. Not only does technology "yield" under this model, but it provides mechanisms for major transformations in learning environments.

3.1 BUILDING "ARCADE-LIKE" FACILITIES THROUGHOUT THE UI LIBRARIES SYSTEM

Using the Information Arcade as a model, the Libraries, in collaboration with academic colleges and departments, have built or are planning similar facilities throughout the campus. The Information Commons, a 5,000 square foot electronic information and multimedia teaching facility at the UI Hardin Library for the Health Sciences, opened in August 1997 [Duncan 1996]. The Commons provides faculty and students, primarily from the health sciences colleges, with access to health sciences databases and computer-based learning as well a multimedia technologies that support faculty and staff in creating specialized interactive technologies. Truly a collaborative effort, use of the Commons as an instruction site has skyrocketed and it has proved to be a fruitful physical location for instructional and research-related partnerships with faculty. At this writing plans are underway for an expansion of two additional electronic classroooms (http://www.lib.uiowa.edu/commons/).

ARTIC, The Advanced Real Time Information Center, is an electronic teaching facility located in the Marvin A. Pomerantz Business Library. ARTIC's purpose is to incorporate state-of-the-art technologies for all kinds of dynamic (real time) business information sources, especially global financial trading markets, into a teaching venue for College of Business Administration faculty and librarians. ARTIC extends the collaborative and innovative philosophies of the original Arcade concept by providing an actual space for librarians and faculty to improve students' ability to compete in our real time global information-driven economy through effective navigation of business information sources.

Ongoing building projects for the Engineering Library and the Biology Library include Arcade-inspired smaller electronic teaching facilities within their walls. These facilities will provide greater access to electronic multimedia resources so important in these disciplines and bring together more students and faculty in subject-specific interactive learning environments. The facilities, planned in close collaboration with the College of Engineering and the Biological Sciences Department, provide yet more venues for dialogue with faculty regarding collaborative ventures for integrating electronic resources into their curriculum.

4. STAFF TECHNOLOGY TRAINING

Getting beyond the first wave of success the Arcade generated was a major challenge. A critical part of the University of Iowa's success in extending the Information Arcade concept was a concerted effort to broaden the technical expertise of library staff from throughout the system. This was accomplished through a variety of staff training sessions covering topics from web page creation to desktop publishing, digitizing and imaging. In order to whet staff appetite for such training as well as minimize fears, technology training days are set aside devoted to hands on experience with the latest software and hardware available for application to user education and learning technologies. The staff technology training series has resulted in an exponential growth in the number and variety of user education programs staff provide on a regular basis for the University of Iowa's 28,000 students and over 2,000 faculty.

5. INTERACTIVE AND " VIRTUAL" USER EDUCATION

Librarians trained to use, not only the electronic classroom in the Information Arcade, but other facilities around the campus, are able to integrate appropriate software and hardware solutions for the creation of interactive general discipline-specific user education sessions on library resources. Newly constructed venues and innovative technological applications have definitely added value to more traditional lecture-based modes of classroom instruction. Thus, the physical space (an electronic classroom) becomes a dynamic learning environment capable integrating information resources into truly interactive courses ranging from Engineering to English, History to Mathematics and throughout the Health Sciences curriculum.

Extending our reach to thousands of students in a large university setting is simply not possible in classrooms (electronic or otherwise) or regularly scheduled educational sessions held in the library. Although engaged in user education programs for some years, it was clear that we were not reaching large numbers of students and faculty. For example, in 1990 a total of 393 user education sessions were held reaching 6,678 students. By 1996 the number of sessions increased to 628 reaching 12,087 students. However, this falls far short of the campus population of 27,500 students. And it was also clear that faculty and students had ever increasing needs in learning how to effectively use the more expanded, more complex, and more numerous information resources available at a large research university [Dewey 1997]. These two obstacles ranked above lack of hardware, software, or even available funds. In fact, a research project funded by the Council on Learning Resources found that a population of 1000 faculty from four research universities identified two major obstacles to increased use of electronic information technology: (1)lack of information about databases and resources and (2) lack of training in their use [Adams and Bork 1995].

One way we can hope to expand user education programs in a truly exponential way is through the implementation of broadly accessible web-based tutorials and information packages which may be used 24 hours a day by many individuals at one time. *Library Explorer*, developed initially as a hypercard program, now web-based, is a computer instruction program designed to help students learn to choose information sources and finding tools appropriate for their work. Using the book as a metaphor, *Library Explorer* directs the user to a variety of "chapters" and allows them to search the Libraries' online catalog at any point in the program (http://www.lib.uiowa.edu/libexp/). A specialized information package, *Engineering Reference Assistant*, provides students "virtual" assistance locating Engineering information resources appropriate to their needs and class projects. The *Engineering Reference Assistant* can be accessed via the Web and available anytime the student needs help (http://www.lib.uiowa.edu/eng/robo/robo1.htm). Other digital information packages for subject domains are in the planning stages at the University of Iowa Libraries.

5.1 TWIST AND SHOUT

A major issue continues to be identifying effective ways to systematically expand our reach effectively to large numbers of students through the curriculum. Thus, an initiative began in the summer of 1996 called TWIST (Teaching with Innovative Style and Technology). TWIST is a three year project funded by a $370,000 grant from the Roy J. Carver Charitable Trust. TWIST's primary goal is to design a model instructional program to assistant faculty to incorporate new technologies and information resources into their courses. During 1996/97 faculty from the Department of Communication Studies worked with TWIST staff as an initial target audience for development of materials and instructional sessions. This particular group of faculty were recruited because they represent a wide variety of interdisciplinary interests within one department, providing a broad testing ground for application of a model for humanities and social sciences (http//twist.lib.uiowa.edu). Initial TWIST projects included: assisting a Latin American media scholar to construct a web page for two courses -- U.S. Media in Latin America and Cultural Imperialism -- providing students with information about traditional and electronic information sources, and working with a cross cultural communication scholar to develop an experimental course -- Intercultural Communication Course -- using electronic communication tools to link students from Iowa to students at the University of Jyvaskyla in Finland.

As with user education programs described earlier, reaching large numbers of faculty, and consequently students in courses via the faculty was unrealistic through traditional methods. Thus, TWIST staff also are in the process of completing web-based tutorials that can be used at the faculty's convenience or point of need (http://twist.uiowa.edu/tutorials/). Topics included: Guide for Beginning Researchers at the UI

Libraries; Introduction to the Internet and the World Wide Web; E-Mail and Mailing Lists; Accessing and Using WWW Browsers; Preparing Search Strategies; Searching for Information on the WWW; Evaluating Web Resources; Finding Information on the Web; Managing Information; Introducing Basic HTML; Using a Webpage Editor: Claris Home Page; Creating a Web-based Syllabus; Converting Files to HTML; Using Web Sites in Classroom Presentations; Using PowerPoint in Classroom Presentations; Conferencing and Other Computer-Mediated Communication; Multimedia; Image and Sound Databases; Electronic Texts and Digital Libraries; and Pulling it All Together With WebCT.

During the 1997-98 academic year TWIST is focusing on developing partnerships of librarians and faculty in a program called TWISTed pairs to explore the use of web-based learning environments for specific classes. A general process for implementation of the TWISTed Pairs model is that TWIST staff: 1) meet with the librarians and show options they can use with faculty; 2) survey the librarians involved to determine current skill levels and develop a training needs assessment; 3) meet with librarian/faculty pairs to develop individualized plans; 4) continue training librarians (and faculty); and 5) work directly with faculty offering assistance as needed (http://twist.lib.uiowa.edu/projects/).

Pairs are in place with faculty from African American World Studies, American Studies, Italian, Pharmacology, Journalism, Geography, Asian Languages, Communication Studies, English, History, Rhetoric, Art History, Comparative Literature, Spanish, and Film Studies. It is hoped that this work, along with the web-based tutorials, will result in a model transferable to other academic communities.

5.2 nTITLE: A CAMPUS-WIDE INITIATIVE

TWIST staff and other librarians have begun an important collaboration with the University's Center for Teaching and Information Technology Systems (ITS) to plan and implement a state-funded program called nTITLE (new Technology in the Learning Environment). A total of 96 professors from across the campus were selected by their college deans to participate in 3.5 day 1997 summer workshops planned and taught by the Center, the Libraries, and ITS in the Information Arcade classroom. Each participant received a grant of $3000 for equipment to be used for technology-based improvements in their teaching (http://www.uiowa.edu/~ntitle/).

6. NEXT GENERATION ISSUES AND CHALLENGES

Next generation advances are naturally accompanied by major issues and challenges. The political difficulties of forging constructive alliances with departments across the campus such as libraries, information technology services departments, and academic departments can be a major barrier to productive collaboration. In today's fast-paced environment there is no time to smooth over philosophical differences or achieve consensus on every detail. All parties must be willing to take risks and move forward. This is the only way to make projects happen. Issues of copyright and other legal concerns can be paralyzing, but should not be barriers to development. Staff training and development is critical to the success of next generation initiatives because of the need for technical expertise, not to mention the necessity of adequately maintaining the hardware and software behind the new learning technologies. Expertise in instructional development and computer-based design is also essential. Also, administrators must consider when to create from scratch or when to implement models taken from other institutions. Basic training of faculty and students in the new technologies is a major need which should not be taken for granted. For example, we found in a pilot needs assessment of beginning University of Iowa freshman, that only 30% were using the Libraries' web-based systems. Therefore, the need for ongoing evaluation and assessment is critical. Recognition via the promotion and tenure system found at the University of Iowa (and most colleges and universities across the U.S.) remains a major issue among faculty who are considering spending time applying learning technologies or developing multimedia research projects.

7. A THIRD GENERATION IS ON THE HORIZON

Advancing the Information Arcade philosophy of transformation through collaboration and creative use of learning technologies and networked information resources to another level is essential for the Libraries' efforts to remain relevant and central to the teaching and research missions of the University. Increasing partnerships and collaboration with faculty and students will become more and more integrated into daily work. Without this kind of major transformation I believe we would not be major players in planning for next steps in the University's advancement of its teaching and research missions. With the groundwork laid by the Information Arcade implementation and development we are an essential part of the University and the State of Iowa's new emphasis on integrating instructional technology into all aspects of university life ensuring that graduates will have the tools they need to function effectively in the next information age and beyond.

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GENTLE - (GEneral Networked Training and Learning Environment)

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Abstract: This paper describes a web based training system which has been used as a working prototype to assist teachers in lecturing since fall 1997. The main goal of this system is to provide an integrated environment for both students and trainers. Lecturers can use it to create, maintain and offer courses and also administrate student affairs. Rich communication facilities extend the advantages the system provides to students. Apart from university areas the system is also designed for usage in companies to train its employees.

1. Introduction

Due to faster development cycles in science and industry, life-long learning has become a key factor for everybody who wants to continue being successful in a job - or even in private life. Great efforts have been put in the task to ease knowledge transfer, make it more pleasant, or simply automate it to become more efficient. Over 30 years ago computer based training (CBT) was introduced as a supplement to traditional classroom courses, with these goals in mind.

The advantages have been that students can decide where, when and how fast to learn; a lot more students can be reached; and learning can even become fun (particularly) if a CBT course makes good use of multimedia. The disadvantages are that CBT students often suffer from a 'tunnel syndrome' because they are restricted to material stored on the CD-ROM, and they don't have the possibility of getting answers to any questions that were not foreseen within the original design of the course system. There is essentially no support for communication between students and a teacher or tutor who might help them. Another major disadvantage is that the generation of a good, comprehensive course is *very* expensive.

A possible solution to these problems is a Web based training system that provides good communication facilities and even better reachability, through use of the Internet (or an intranet) combined with powerful tools to generate, maintain, and offer courses. The following documentation concerns such a system, based on Hyperwave [Maurer 96a], called GENTLE (an acronym for 'GEneral Networked Training and Learning Environment') [Maurer & Dietinger 97].

Note: Whenever we speak about the 'Internet', 'students' or a 'campus', this doesn't mean that this system is restricted to university applications. It can also be used effectively within local network systems by companies that want to train their employees!

2. GENTLE knowledge management system

Traditional CBT and even WBT systems have the problem that they not only isolate the students from each other, but also from the courseware authors and course contents they have created. GENTLE provides mechanisms to automatically store and maintain courses; this helps to increase reusability and thus reduce course creation time and cost.

The module repository and the course wizard

Each course, which is stored in a course library, consists of several *course modules* which again are stored in a module repository. Each module is characterized by a set of attributes and keywords to ease re-use when looking for already existing lessons to include in the development of new courses. Courseware authors can decide to physically copy a module and make their own changes to the module afterwards, or they can just link a module to their course (logical copy). In the latter case modifications to the module can only be made by the original module author - not by the author of the course who wants to include the module. The advantage is that any update or changes to a course module, by the module author, are immediately reflected in all courses where this module is included. If wanted the Hyperwave billing mechanism can help in establishing courseware-module markets, in contexts where modules can be sold or exchanged.

The authoring tool that supports the creation and administration of learning modules is called the *course wizard*. It also assists in creating new courses that follow clearly predefined pedagogical guidelines by suggesting a consistent structure.

Each new course includes an introductory page that has to be publicly readable (even if attending the course is not free) and contains the following information:

1. overview/aims/content
2. prerequisite and course level(s)
3. how to use this course
4. time required to master the course
5. references
6. samples/highlights

In the first section an author should give a short abstract about the courses content, its aims and how a student would benefit if completing the course. The prerequisite section has to describe the required knowledge background of the student and the difficulty levels in each case. Alternatively, the system could offer an introductory questionnaire upon course enrollment wherein the existing skills of the student are tested and this information is then used to generate an adaptive *course*, customized to that individual. In the same way, the student's learner type could be taken into account and thus provide a maximum adaptation to the student's individuality. Please note that this does not mean that a special version of the course is created for each student, but that the system dynamically decides upon retrieval which student should get which course page in what way!

In the third section the author can state whether this is a computer-assisted instruction course that supports a traditional lecture, or if it is a true Web-based training course, without physical presence of a teacher. This can also be the right place for including links to the teacher and the supporting staff (possibly automatically generated by the system). In addition, the system automatically creates a link to an 'introduction to the WBT system' lesson (which is included in every course and publicly readable).

Another quite important piece of information is how long the students could reasonably expect to take in completing the course. This of course depends on their own knowledge background and abilities - and thus might be re-adjusted after they have done the first lesson!

'References' is a link to the course's *background library* - including all relevant material that complements the courseware content; like full online books, descriptions of traditional books, or links to other interesting pages on the Web.

The last section could show a few highlights out of the course to whet the appetite, give an overview of the course style or quality, and also work as an advertisement (especially for courses that students have to pay for).

Apart from the introductory page a course also consists of course modules. Each module should address each topic treated, described in a short introductory page within that module, and may include frames and chapters, or subchapters that combine several frames. A frame can be composed of any document type like text plus images, audio, video, animation, simulation, tests or of a mixture of these elements. It is recommended that at the end of each lesson the author should add a self-test for the students, to let them evaluate whether they have understood the content completely. The course should suggest a specified set of frames to redo if necessary. Note that because this test is not used to assign grades, students are given the means to be able to decide for themselves whether or not they have solved a problem correctly. There is no need for 'artificial intelligence' to check answer for correctness.

The course environment

Whenever an author creates a new course using the course wizard, it will also automatically generate a *course environment* that provides the following features:

- navigational aids (table of contents, next/previous frame, last page visited)
- several ways of student/student and student/teacher communication
- systems to support the inclusion of private notes
- search routines for the background library

Due to the features of the Hyperwave server, no extra programming (apart from layout-specific features) is required to provide a table of contents at the beginning of a new chapter, or to update the 'next' and 'previous' frame function. The last page that a learner visited can automatically be accessed on any later occasion, after interrupting a course session, in order to guarantee a smooth continuation of learning.

To reduce the tunnel syndrome, both synchronous communication (like online chat), as well as asynchronous communication (like discussion forums) are supported. Annotations serve a special role in GENTLE. Students can either make private annotations (as personal notes to a special point within a frame) or public annotations of several types. Annotation types are

- comment
- supporting argument
- counter argument
- question to the teacher (private and public), or to other students (public only),
- answer
- teacher 'hints'

Annotations can be created by the students either identified or anonymously, or by the teacher. These types can also be used in the discussion forum and are visualized using different icons. If students have posed new questions to the teachers, those teachers will be notified by an email.

The course environment also provides a powerful search function; with the capability to restrict the search scope, to the background library, the entire course content, or the complete courseware server.

Delivery tools

GENTLE can either be used online, where the students are connected to the server all the time (useful in PC-laboratories or in student residences that have a direct network connection), or offline. For primarily offline use the whole course content, including the background library, can be extracted from the courseware server and put on a CD-ROM. Hyperwave functions like searching are emulated using Java applets, requiring only an ordinary Java-capable Web browser. To prevent the 'tunnel effect', annotations and intermittent links to discussion forums are supported. The students simply have to go online occasionally for a short period of time to synchronize their data with the server and to fetch new answers or annotations. The course environment is slightly different because additional online functions (*synchronize feature*) have to be added, but it generally appears the same to the students either way they use the system.

Course Evaluation tools

Due to the fact that GENTLE is based on the connection-oriented protocol of the Hyperwave server, user-tracking and even student-modeling become possible. This can be used together with pre- and self-tests for improving the overall quality of the courses as well as fitting the personal needs of the students during the dynamic customization process (of adaptive courses).

Students management

Whenever new students enroll at the courseware server, they will have to answer a few questions to inform the system about their knowledge background and their aims. This information can be used to automatically determine what courses (e.g. additional optional subjects) students should take and automatically suggest them. At the university level a customized study plan for each student can be generated. Commercial companies could use this feature to design a career plan for each employee (of course the decision process can be influenced by relevant authorities).

To sum up all the features of GENTLE: It is not only a network-based CBT system, using the Web simply as a transport medium for static courseware, but can be more clearly seen as a dynamic and comprehensive *knowledge management system.*

3. GENTLE from the student's point of view

Although certain features are also available to anonymous users, full benefit can only be granted to identified users. Each new user has to fill out some form to specify at least a few personal details. For a student this could be name, registration number, area of studies, intended outcome, etc. This questionnaire can also be extended to become a so-called *profiler*, where the students answer some test questions to find out their level of background knowledge, learning habits ('learner type' according to Meeker) and cultural background. This information can later be used in the formulation of *adaptive courses* which dynamically adjust their content and style according to the students' profile. In this way a very individualized training environment can be offered, of a sort which otherwise can only be found in a single-teacher/single-student relationship.

Upon completing these questions, users will get a personal working area on the server called "*locker*". It contains the following elements: *Courses Suggested, Courses Enrolled, Courses Taken* and *Private Working Space*.

In the 'courses suggested' section, students will find all courses that the system thinks would be appropriate for them. In the most trivial case, all courses available would be listed here. In the more advanced versions it would depend on the user's detailed profile whether or not a course will be listed here. This is also the place where students will select which course they would like to enroll in. If the user has registered for a course (using the *course registration*) it will be listed in the 'Courses Enrolled' collection which serves as the entry point for the course itself. The collection 'Courses Taken' may be used for administrative purpose, but can also function as a private area for the student to maintain their own overview of any courses they have already mastered and how well they did. The 'Private Working Space' may be used as a working area for doing exercises or to store e.g. personal pages.

The course environment

After signing up for a course, each student will experience the course through access to the following functions: 'start', 'next/previous page', 'search', 'annotate', 'discussion forum', 'online chat', 'continue' and 'exit'.

Navigational aids

Whenever the students enters a course they will automatically arrive at the last visited page (or the introduction if this is the first visit), so that it is easy to continue after an interruption. To come to the next/previous page the user has to click on the 'next/previous page' button, 'start' will lead to the introduction page of the course and 'exit' will leave this course and bring the student back to the locker.

Searching in the background library

With 'search' one can query either a customized background library, the whole course content, the discussion forum, or the whole server. The background library is automatically generated during the course-creation process, based on the guidelines of the courseware author.

The annotation facility

Annotations can be placed within an HTML page using various annotation types; they are be visualized with different icons that appear within that page upon its delivery from a Hyperwave server. These annotations can be made by either participating teachers or students; in either 'identified' or 'anonymous' mode (in the latter case, no information about the creator of the note will be stored on the server).

Note: The annotating document as well as the annotated document can (theoretically) be of any type (audio, video, whiteboard, etc...). However only with text documents serving as a base all features are available.

The discussion forum

Another form of asynchronous communication supported by the system (besides annotations) is a discussion forum, where each thread is hierarchically visualized. This is tightly integrated with the annotation facility, so that it is possible for an annotation to become the main starting point for a new discussion thread. Again a discussion contribution may be any document type, and the same combinations of annotation and user types are allowed. A discussion forum can be moderated (posted notes being checked and afterwards released to public by a moderator) or unmoderated (every contribution will be visible, according to the individual access rights, immediately after posting).

The online chat

The online chat can be used if two or more people are online at the same time. Students can chat amongst themselves, or even with the teachers within their office hours. Text may be augmented by drawings on a *whiteboard*, but in theory any document type is allowed (especially audio documents, as an alternative to text). A possibility to archive chat sessions (especially student-teacher chats) can be made available (and such sessions are afterwards treated like an asynchronous discussion).

4. GENTLE from the teacher's point of view

The systems provides good tools to make learning easier and more efficient, but students can only benefit from them if teachers use the system for their courses! To increase acceptance the system has implemented a number of wizards and assistants to simplify several tasks. (These wizards are accessible when entering the courseware collection, if a teacher has the necessary access rights to create a new course.)

The course wizard

This is the main tool if a teacher intends to use the system to create a new course. The spectrum of possibilities starts with auxiliary support for a traditional lecture and ends at a self-contained Web Based Training course, where the teacher needn't physically meet the students at all.

Upon launching the course wizard, the teacher will be asked a few questions by the wizard:

- information about the teacher (name, image (to be uploaded or existing URL), office address, office hours, email address, home page, phone number etc.)
- if the system is supporting a traditional lecture: lecture hours and place
- title of course, table of contents and short introduction into course objectives, additional information (like special keywords categorizing the course content for the *course manager*) if necessary
- the teacher may select supporting material (from the online library) for the background library. If the online library is really huge, the teacher may specify the subject area using keywords to reduce the list of available books and choose the appropriate ones.

The fields for information about the teacher are preset and need to be filled out only if something changed since the generation of the teacher's profile. After filling out all fields in the form, the course wizard will create a *course skeleton* including the discussion forum, the background library, the 'introduction to course and instructor' chapter and placeholders for empty modules (according to the table of contents).

Even if a teacher does not want to invest more time, the students now have information about the course and the teacher electronically available. In addition, the course will automatically be supported by a discussion forum and a background library (if the instructor selected some books during the course creation process). Of course the students would benefit much more from the system if the teacher decided to create more detailed online course content. For this purpose the instructor may use the *page wizard*:

The page wizard

The page wizard helps the teacher to design and create a new course page or to edit a pre-existing one. When creating a new page, the author can choose from several different templates (e.g. a template for material to accompany a traditional lecture, or some chosen template for a pure online course, etc.) and then change the style and color according to their own taste.

After creating a new page the teacher may use the wizard to access editing tools to rework the page. The integration of many editing tools (HTML-editor, HM-card, Macromedia Director etc.) is configurable to support whatever tools are in common use at this campus (campus-wide software), or special ones that correspond to the author's preferences.

The module manager

The module manager is important if there are a large number of course modules (each course consists of modules) that are stored in the module repository. The module manager can be used to categorize each module, in order to simplify administration. One can thus automatically generate a completely new course out of existing material, just by specifying some keywords. The manager will then suggest a list of modules that fit these categories. If access rights permit reuse, the author may link these modules in the new course or make a physical copy and rework the module according to the new requirements. The billing mechanism of Hyperwave can even be used to establish a global 'trade' in courseware modules.

The course manager

The course manager is used to automatically assign courses to students (in the 'courses suggested' folder). Decision criteria for this might be the syllabus, a career plan etc.

The offline wizard

This tool will be used to create a special offline version of a course that works without the WBT server. Nevertheless should key features as searching and adding private annotations will still be supported by the offline version.

A more powerful version could also support going online from time to time, to synchronize the offline content with the server (very important for discussion forum and annotations!).

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Object modeling of an Adaptable Virtual Class using OMT methodology

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Abstract: This paper describes a virtual class which is based on the principles of CSCW (Computer Supported Cooperative Work) and ICAL (Intelligent Computer Aided Learning) systems. The virtual class proposed allow to a group of learners to participate in training sessions of an adapted tele-teaching system or adapted virtual class; this system takes into account progression rhythm differents inside a community of remote learners. The virtual class allows to adapt the teaching system in a flexible, individual, and collective way. This system also allows the implementation of a pedagogical method: the cooperative learning. This implementation is being developed in a distance education context using the Internet and Java. The OMT (Object Modeling Technique) methodology is being used to specify architecture of the adaptable virtual class.

I Introduction

The principle of the architecture proposed for an adapted training service is to allow the adaptation of knowledge transmission from a teaching function managing a virtual group of learners by a communication system [figure 1]. Teaching functionality's are distributed taking into account the participation of teachers, system, resources and learners in some cases (when a learner has the knowledge or experience necessary for playing the teacher's role).

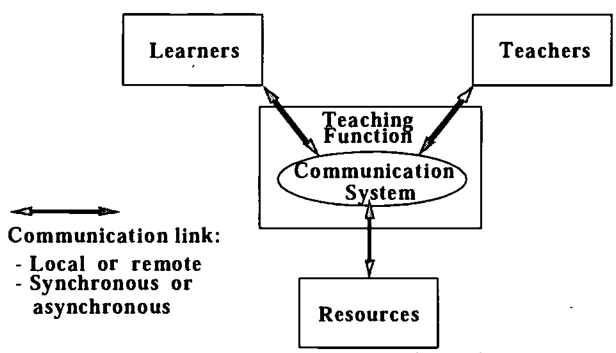


Figure 1: General architecture for each adapted training service.

The majority of learning telematic systems developed does not or rarely enable the system to control the teaching module. In general the teachers control this function, in the same way as traditional classrooms. In this paper, we propose for each adapted training service that the system allow to distribute the teaching functionality with the participation of teachers, learners and resources in a virtual class system. We take into account two kind of sites in a multi-site environment for distance education [figure 2].

a) The central site which provides a set of reusable SITB from a server.

b) The decentralized sites, which allow to learners to participate in an adapted training class.

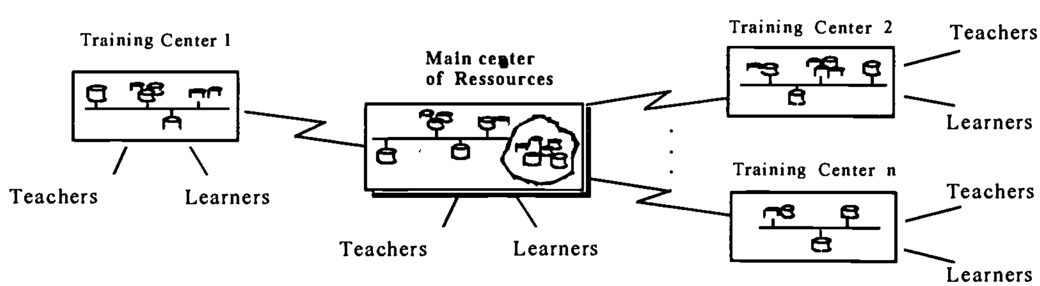
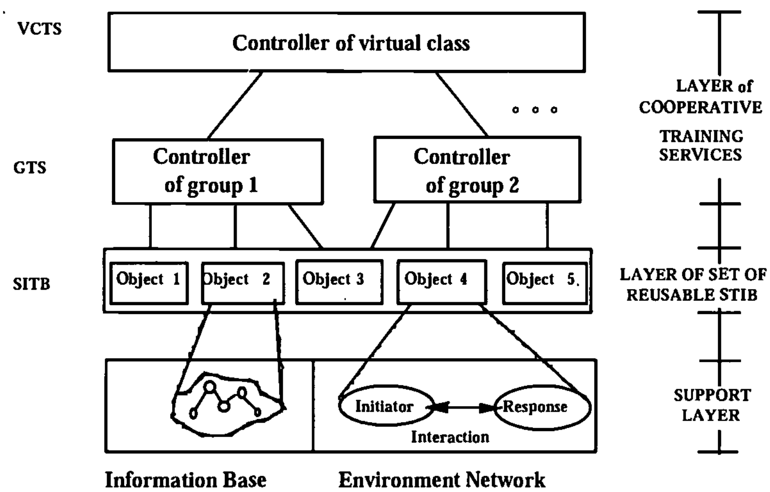


Figure 2: A multi-site environment for distance education.

II General architecture

In the multi-site environment of tele-teaching, we propose that any training site must be represented according to the ARESFED (In french: "Architecture pour la Reutilisation et l'Exploitation des Services de Formation dans le contexte de l'Education à Distance") [Hernández 95d]. This architecture is composed of three layers: support layer, layer of a set of reusable SITB (Service Independent Training Building Block) and a cooperative service layer [Hernández 95d] [figure 3].



SITB: Service Independent Training Building Block
GTS: Group Training Service VCTS: Virtual Class Training Service

Figure 3: Training architecture of a virtual class.

In this way, the representation of each training site is simplified and standardized. Thus, we must specify only an architecture: the ARESFED (in portuguese it is called ACVA: "Arquitetura de uma Classe Virtual Adaptativa").

II.1 Support Layer

It represents a set of frameworks from which the training architecture is built:
Information Space, provides information management services relevant to the courseware developed (for example: an object-oriented database management system stocks all the reusable objects).
Communication Space, supplies services supporting a distributed system and network service.

II.2 Layer of a set of Reusable SITB

This layer is represented by a set of functional, independent, and reusable components. These components will be shared and reused for creating a new service. We have identified with a participation of educationalists two kinds of resources: didactic (teaching activities) and information resources ("bricks of domain")[Canut 94], [Vincent 94]. From reusing of these types of resources a training service can be specified as a dynamic training service.

II.3 Cooperative Service Layer

This abstraction level represents the two kind of cooperative training services provided by this architecture. We consider two kind of adaptable services [Hernández 95c]:

a) global level represents a virtual class composed of a set of remote learner groups and
b) local level represents a particular learner group, each remote learner group is classified by a knowledge level.

These two classes of cooperative services must be adaptables to learner's behavior in a training session.
The composition criterion of virtual class takes into account a pedagogical context, this pedagogical context is based on the cooperative learning [Doyon 91]. A virtual class will be composed of a set of heterogeneous groups, each group allows to a set of remote learners to participate to a training session. In a traditional class the homogeneity of knowledge level is not always assured. Some cases, this homogeneity of knowledge level becomes very superficial. For solving this problem, we consider a first level of adaptation to learner's educational needs, this

level correspond to take into account a composition of a virtual class from heterogeneous groups. These groups have a variable composition [Hernández 95d]. Each heterogeneous group corresponds to a different level of knowledge allowing characterizing a group of learners with the same level of knowledge about a particular domain. However, inside a group of learners is possible to find different behaviors of learners according to progression rhythm of each learner. The second level of adaptation is taken into account into a group of learners. A particular knowledge level associated to a group of learners may also become superficial and not adapted. For preventing this problem, we propose to consider the behavior zones into a group of learners. In this case, it is necessary to allow and manage the change of behavior zone of a learner inside a group (*inter-group change*) for assuring an adapted knowledge level of learners inside a particular group (local view). For assuring an adapted virtual class (global view) also is necessary to allow and manage the change of group (*intra-group change*).

II.3.1 The Adapted Training Service of a Virtual Class Architecture

The adapted training service of a virtual class has as principal objectives:

a) managing of progression of a set of remote learners,
b) controller of the VCTS (Virtual Class Training Service) takes into account a pedagogical, structural and adaptable control of a virtual class.

An initial composition allows creating a set of heterogeneous groups, this initial composition is based on a learner evaluation. However, for preventing that the initial distribution becomes static and not adapted during a training session, we must consider a *logical mobility of learners*. This logical mobility must respond to learner's educational needs according to behaviors detected of a group of learners during a training session. So, two levels of distribution of learners have been considered: *variable groups* corresponding to level of class and inside a group of learners, that is a set of *behavior zones* have been established [figure 4] [Hernández 95c].

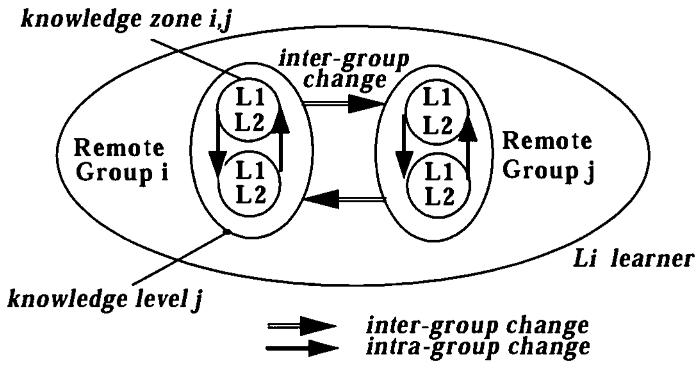


Figure 4: The distribution of learners in the virtual class.

II.3.2 Group Training Service (GTS)

A controller of a Group Training Service (GTS) must adapt a training session to learner's educational needs.
The actors considered in a virtual class are remote learners, teacher and shared didactic resources (didactic and domain entities).
Activating didactic interactions represents a local didactic strategy. The controller of a GTS manages these didactic interactions.
The controller of a GTS must establish a dialogue with the controller of the virtual class. This dialogue allows indicating either a learner may change of group or a learner has a problem or a learner send a request (when he wants to express a problem or point of view).
We established with educationalist team three behavior zones inside a group, these behavior zones represent three types of possible progressions: normal, intermediate and critical zones [Hernández 95c]. The control of behavior zones represents a *fine adaptation to knowledge level* and to learner's educational needs.
The architecture for each controller of a group training service (GTS) was specified in [Hernández 95d].

III Specification Object-Oriented of the Adaptable Virtual Class

The first step of the OMT (Object Modeling Technique) methodology [Rumbaugh 91et al.] is concerned with devising a precise, concise, understandable, and correct model of the real world.

III.1 Global view of the ACVA ("Arquitetura de uma Classe Virtual Adaptativa")

In the case of ACVA we represent each layer of architecture as a subsystem [figure 5]. In this way, the global view of ACVA is represented by an object model, which takes into account the three subsystems of the ACVA.

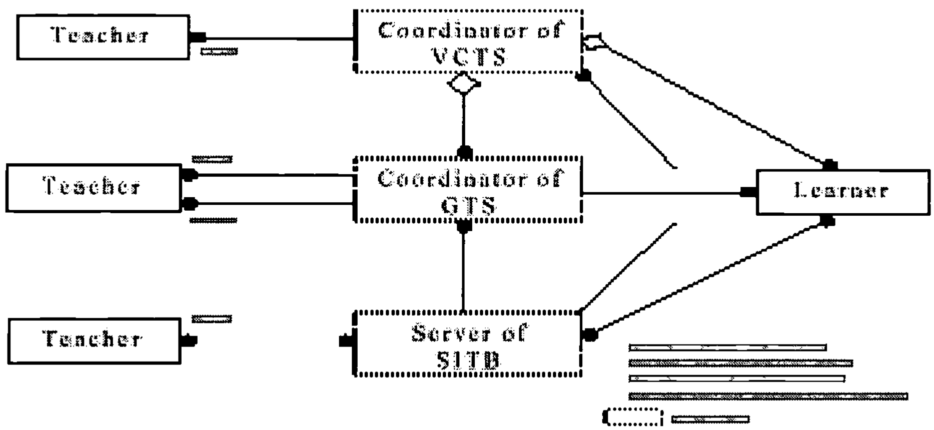


Figure 5: Subsystems of the ACVA.

III.2 Server of reusable SITB (Service Independent Training Building Block)

This server represents the layer of reusable SITB [figure 6]. The coordinator of SITB must control the interactions with GTS (Group Training Service) and VCTS (Virtual Class Training Service) coordinators, and the recovery interaction with a learner or teacher.

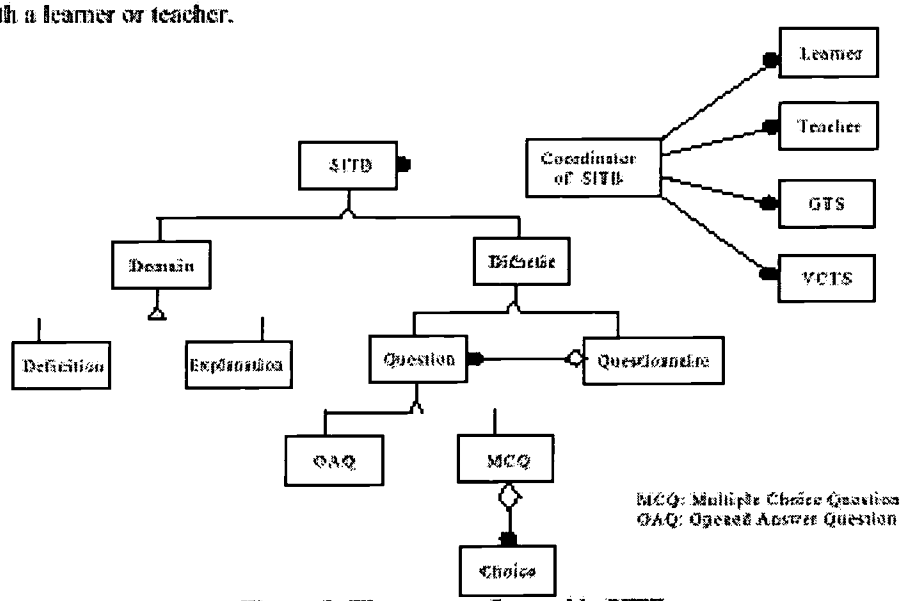


Figure 6: The server of reusable SITBs.

III.3 Group Training Service (GTS)

A Group Training Service belongs to cooperative service layer [figure 7]. The coordinator of Group Training Service has to manage: - the communication with the VCTS (Virtual Class Training Service), - the reusing interaction with the server of SITB and - the didactic control taking into account a didactic strategy. One coordinator of GTS allows considering the behavior of group by behavior zones (which were specified in [Hernandez 95d] and two kind of profiles: learner's profile and profile of group [Hernandez 95d]).

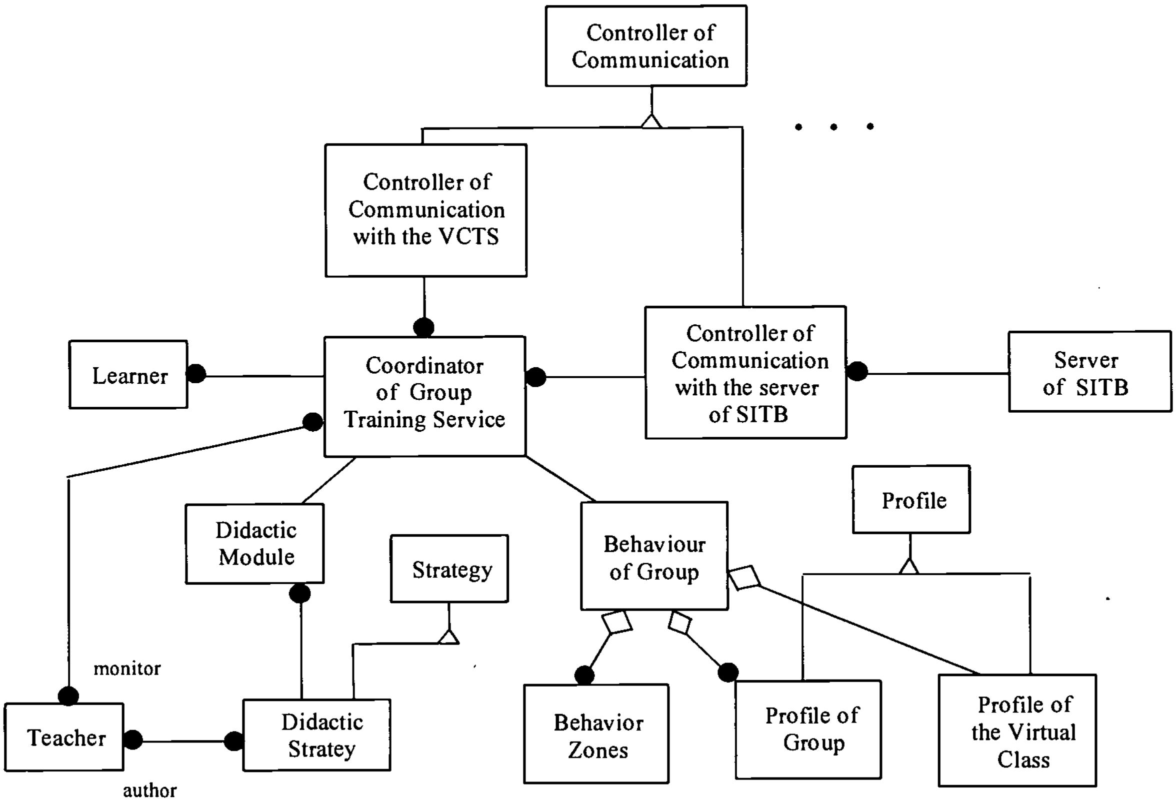


Figure 7: Group Training Service.

III.3 Virtual Class Training Service (VCTS)

The VCTS also belongs to cooperative service layer [figure 8]. The coordinator of VCTS has to manage: - the communication with each group, - the reusing interaction with the server of SITB and - the pedagogical control taking into account a pedagogical strategy. The coordinator of VCTS takes into account the behavior of each group and virtual class by two kind of profiles (profile of group and profile of virtual class).

IV Conclusion

The architecture of the virtual class proposed is a response to traditional virtual classes, which are not adapted. Works are in progress for implementing a server of reusable SITB in the object-oriented domain. This server will be implemented using of Internet and Java; the access to server will be analogous to a learning environment. The same server will be also used for reusing a set of reusable SITBs and adapting them in a virtual class by Internet. A tutoring system also is being developed (using Java) to reuse a set of reusable SITBs from the server.

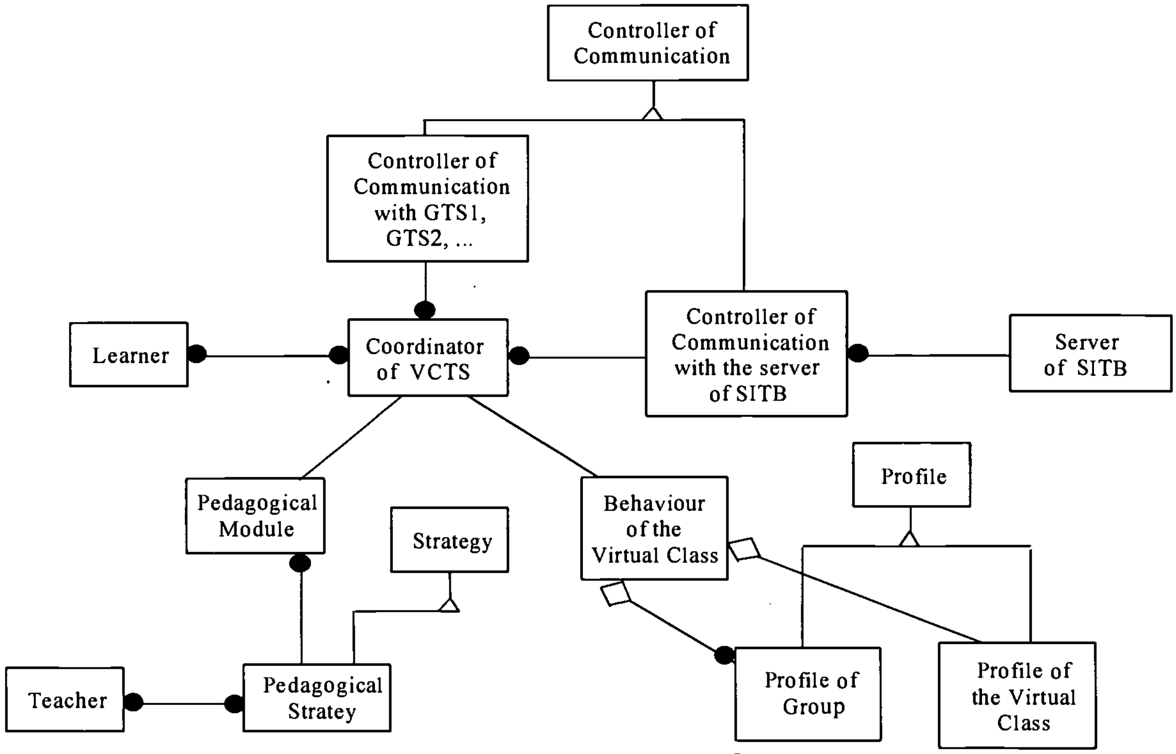


Figure 8: Virtual Class Training Service.

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Value, Cost and Evaluation - It is a Matter of Perspective: Justifying the Allocation of Resources to Develop a Specialised Interactive Multimedia Package in a University Setting

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Abstract: Since the development of interactive multimedia (IMM) and its application to course delivery in universities and schools much research has been conducted into the pedagogical validity of IMM, its development and evaluation. A small amount of research has attempted to quantify the costs and benefits of IMM as a curriculum tool for the purpose of accountability and the justification of resources used to develop the IMM software. Incomplete definitions of value and cost have resulted in this work being viewed with suspicion, resulting in a general unwillingness to incorporate such techniques in the evaluation process. This paper seeks to establish a framework to more correctly identify and quantify the expected value of a proposed IMM product and suggest how the utilisation of willingness to pay techniques may result in a more comprehensive and acceptable definition of value.

Introduction

The introduction of computer based education into the university environment for the purpose of instructional delivery has triggered much debate about the costs and benefits of technology in the learning process. The development and introduction of interactive multimedia products has added fuel to the debate about pedagogical performance verses educational efficiency. Literature on interactive multimedia evaluation has emerged in two distinct streams. The majority of discussion centres around the evaluation of interactive multimedia on pedagogical grounds, spending much time defining development methodology which results in the best educational outcome. A much smaller contingent of researchers have centred their attentions on the cost/benefit issue, with much of the attention given to quantifying cost and justifying interactive multimedia in a cost per student framework.

It is important to justify the allocation of resources in interactive multimedia on pedagogical grounds and important to quantify the costs of development, production and operation of the product but the *value* of the product also needs to be quantified to complete the information set for the purpose of accountability. Comparing cost and value has its foundation in economics where the allocation of scarce resources should be conducted in a manner that maximises the collective benefit of the community. In efficient markets willingness to pay directly relates to the value an individual places on a resource and forms the basis of resource allocation. There is much debate about multimedia products and how one should evaluate their pedagogical "correctness" but overarching all of this is a quantifiable cost limitation and the desire to achieve the best value for money. How do you quantify value? This paper seeks to introduce some ideas about quantifying the educational value of interactive multimedia and stimulate further discussion in the area.

This paper has four purposes. The first, is to establish the need to quantify the value of interactive multimedia courseware within a traditional economics of education framework. The second, is to explore the question of how to value interactive multimedia courseware. To answer this the beneficiaries need to be identified and their value criterion examined. The third purpose is to review the current literature on the cost and benefits of interactive multimedia and the arguments for and against the need to quantify benefits. Fourthly, introduce the concept of "willingness to pay" and the contingency valuation method as a means of quantifying the student's perceived value of an interactive multimedia package.

A Need for the Economic Justification of Interactive Multimedia Educational Software

Blauge [Blauge 1989], conducted a review of the then current literature in the economics of education and despaired that the topic was "dead in the minds of the professional economist and professional educator." Whilst these comments were made in relation to ongoing discussion about the economic justification of education itself, they do reflect a hole that has largely been ignored in interactive multimedia (IMM) literature, the economic justification for the allocation of resources into the development of IMM software.

Traditionally education can be justified in economic terms where the perceived benefits to the wider economy justify the cost. In this respect education is considered to be a community investment, where the long term benefits or returns on the investment must be greater than the up front costs in order to justify a public subsidy which directly only benefits the few. Cohn and Geske [Cohn and Geske 1990], described education in the United States as a gigantic industry. Pursuing this analogy, an educational institution can be described as a company in this industry that traditionally operates with the sole purpose of maximising benefits to its stakeholders. All investment undertaken must be justified in a cost/benefit framework. The cost/benefit framework has to be applied at all levels of the education hierarchy and in a university setting this equates to the allocation of resources between faculties, within faculties the allocation to courses and within courses the allocation to unit materials and mode of delivery.

Expenditure on IMM can be justified if you demonstrate its value. This is not an easy task and the next section attempts to classify the stakeholders which stand to gain value from the introduction of an IMM product into a university setting.

Defining value

The stakeholders in a university are the university itself (represented by the needs of its academic and administrative staff), the students and the wider community. Each benefits from the operation of a university in a different way and hence each stakeholder will have a different perspective of the value of the education delivered. The aim is to allocate the resources in a way that maximises the stakeholders' collective benefit. The cost of developing an IMM package for the delivery of curriculum can be justified if the benefits to the institution, students and community are greater than the costs and that the collective benefits are higher than those achievable if the resources were used in another way.

For a university, the benefits received from the introduction of IMM courseware are directly and indirectly observable. If the use of IMM simply replaces a component of the teaching process such as lectures, tutorials or workshops, freeing up facilities and lecturer time for other purposes, the impact of IMM is directly observable with the costs and benefits easily quantified. If the introduction of IMM enhances and improves delivery within the same facilities and the same use of lecturer time the task of quantifying value becomes more difficult. The source of value for a university may be that the educational program delivers a better quality of student, enhancing reputation in teaching excellence and attracting more students (and hence more dollars) into the university in the most cost effective way. In this respect it is hard to place a precise dollar value on a particular IMM package. As a result, developers rely on justifying effort and expenditure through the use of education evaluation techniques, demonstrating enhanced delivery and implying value to the university on those grounds.

For the student, investment in education involves the development of human capital to be more productive and to improve future earnings potential [Cohn and Geste 1990]. A student should only invest in education when the long-term benefits exceed the cost. It is reasonable to suggest that a student is mindful of the long-term benefits when evaluating and selecting a university or course of study but the focus of a student is more short-term when valuing a mode of study within a unit. In this respect the benefit is an operational one, recognising that whilst attending university the student's most scarce resource is time. To better manage time the student needs curriculum delivery that is more flexible and effective therefore improving the student's learning efficiency. The utilisation of IMM in education is built on this foundation and should be valued according to the ability to deliver greater choice of when to learn and how to learn in addition to the usual requirements of quality education.

If, through the introduction of IMM, a student becomes more employable, this has obvious benefits for the student and for the university but not necessarily for the community. For the community, value is added when, as a result of education a student's contribution to the community is greater and the collective community quality of life is enhanced. How the student goes on to better utilise scarce resources as a result of their educational experience is the community test of the value of that education.

It is the author's view that the university and the student stand to receive the greatest value from the introduction of IMM courseware, where the community's benefit is only residual. All future discussion of value will focus on the university and student benefit.

Cost/Benefit Analysis for the Educational Use of IMM - Discussion to Date

The research literature is quite rich in the area of assessing instructional design and the impact of computer based instruction on the delivery of education, and developing in the area of evaluation of multimedia and other software. The general thrust of the instructional design literature revolves around development, implementation and assessment. The evaluation focus is on the operational and pedagogical aspects of instructional delivery, incorporating formative evaluation during the design phase and summative evaluation upon implementation.

With the introduction of IMM into the education environment assessment of course specific IMM has parallelled the instructional design assessment path. Most of the evaluation has been conducted on pedagogical and operational grounds with recent papers on IMM design discussing in length how to conduct formative evaluation of multimedia (MM) software. Taylor Northup [Taylor Northup 1995] indicates the need to widen this view in the case of MM evaluation, suggesting it is time to shift the MM focus toward "the instructional product itself and the process used to produce it." Taylor Northup examined the use of rapid prototypes as a means of early feedback to indicate the likely success of MM design. How do you define success? This question is typically left out of the MM development process in the literature. In addition, the cost of developing MM, defined in dollars, is usually omitted from formative and summative discussion, which usually justifies the final product on the grounds of educational benefits alone.

Reeves [Reeves 1994], asks the question, "what really matters in computer based education (CBE)?" and goes on to describe fourteen pedagogical dimensions. Reeves explains that one of the reasons for the lack of systematic evaluation in CBE is "because the process has often been reduced to a numbers game" and that decision makers allocate resources based on data that is easy to collect, rather than seeking a true measure of what practitioners are trying to achieve. This highlights why there is resistance to any attempt to quantify the benefits of CBE and the need to develop valuation techniques that are acceptable to policy makers and developers.

Its needs to be recognised that there are much wider aspects of value that need to be captured here and in the case of IMM, given the discussion above on stakeholder definition of value, quantifying benefit is not easy and in the past has been largely ignored. At most, it can be claimed that quantifying the value of IMM in education has been conducted very poorly with very blunt instruments but to retreat to the pedagogical high ground ignores the basic need to reconcile cost and benefit in similar measures for the purpose of accountability. Whilst it is naive to believe that all costs and benefits can be quantified it is equally naive to try and dismiss the need for harder measures of performance (predicted or otherwise) in an environment of increased competition for scarce development funding.

In recent times papers discussing MM courseware development issues have added more dimension to the evaluation discussion. Blalock [Blalock 1995], makes the statement "everyone in interactive multimedia should be fluent in the language of return on investment (ROI)" and although the article primarily relates to MM training in an industrial organisation context, the lesson should not be ignored in academia. Blalock develops a ROI model, which elegantly captures the essence of investment decision making.

For a MM investment to be acceptable the ROI must match or better a minimum return criterion.

$$ROI(\%) = (Benefits - Costs)/Costs$$

A number of authors have examined the cost of producing IMM. Marshall [Marshall et al. 1995] proposed a framework for measuring IMM development effort and, expressing effort as a proportion of learner time, came up with a workable definition of IMM productivity. Tan and Ngyun [Tan & Ngyun 1993] examined lifecycle methodology in the costing of IMM for an Australian Institution. Lifecycle cost is the total lifetime cost of an IMM package and includes development and recurring costs. Cost efficiency is affected by the number of students using the package every year and the number of years the package is expected to be useable, resulting in a cost per student schedule similar to the one graphically represented below in figure 1.

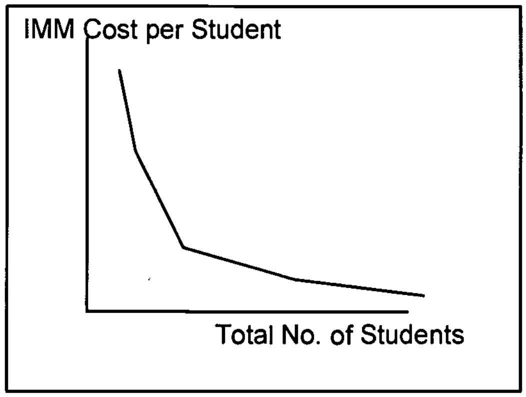

Figure 1: Cost per Student Diagram

The total number of students equals the number of students per annum multiplied by the number of years the IMM package is used.

Tan and Ngyun compared three types of IMM from low cost, low educational value to high cost high educational value and then all three types to the normal instructor led delivery. As part of the analysis, possible savings in the instructor's time were included. The conclusion was that high quality courseware can be justified if used by large populations of students.

Canale and Wills [Canale & Wills 1995], looked at the difference between anticipated costs and actual costs in the management of an IMM project. They discovered cost overruns in both project management and IMM development. As part of their conclusions the following important implication was stated.

"Projects are rarely considered to be outright failures. It is common for expectations to gradually diminish during the life of a project as difficulties compound over time. The gradual erosion of expectations means a resetting of goals to lower levels of acceptability. Quality is compromised because time and funding are fixed."

In order to measure the success of an IMM package, it may be prudent to compare actual verses anticipated value, as well as actual and anticipated cost.. Pre project, defining anticipated cost and value is necessary for three reasons. Firstly, to demonstrate that the project is likely to be a worthwhile exercise on its own merits. Secondly, to facilitate the project selection process where there are a number of possible projects and limited funds. Thirdly, as a self assessment tool for developer performance to see if the product meets their original expectations.

Blalock and Tan and Ngyun have attempted to capture the value or benefits of developing IMM software and whilst it is a step in the right direction, they both opted for obvious and easily quantifiable values such as reduced instructor time. As discussed above herein lies the fault of existing valuation methodologies which leaves them wide open to criticism from the pedagogical purists, the measure of value is too narrow and targeted at one stakeholder only, the university. The next section discusses how it may be possible to capture the IMM value from the student's perspective.

Using "Willingness to Pay" to Determine the Value that Students' Place on an IMM Package

Discussion above has established there is need to estimate the likely value of an IMM package prior to development and production in order to determine an appropriate amount of resources to allocate to the development of that product. The value of the IMM product is a function of the value gained by the University and the students. As suggested above, quantifying the value to the university is straightforward where the introduction of the product results in better utilisation of facilities and academics' time but there are potentially other residual benefits for the university which are harder to quantify. The stakeholder that stands to gain more value from the introduction of an IMM package into the learning process is the student. Whether the intention is to sell the final product to the student or to provide the product free of charge, we need to establish a willingness to pay to know what value the student puts on the product to insure we do not over invest in its production. How can we estimate the value of the product, where no formal market exists and therefore no market price information is available? The answer potentially lies in a technique called the Contingency Valuation Method (CVM).

What is the Contingency Valuation Method?

CVM is a technique used by economists to value resources with no observable price. The technique parallels methods used by marketing groups to establish the likely sale price of a product in the embryonic stage of its development cycle.

The principle behind CVM is to use survey methodology to determine the price individuals are likely to be willing to pay for a product contingent on a hypothetical market situation. This price information is used as a proxy for the value of the product or amenity and the range of responses used to sketch out a hypothetical demand function. If the hypothetical market described is plausible and closely resembles the conditions under which the product or amenity is to be introduced, the price given by the individual under hypothetical conditions will mirror their true actions if the market actually existed.

Wilks [Wilks 1990], states that the CVM was first applied in 1963 in the area of recreational planning and has principally been used to value a host of public goods and sensitive environmental amenities such as recreation, toxic waste dumps and goose hunting permits. To date the technique has been used primarily to value environmental goods but the question of willingness to pay and the determination of an appropriate measure of value, where true value is not readily observable, is an problem shared with the developers of IMM products albeit on a smaller scale and potentially can be addressed by the use of the CVM.

There is some evidence of research into willingness to pay for education generally. For example, Gertler and Glewwe [Gertler & Glewwe 1989] modelled a demand curve for user-pays education in Peru to determine how people would respond to such fees and whether or not the general population believed there would be value in developing educational facilities and programs.

CVM – The Process and Possible Application to Assess the Perceived Value of IMM courseware

Wilks [Wilks 1990], reviews the CVM and describes a general procedure that uses a survey instrument administered face to face, over the phone or by mail, to establish the price at which an individual will no longer be willing to purchase the good or amenity, determining maximum willingness to pay. As suggested above the nature and presentation of the survey instrument has to be carefully controlled in order to elicit meaningful responses. The survey instrument can take many forms but generally consists of three components.

A comprehensive description of the good or amenity is provided in order to establish a plausible and relevant scenario from which the respondent can form an idea of value. One concern commonly raised is the inability of the respondent to comprehend all the issues presented and therefore make an informed and appropriate decision. This may be a problem when asking about complex and sometimes abstract environmental issues but if the sample group to be questioned are existing and past students of the unit who have experience of the current format and delivery, their ability to comprehend the likely benefit of introducing a tangible IMM product will be quite strong. The use of students can also minimise the concern that a hypothetical scenario will result in a hypothetical response because the context in which the product is to be used is quite real to them.

Once the contingent market is established, questions are asked, designed to determine the individual's maximum willingness to pay. The form the questions take vary but common techniques include simulating an auction and bidding the price up or down until the individual decides to buy, an alternative approach the placing of prices onto a card and then asking the individual to select one. Another method involves presenting one price only and asking for a yes/no response, the responses are then aggregated to determine a response profile at each price.

Questions are then asked to establish the profile of the respondent and used in later analysis to gain some insight into reasons why particular responses occur. In addition to the usual age, sex and income questions it may be useful to ask questions that expose how the student utilises their non study time, such as work, sport and social activity in order to establish the potential opportunity cost of allocating time to study.

CVM as an IMM Project Development Management Tool

CVM has the potential to be used as an integral part of the product development process. The survey will be cheap to administer with a high response rate if you use existing students to generate the data set and capture your sample by conducting the survey in class.

The success of the procedure depends on the quality of the market scenario created by the developer. Creating the product description forces the developer to carefully consider the purpose, context and goals to be achieved by introducing the IMM package and then presenting this in a clear and understandable way. The process of defining the product may help in achieving a compromise between pedagogical prowess and practical outcomes, highlighting the difference between the developer's value set and that of the student.

The result of the contingency valuation survey can be integrated into project funding submissions, providing a monetary value argument and directly justifying anticipated costs. Once the contingent value of the IMM project to the student has been established it can be combined with the anticipated benefits to the university and a total value estimate calculated. If the project cost is less than the anticipated value, the project it is viable.

Once funding is approved and the project moves into the development stage, the product description can be continually revisited through the development process to ensure the promised product quality is not compromised. This directly relates to the concerns of Canale and Wills [Canale & Wills 1995] quoted earlier. Post production and implementation, a similar survey can be conducted as part of the evaluation process.

Conclusion

Quantifying the value of interactive multimedia courseware needs to be given more attention by researchers and developers. This area has only attracted small interest in the past and has been treated with a degree of suspicion by product developers and educationalists because of blunt measurement devices that do not capture the true value attributed to an IMM product. It is not enough to justify an IMM product on pedagogical grounds, there is a need to explore ways of better capturing total value so that developers and educationalists can use this information to add an extra dimension to the justification of proposed projects.

This paper has attempted to set the framework for examining the issue of quantifying value. Three stakeholders are identified, two of which, the university and the student, directly stand to gain value from the implementation of an IMM product into coursework delivery. To date quantifying value to the university has been attempted by estimating the potential cost savings achievable if an IMM product is incorporated into the curriculum. To date, quantifying value to the student has been ignored and until a method is introduced that can adequately estimate the likely benefit to the student of an IMM product, any attempt to quantify the true value of a package is likely to result in an underestimation.

Willingness to pay is presented as a possible solution, incorporating the use of the contingent valuation technique. CVM has the potential to capture the expected value an IMM product will deliver to the student and greatly improve the total estimation of value. This value can be used to justify funding application and satisfy the developer of the market worth of the IMM package.

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Encouraging Lifelong Learning with Learner-constructed Web-based Performance Support Systems

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Abstract: Influenced by generative and intentional learning environment strategies and tools, a Web-based tool has been developed to empower learners to build their own Web-based Performance Support Systems (WPSS) to support their learning, professional development, and performance within a domain. Enabling learners to develop their own WPSS accomplishes two goals: (1) people learn about the domain while they are locating, evaluating, and organizing resources to support their work activities and/or their intentional learning activities; and (2) once the WPSS is completed it can be used to support performance and further professional development while working in that domain. In this way, the WPSS not only enables learners to build a learning and performance resource that will provide them with immediate support and guidance, but also helps them develop structure, strategies, and skills for subsequent lifelong learning activities.

In a climate of rapid change, increasing innovation, emerging technologies, and proliferating knowledge, lifelong learning is a necessary professional development objective. In order to keep current, people have to be willing and able to continually "retool" their knowledge and skill base. The need to be a continuous learner is especially apparent in domains influenced by scientific and technological advances; these advances cause knowledge and skills to become obsolete overnight. Yet, employers need personnel who possess contemporary skills and knowledge, and are willing and able to proactively update their abilities to meet the ever-changing needs of the organization. Employees who are able to keep up with the information explosion are valuable assets; employees who fail to "grow with the flow" are restructured out of their positions. Therefore, lifelong learning is essential to staying current, competitive, productive, and innovative in today's workplace, and therefore employed and in-demand.

Following the prescriptions of the intentional learning methodology which promotes the development of metacognitive and self-directed learning skills, a web-based development tool was created. This tool was designed to help people generate their own, individualized web-based performance support systems (WPSS) to address the concerns described above by encouraging and providing a supportive structure for lifelong learning activities.

Lifelong Learning Defined

The knowledge explosion requires professionals to engage in lifelong learning if they intend to stay current — let alone evolve, advance, and remain competitive — in their profession. Therefore, lifelong-learning skill development is imperative if people are expected to learn over the full expanse of their professional lives. Unfortunately, some of the people that most need lifelong learning skills — those with careers in ill-structured, complex professions — are not developing them during their formal education. Regarding the lack of lifelong-learning skill development in schools, Walton and Matthews [Walton & Matthews 1989] state, "Some [professionals] from...schools with the usual type of curriculum behave as if they had been immunized against further learning, and many [professionals] often do not continue to learn sufficiently." In order to better prepare people for lifelong learning, learners must be exposed to learning activities that require them to take on and develop many of the responsibilities normally afforded to educators. "We teach most effectively when we help our students learn how to learn...not what to think and make and do in [the current year]; but how to think and how to learn for those years of life and profession than lie ahead"

[Nash 1994]. To achieve this requires moving away from a view of learning that is controlled outside the individual — by a teacher, trainer, instructional designer, or subject matter expert — to a view of learning that is internally controlled by the individual [Overly et al. 1980]. The ability to engage in lifelong learning, therefore, is based on the development, and subsequent successful application, of two skill areas: metacognition and self-directedness.

Metacognition

Von Wright [Von Wright 1992] defines metacognitive skills as "the steps that people take to regulate and modify the progress of their cognitive activity: to learn such skills is to acquire procedures which regulate cognitive processes." Glaser [Glaser 1984] describes metacognitive or self-regulatory skills as knowing what one knows and does not know, predicting outcomes, planning ahead, efficiently apportioning time and cognitive resources, and monitoring one's efforts to solve a problem or learn. Metacognitive skills include taking conscious control of learning, planning and selecting strategies, monitoring the progress of learning, correcting errors, analyzing the effectiveness of learning strategies, and changing learning behaviors and strategies when necessary [Ridley, Schutz, Glanz, & Weinstein 1992]. Because metacognition involves these self-regulatory skills, it can have a positive impact on problem solving ability and the transfer of knowledge across domains and tasks if developed during instruction [Bereiter & Scardamalia 1985] [Bransford et al. 1986]. In fact, if not developed, students have difficulty recognizing when they have failed to adequately meet learning goals or complete tasks [Bransford et al. 1986]. Since these are skills utilized by successful practitioners and experts [Chi, Feltovich, & Glaser 1981] [Bransford et al. 1986], adequately developed metacognitive ability is needed in order to engage in effective problem solving and reasoning activities.

Self-directedness

> To be successful, students must develop the self directed learning skills needed [within the domain]. They must be able to develop strategies for identifying learning issues and locating, evaluating, and learning from resources relevant to that issue. [Savery & Duffy 1995]

The domain of medicine provides a perfect example of self-directedness. When dealing with real patients, the doctor has to begin assessing the patient's condition before having all of the data necessary to evaluate, diagnose, and treat the patient. Characteristically, the patient provides the doctor with fragments of information ("My stomach hurts. I can't hold any food down. No one else in my family is experiencing any problems."). The rest of the information needed to solve the patient's problem comes from the study of a variety of other resources: patient and family history, laboratory results, x-rays, other doctors' opinions, past experiences, similar cases in the case file, and current research findings on new diagnostic and treatment procedures. The doctor has to determine what information is needed, what resource should be used to acquire the information needed, how to use the resource effectively, how to come to terms with opposing or contradictory information, and how to apply the information acquired to the problem to achieve a solution for the patient. These skills are described as "self-directed learning skills" [Barrows 1985] [Barrows 1986]. Barrows [Barrows 1995] defines the process of self-directed learning as utilizing the following skills to solve a problem or fulfill a learning requirement:

- the ability to identify and define a problem/learning need;
- the ability to identify, find, use, and critique resources for solving the problem or meeting the learning requirement;
- the ability to capture and apply information from resources to the problem or learning need; and
- the ability to critique information, skills, and processes used to solve the problem or meet the learning requirement.

Staying abreast of new innovations, research, techniques, and information is a prerequisite for successful decision-making and problem-solving on-the-job. Therefore, professionals need to develop lifelong learning skills, specifically metacognitive and self-directed learning skills, if they intend to stay current in their fields.

Organizations and Professional Development

Although employees' ability to engage in lifelong learning has a direct impact on an organization's effectiveness in today's ever-changing marketplace, the development of the skills needed to engage in perpetual learning activities has been neglected by many employers. Unfortunately, many organization's rely on short-term solutions, such as conventional training and performance support tools.

The Conventional Training Solution

How are professional development activities typically addressed? We often see trainers imparting knowledge and procedures to trainees using canned, inflexible instructional materials which often do not reflect the true complexity or the current reality of an ever-changing work environment. [Unfortunately, this is the case whether we are describing an instructor-led environment, computer-based training (CBT), or Web-based training (WBT) (which is often just CBT repurposed for the Web).] After the training activity is over, employees struggle with applying what they learned from their training experience to the demands of their jobs. Not only did the conventional training solution not accurately represent the on-the-job performance requirements, but it did not prepare the employees to:

- transfer the knowledge and skills to their specific job requirements,
- extend the knowledge and skills presented during training to address increasingly complex job requirements, or
- update the knowledge and skills presented during training when their job requirements change or the knowledge and skills change.

In other words, what is missing from the equation is the development of domain-specific lifelong learning skills so those employees can actively transfer, extend, and update the knowledge and skills acquired during training. So, employers have looked for other professional development solutions that address this problem. One solution that has presented itself is electronic performance support systems (EPSS).

The Electronic Performance Support Systems Solution

Although redefined and revised over the last few years, the term electronic performance support system refers to an integrated database of information, tools, learning experiences, resources, and guidance/advise designed to help people learn how to perform a task just-in-time or on-demand with limited conventional training support [Gery 1991] [Raybould 1995]. Addressing the failings of conventional training, electronic performance support systems have been utilized as alternatives and supplements for conventional training solutions.

However, the problem with conventional training is also, in part, the problem with EPSS. EPSS products are typically developed by instructional designers or performance technologists working with content experts. All of the tools, references, job aids, and tutorials are created to meet the general and generic needs of all the individuals who will access the EPSS; assuming that everyone who needs to access the EPSS has the same performance issues, learning needs, and learning preferences, EPSS limits individualization. In addition, like with conventional training solutions, all of the higher-order thinking, problem-solving, and decision-making that goes into creating the "content" of an EPSS — all of the activity that helps people develop domain-specific lifelong learning skills — is done by the development team. So, again, the issues of transfer, extension, and updating are not effectively addressed by EPSS.

Instructional Methodologies for Developing Lifelong Learning Skills

In order to develop lifelong learning skills, the learners — as opposed to the instructor or development team — need to be directing and driving the learning process and activities based on their learning and performance needs. Two instructional methodologies that specifically address the development of lifelong learning skills are generative learning and intentional learning.

Generative Learning Environments

Instead of the accessing information from the system that was input by someone besides themselves (such as a teacher, subject matter expert, or instructional designer), a generative learning environment requires students — individually and collaboratively — to be responsible for creating, elaborating, and representing domain knowledge in an organized manner [Cognition and Technology Group at Vanderbilt 1992] [Hannafin 1992] Scardamalia et al. 1989] [Scardamalia & Bereiter 1991]. Some generative learning environments provide students with a context or situation requiring them to take action (e.g., a problem that needs to be solved or a case that needs to be analyzed). Other types of generative environments require students to determine what it is about a particular content area they wish to know, and then take responsibility for answering their own questions through research and synthesis and representing the acquired knowledge in an organized and accessible way. It is through this process of "generating" knowledge, instead of passively receiving information, that help learners develop structure, strategies, and habit for lifelong learning.

Generative learning environments require students to take responsibility for determining what it is about a particular domain they need to know, and then direct their activities accordingly to effectively research, synthesize, and present their findings. Schank and Jona [Shank & Jona 1991] describe a generative learning environment in their discussion on the research method of teaching. Under the research method of teaching, students are asked to research a particular topic and then present their results to others (the class, a collaborative group, etc.). In this way, students are taking over the responsibility of information gathering and synthesis and dissemination/presentation from the teacher.

For this teaching method to lead to successful learning, students need to be allowed to select their own topics to research and report on, so that they have a real interest in proceeding with the assignment and have more control over their learning. Because the learning is student-directed, where each student makes choices and takes responsibility for those choices, the learning is more meaningful; "...in general, material that is organized in terms of a person's own interests and cognitive structures is material that has the best chance of being accessible in memory." [Bruner 1961]. In addition, because students are responsible for selecting a topic, developing a question to research, making decisions about how to gather information, analyzing and synthesizing information, etc., they are engaging in activities that help to develop high-level thinking and problem solving abilities.

Intentional Learning Environments

Intentional learning refers to the "cognitive processes that have learning as a goal rather than an incidental outcome" [Bereiter & Scardamalia 1989]. When employed in a learning environment, intentional learning encourages students to take "an intentional stance toward cognition" [Scardamalia & Bereiter 1991], which means that learners must learn how to monitor and be aware of their own learning processes, and take responsibility for pursuing desired and/or required learning outcomes. Intentional learning is learning that is actively pursued by and controlled by the learner [Resnick 1989]. Palincsar and Klenk [Palincsar & Klenk 1992] describe intentional learning as an achievement resulting from the learner's purposeful, effortful, self-regulated, and active engagement. By encouraging students to take "an intentional stance toward cognition", intentional learning helps students learn how to not only monitor and be aware of their own thinking and learning processes (i.e., metacognitive skills), but also to take responsibility for pursuing individually-determined learning goals (i.e., self-directed learning) — the "cognitive processes that have learning as a goal rather than an incidental outcome" [Bereiter & Scardamalia 1989].

An example of a computer-mediated, intentional learning environment is the Computer-Supported Intentional learning Environment (CSILE). The goal of CSILE is to support students in the purposeful, intentional processing of information [Scardamalia et al. 1989] [Scardamalia & Bereiter 1991]. Using CSILE, students are supported in the construction of a shared knowledge base, representing and organized the domain in ways that can be understood and utilized by others interested in the domain. In other words, instead of accessing information from a pre-existing database that was structured, organized, and filled in by someone else, students engaged in CSILE create their own knowledge base based on what they want to learn and on how they want to structure and organize the information to be an effective resource for other learners.

Generative and intentional learning environments encourage students to construct their own meaning, perception, understanding, and knowledge. Through the process of creating, elaborating, and representing their own knowledge, these learning environments utilize instructional strategies such as collaboration, knowledge construction, reflection, and self-directedness to promote the development of lifelong learning skills and strategies, as well as a predisposition to lifelong learning activities.

Learner-center, Web-based Performance Support Systems

Influenced by generative and intentional learning methodologies as well as the EPSS technology, I have developed a Web-based tool empowers learners to build their own Web-based Performance Support Systems (WPSS) to support their learning, professional development, and performance within specific domains. Similar to electronic performance support systems (EPSS), a WPSS uses the Web to provide on-demand access to integrated information, guidance, advice, assistance, training, and tools to enable high-level job performance. In fact, using the Web to create performance support systems is a perfect fit because the Web is actively used by professionals as a forum for the distribution of current and up-to-date references, instruction, and guidance. By creating a structure that supports individualized and collaborative knowledge building by the people who will actually be using the knowledge, the higher-order thinking, problem-solving, and decision-making regarding the selection and utilization of appropriate learning materials and performance support is done by those who can get the most out of the process. Enabling employees to utilize an easy-to-use tool to develop their own WPSS accomplishes two goals:

1. they learn about the domain while they are locating, evaluating (which requires utilization of resources), and organizing resources to support their job performance activities and/or their generative and intentional learning activities; and
2. once the WPSS is completed it can be used to support performance and further professional development while working in that domain.

In this way, the WPSS not only enables learners to build a learning and performance resource that will provide them with immediate support and guidance, but also helps them develop structure, strategies, and skills for subsequent lifelong learning activities.

Overview of WPSS Development Tool Components

The WPSS development tool helps employees — collaboratively and as individuals — organize, assess, and utilize Web-based resources. In order to build an effective WPSS, the development tool enables employees to organize Web resources into a variety of self-determined categories. Categories may include:

- cue cards: brief definitions, reminders, directives, job aids, best practices
- computer-based instruction: tutorials, case studies, practice activities
- wizards: intelligent demonstration/application functions; assistance
- coaches: response sensitive correction and feedback
- mentors: individualized responses to questions from experts in the field
- practitioner forum: access to other practitioners in the field
- examples
- tools

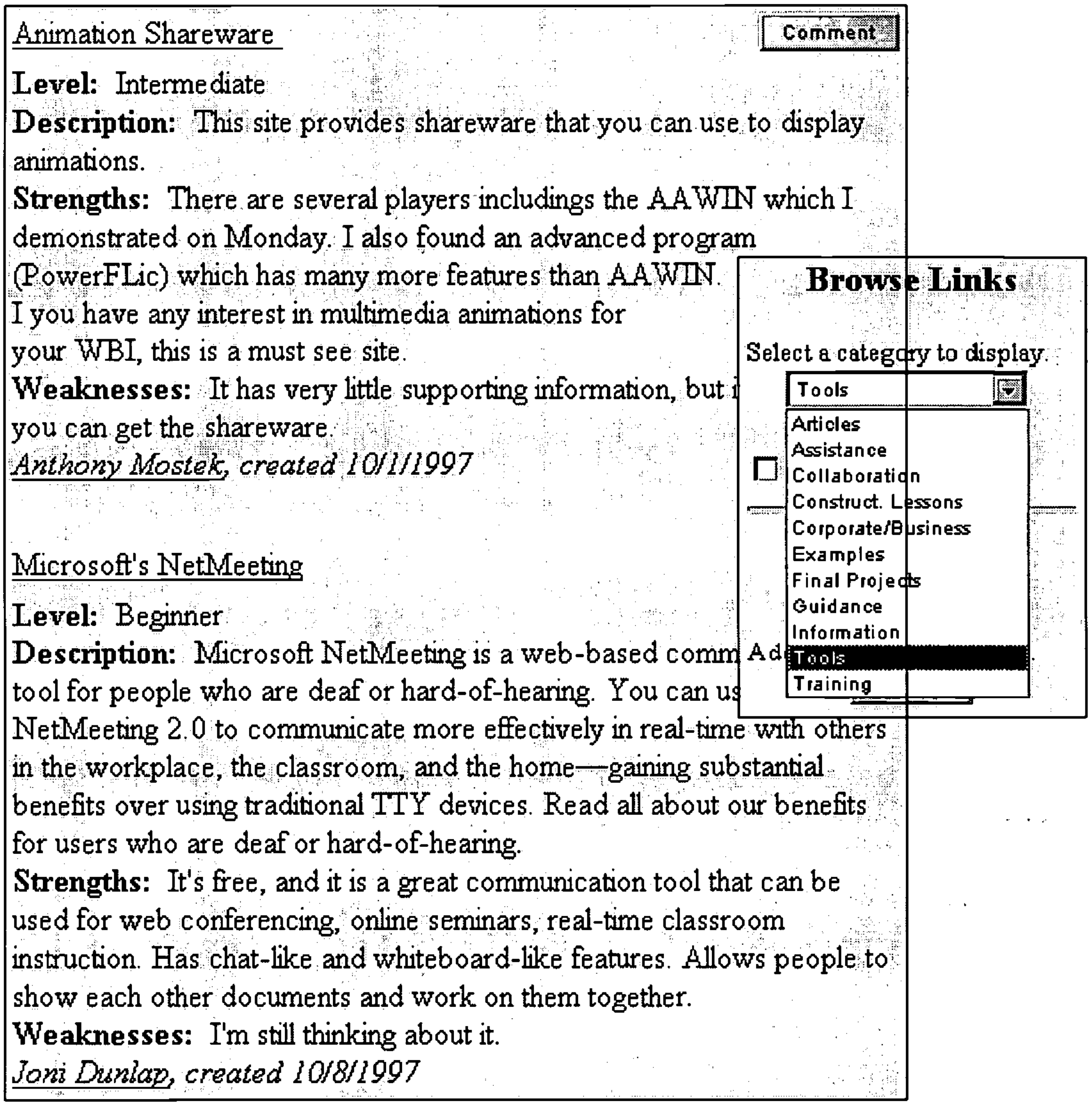

Figure 1: Sample categories and corresponding entries

In order to build a WPSS that meet individualize, specific learning and job performance needs, employees engage in a number of generative and intentional learning activities including:

- determining their learning needs and goals
- developing a plan for action for finding resources to help fulfill those goals
- researching Web resources that meet the appropriate needs
- utilizing Web resources in order to evaluate usefulness, difficulty level, strengths and weaknesses
- updating links to Web resources when appropriate
- responding to other learners' comments regarding WPSS contributions
- developing Web resources via HTML pages and threaded discussion forums

In other words, employees practice and develop the very skills and strategies needed to engage in lifelong learning activities while they are learning domain-specific content and skills needed for their jobs.

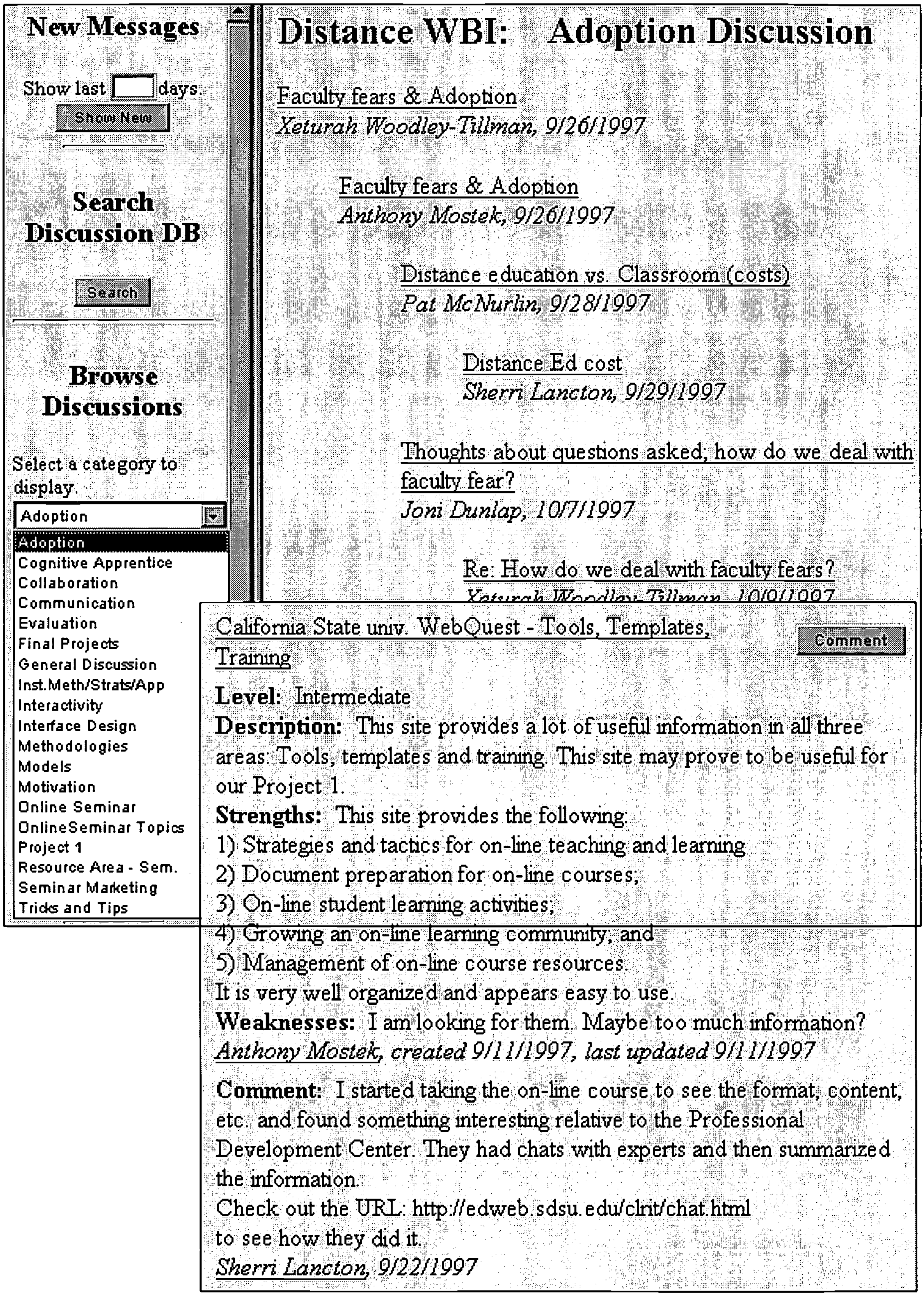

Figure 2: Example of a threaded discussion and commenting on others' contributions

Examples of the WPSS in Use

Although still in a formative stage with enhancements being added all the time, there are a number of examples of the WPSS tool in action. These WPSS examples can be viewed for examination purposes only via the following URLs:

- Domain: Designing Distance Learning for the WWW
  http://www.cudenver.edu/~jdunlap/wpss.cgi/5990
- Domain: Multimedia Authoring with HTML
  http://www.cudenver.edu/~jdunlap/wpss.cgi/5600
- Domain: C++ Programming
  http://www.cudenver.edu/~jdunlap/wpss.cgi/cplpl

To experiment with the tool, access to a sample site is provided at: http://www.cudenver.edu/~jdunlap/wpss.html

[Note: In order for the WPSS to function properly, your browser must accept cookies and have JavaScript enabled.]

Conclusion

Because lifelong learning is now such a critical success factor for professionals in business and industry, learning environments that help promote the development of lifelong learning skills and strategies are in high demand. Influenced by generative and intentional learning environments, a Web-based development tool was designed to enable employees to develop their own Web-based performance support systems. The activity of building a WPSS helps employees learn about a domain, construct a knowledge base to support their future performance and professional development in that domain, and develop the skills, strategies , and structure needed to engage in the type of lifelong learning activities that will help them stay current in their professions.

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A Study of Adaptive Link Annotation in Educational Hypermedia

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Abstract: Adaptive link annotation is a new direction of research within the field of user-model based interfaces. It is a specific technique in Adaptive Navigation Support [ANS] which aims to help users find an appropriate path in a learning and information space by adapting link presentation to the goals, knowledge, and other characteristics of an individual user. More specifically, ANS has been implemented on the WWW in the InterBook system [Brusilovsky, Schwarz & Weber, 1996] as link annotation offering four states: Ready to be learned, visited, not ready to be learned, and unknown. In this paper, we present preliminary results from an investigation to determine the effectiveness of user-model based link annotation on learning outcomes for a group of twenty-five second year education students, in their study of databases and spreadsheets, using sections of a textbook on Clarisworks, which had been authored into the InterBook program. Through the use of audit trails, questionnaires and test results, we show that while this particular form of ANS implemented in InterBook initially had a measurable negative effect on student's learning, it appears to have been beneficial to the learning of those students who tended to accept the navigation advice, particularly initially when they were unfamiliar with a complex interface. Discussion and suggestions for further research are provided.

Introduction

Adaptive annotation of links is a new and promising technique for adaptive navigation support in educational hypermedia. This technique was suggested in Brusilovsky, Pesin, & Zyryanov [1993], and in de La Passardiere & Dufresne [1992]. The idea of *adaptive annotation* technology is to augment the links with some form of comments which can tell the user more about the current state of the nodes behind the annotated links. These annotations can be provided in textual form [Zhao, O'Shea & Fung 1993] or in the form of visual cues using, for example, different icons [Brusilovsky, Schwarz & Weber 1996; de La Passardiere & Dufresne 1992], colours [Brusilovsky & Pesin 1994; Brusilovsky & Zyranov 1993], font sizes [Hohl, Böcker, & Gunzenhäuser 1996] or font types [Brusilovsky, Schwarz, & Weber 1996]. Link annotation is known as an effective way of navigation support in hypermedia [Zhao, O'Shea & Fung 1993]. Annotation seems to be a very relevant way of adaptive navigation support in educational hypermedia. Annotation can be naturally used with all possible forms of links. This technique supports stable order of links and avoids problems with incorrect mental maps.

Adaptive Navigation Support in InterBook

InterBook is a system for authoring and delivering adaptive electronic textbooks on WWW. All InterBook-served electronic textbooks have a generated table of content, a glossary, and a search interface. Each electronic textbook is based on knowledge about the subject domain represented in a form a network of concepts.Each node of the domain network is represented by a glossary entry. Likewise each glossary entry corresponds to one of the domain concepts. All sections of an electronic textbook are indexed with domain model concepts. For each section, a list of related concepts called the spectrum of the section is provided. The spectrum of the section can represent also the role of a concept in the section (each concept can be either an outcome concept or a background concept). The knowledge about the domain and about the textbook content is used by InterBook to serve a well-structured hyperspace. In particular, InterBook generates links between the glossary and the textbook. Links are provided from each textbook section to corresponding glossary entries for each involved background or outcome concept. Similarly from each glossary entry describing a concept InterBook provides links to all textbook units that can be used to learn this concept. It means that an InterBook glossary integrates features of an index and a glossary. These links are not stored in an external format but generated on the fly by a special module that takes into account the student's current state of knowledge represented by the user model. InterBook uses coloured bullets and different fonts to provide adaptive navigation support. Wherever a link appears on InterBook pages: in the table of content, in the glossary or on a regular page, its font and colour of its bullet will inform the user about the status of the node behind the link. Currently four colours and three fonts are used. Green bullet and bold font means 'ready and recommended', ie., the node is ready-to-be-learned but still not learned and contains some new material. A red bullet and an italic font warns about a not-ready-to-be-learned node, while white means 'clear, nothing new', ie., all concepts presented on a node are known to the user. Violet is used to mark nodes which have not been annotated by an author. A check mark is added for already visited nodes.

The literature on the evaluation of adaptive link annotation in educational hypermedia is limited and sometimes characterised by anecdotal evidence from a variety of less formal experimental designs. Further, the evaluation of adaptive hypermedia systems has generally has been noted by writers in the field as a much under-investigated area. Existing studies have tended to focus on the use of audit trails to provide information about the effectiveness of link annotation in terms of improving browsing or learning efficiency. A survey of the literature on adaptive navigation support in educational hypermedia reveals just a few empirical studies, or at least papers with a non-trivial evaluation component, that serve to set the context for the study reported in this paper. de La Passardiere & Dufresne [1992] conducted experiments with MANUEL EXCEL focussing on the value of history-based mechanisms such as a three-stage footprint [unseen, partially seen and completed] and the use of adaptive advice. Their work pointed to the value of an adaptive history-based mechanism as a means of navigation support. Brusilovsky & Pesin [1995] conducted one of the earlier studies with the adaptive link annotation and hiding mechanisms of ISIS-Tutor. This was an important piece of work which reported some positive results with ISIS-Tutor which used colours and symbols to adaptively mark the links on a page to related pages. This environment used annotations of "not ready to be learned", "ready to be learned", and "in work". As another extended "with and without" experiment conducted at The University of Moscow, it was found that "...the overall number of navigation steps, the number of repetitions from concept to concept and from index to concept are seriously less for [adaptive hypermedia]" [Brusilovsky & Pesin, 1995, p. 222]. In a recent study using ELM-ART-II, Weber & Specht [1997] compared the mean number of pages and tests that visitors to the ELM-ART-II Web site made [those who made a non-trivial visit], both with and without adaptive link annotation and adaptive curriculum sequencing. It was found that there was a statistically significant effect of adaptive curriculum sequencing at $p<0.05$ but no significant difference in link annotation. Here, it is the ability of these adaptive interface tools to motivate the users to proceed that is being evaluated. Further, Weber & Specht [1997] report that adaptive link annotation had no significant effect on the number of navigation steps. Weber & Brusilovsky [submitted] used the ELM-ART system to test the effect of both adaptive curriculum sequencing, as mentioned, and link annotation. No significant effect on the number of navigation steps was found through the use of adaptive link annotation. There was some evidence that the adaptive component was useful for beginners, but the small effect faded as the users became more familiar with the system.

Empirical Study

In a study involving 25 undergraduate teacher education students in an educational computing elective at the University of Technology, Sydney, students were exposed to two chapters of a textbook [Rubin, 1996] about *ClarisWorks* databases and spreadsheets, and used the InterBook system both *with* and *without* adaptive link annotation. The goal of this experiment was to assess what impact, if any, user-model based link annotation would have on students' learning and on their paths through the learning space, in this realistic situation. The experiment was aimed to investigate both the effect of link annotation on learning and the effect of link annotation on user paths. The hypothesis was that adaptive link annotation would provide students with a more efficient path through the knowledge space with improved learning outcomes. Tests of knowledge were carried out, audit trails and questionnaires were gathered and the results analysed. The experiment took place over a four-week period. In the first two-hour session, students were introduced to InterBook and its features explained to them. They used the system for an hour, and answered a questionnaire about its features. This questionnaire showed that almost all students were familiar with what each of the buttons and annotations meant. They were then free to use the system at any time during the following week. In the second session, students were randomly divided into two groups of equal size, one group receiving the link annotation, while the other group did not. They were allowed access to the chapter of the textbook on databases which had been authored into InterBook and they completed a questionnaire. Students had access to the database chapter for the following week. In the third session, students took a multiple choice test on the database section of the textbook. They were then allowed access to the spreadsheet section of the textbook in InterBook which they could access for the following week. This time, the group that did have the adaptive link annotation for the database section now did not receive it, and vice-versa for the other group. In the final session, students took a multiple choice test on the spreadsheet section and completed a questionnaire. The audit trails from the sessions were extracted, and analysed along with the test results and the questionnaire responses.

Results

Questionnaires were used to assess the functionality of each of the key interface features of InterBook, the results showing that all the features were working as expected, quite uniformly across the group. The students' test scores were then used as a measure of their learning of the material in each of the sessions. Adequate reliability and performance of all test items were established by discarding some of the test questions or individual distracters. In this way, each of the test questions was constructed to be an adequate predictor of how a student would score in the overall test, as is desirable in a norm-referenced test. At the conclusion of the experiment, alphas of 0.75 and 0.82 were obtained for the database and spreadsheet tests respectively, and these very acceptable values were interpreted as establishing adequate reliability for the tests to be used in this and any subsequent experiment. A two-sample t-Test was performed on the test results, and a t value of -0.3667 showed that link annotation had a statistically significant *negative* effect at the $p<0.05$ level on the database section [the first session], and no effect on the spreadsheet session [the second session]. This unexpected initial result suggested that further investigation was required.

To exclude students who learned less from the system than from other sources in the study, two subgroups were introduced, the first based on spending a 'reasonable time' with the system. This consisted of those students who spent a reasonable time using InterBook over both sessions, as it became clear from the audit trails that a number of students relied heavily on either their previous knowledge of the content, or on the printed version of the *ClarisWorks* book. For both the database and spreadsheet sections, two-sample t-Tests showed that there was no significant difference at the $p<0.05$ level in the test means for those with ANS and those without ANS. Separate audit trails for each of the two time periods were generated, to examine how users navigated through InterBook with and without ANS. For each user these trails showed the number of times they selected a link with a green ball and also a red ball, as well as their use of all the other features of the interface. The non-annotated 'continue' button was used more than all other interface features put together. This button takes the user to the next node in the courseware as sequenced by the author. Certain unexpected behaviour was immediately apparent for a small group of students, who were purposefully and continually selecting nodes which were not recommended. More generally, it was noted that just because link annotation was evident in the interface for one group, individual students within that group were accepting it to vary extents. Just because a student was offered link annotation does not mean that they were accepting or making profitable use of it. A measure of the student's acceptance of navigational advice was calculated from the audit trails, taken as the number of green ball hits minus the number of red ball hits divided by the total hits.

A clear correlation of 0.670 was found between the agreement rate and score in the database tests: The more students agree with system's suggestion, the better is the score [for the group receiving link annotation]. This positive correlation in the first session on databases suggests that while link annotation may be a distracting complication to an interface, it is helpful to those that choose to follow it in terms of improving their knowledge of the content. We also examined the paths of each group through the hypermedia, and found that those with link annotation had more exploratory, less linear paths, although this difference was marginal. This reflected their trust in the the system's suggestion and the support that they were offered by link annotation to do something other than press the 'continue' button.

Conclusion

These results suggest that ANS is a feature which is initially useful in improving comprehension for those new to a complex interface who are prepared to accept it. However, it adds another option to an interface: a cognitive overhead which may distract users from the content. This was reflected in the fact that the overall group who received ANS initially performed significantly worse in the knowledge tests. User model based link annotation seems to be of value to those that agree with it, those that accept and follow the annotations. They take advantage of the fact that the content has been examined and structured for them, and they make use of both the implicit structure of the knowledge that the courseware embodies in its static form, as well as the individual link annotations which hint at the domain structure relative to the current path of the learner through the user model. The experiment offers firm evidence that adaptive link annotation has a significant positive effect on student learning in an educational system. However, once users with minimal hits on the system were excluded, numbers in each of the two groups with and without annotations was a mere 8 and 9 respectively, and this is one of the severest limitations of the experiment. This study also suggests that the existence of ANS in the interface has an effect on the linearity of a user's path through the learning space, with those users experiencing link annotation being prepared to use those annotatable links more often than those who received no link annotation. As a result, their paths through the material were less linear, more exploratory, as they selected more "real links" and exhibited less use of the Continue button. In some ways this is hardly surprising, and again reflects the learner's trust of the system's annotations. If a link is annotated, a user has more confidence about the relevance of the material behind it than under a non-annotated link. In a non-annotated InterBook interface, the safest option for users was the repeated use of the Continue button.

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Information Structuring in Educational Software Using Formal Concept Analysis

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Abstract: Reusing pre-existing electronic information in the design of educational software has become a new perspective able to reduce the development costs of such systems. This approach has to face the problem of organizing and structuring this pre-existing information in a way that ease users´ understanding and assimilation. Formal Concept Analysis (FCA) Theory is proposed as a technique to extract and organize the domain information contained in the reused information and as a suitable method to implement different interaction techniques. Therefore, FCA can be used as a complementary tool in the production of systems with educational or help purposes.

1. Introduction

Due to the advent of Internet and the massive dissemination of bibliographic collections, software libraries and multimedia repositories, the amount of electronic information available has rapidly grown. In many educational contexts reusing all this knowledge to provide tutorial or help support would avoid constructing this kind of systems from scratch and it will reduce their final production costs. Reusing this knowledge leads us to solve the problem of how to make useful for users this information that was originally created without educational purposes. To obtain this educational aim we propose to structure and to organize this pre-existing information in a way that ease users´ understanding and assimilation. With this goal we propose to integrate in the same educational system different organisations of the domain information (based on different techniques) that allow multiple kinds of interactions with users. We applied this approach to the construction of assistants for complex software applications [Fernandez-Manjon 98, Fernandez-Manjon 97].

Frequently, educational applications are built around some kind of conceptual network (knowledge base) representing experts' view of the domain that is used to organize the information. Gathering experts' knowledge identifying what are the domain key concepts; what are their attributes and what are their interrelations is an essential and difficult phase in the software design process [Winkels 92]. This is usually done in a manual way and it is difficult to apply in complex domains. Also, there is no perfect structure for a concept map (or a single view for a domain) and it can always be discussed, improved or adapted. To cope with these problems we propose to integrate the manual approach with other complementary techniques. In many real scenarios the main objective is to face the problem of extracting, organising and structuring automatically the domain information in order to build low cost, pragmatic and "easy to access" conceptual networks.

In this paper we focus on an approach to the automatic construction of conceptual networks based on Formal Concept Analysis (FCA) Theory and its application in the development of help tools. We think that FCA can provide the basis for educational tools that use a conceptual network as a learning tool, as a navigational support (e.g. giving access to a rich multimedia documentation), or even as a method for designing educational applications. This theory is especially suited to areas where there is a large number of objects that can be described using a rich set of attributes. FCA theory allows the construction of a conceptual network whose (formal) concepts are automatically extracted from the objects and attributes of the domain. We choose the Unix operating system as a complex and well known domain to exemplify our approach.

The rest of the paper is organized in the following way. First, we present what is necessary to turn the pre-existing information into an effective educational medium. Then we introduce the basics of the formal concept analysis theory and how this theory can be used to support design and production of educational software. Finally, we present some conclusions of our approach.

2. Information Reuse, Organisation and Interaction in Educational Systems

We understand the construction of educational software (and more specifically of help systems) not only as a process of software development but also as a process of organizing, accessing and structuring pre-existing electronic information oriented to obtain useful and effective assistants. The information reuse approach proposed leads us to solve the problem of how to extract, organize and structure the domain knowledge embedded in a set of documents whose final objective is to be presented to the user in a comprehensible way. Also, the application should allow different and "easy to use" interaction methods (e.g. information retrieval or browsing) to simplify the access, relation and understanding of the information presented.

Usually the help systems are accessed by the user in a free learning way (not in a driven learning way) to retrieve some items of interest, to obtain complementary information or to explore the related contents of the domain [Winkels 92]. In this situation it is appropriate to organize the domain information into some kind of structure that could be explored by the user in a simple and "browsable" way [Wasson 92].

The idea is to merge structuring and browsing methods in order to provide user with a flexible way to interact with the domain knowledge without knowing precisely how it is organized or what are exactly his learning goals. The main difference between browsing methods and the more classical accessing methods based in information retrieval techniques is that browsing allows a "free" examination of the indexed information without any preliminary knowledge of the domain while most of the information retrieval methods make necessary a previous knowledge of the domain in order to construct queries able to specify the user's needs [Salton 89]. Also, when applying information retrieval techniques users can not directly explore the structure of the domain knowledge and, as a consequence, the learning component of the system is reduced due to it not being possible to view similar or related concepts at first sight.

The domain knowledge in such a navigational educational or help system should be arranged in a conceptual network (or hierarchy) permitting the user to easily move around and examine concepts. Within this network similar domain concepts should be clustered allowing direct accessing to other related concepts. The construction of such networks is usually done manually by human experts that select and index the main concepts of the domain. Concepts obtained and arranged following this approach may be perceived to be similar in many senses and the corresponding mapping to a specific conceptual network may often turn out to be quite arbitrary, depending on the subjective judgement of the expert. Systems created using this approach are expensive and very difficult to maintain. Also, besides the conceptualization difficulties, attempts to provide efficient network navigation are hindered by visualization technical problems. In order to fully exploit the conceptual network created and not to overcharge the user with extra information the browser interface should allow to make a partial exploration of the hierarchy.

Our approach to the construction of educational software reusing pre-existing electronic information is supported by the (complementary) use of FCA theory. FCA suits the needs of the organizing-navigational paradigm presented above due that it can be understand as a technique able to extract and organize the domain knowledge embedded in a document collection within a structure suitable for browsing. As FCA is an automatic method, the development and the maintenance costs of systems based on this approach are competitive.

3. Formal Concept Analysis Theory: Formal Concepts, Contexts and Hierarchies

FCA provides a complete set of mathematical tools to analyze and to obtain conceptual hierarchies [Wille 92]. Here we introduce in an informal way the main notions of FCA without using the mathematical formulation of the theory (as previously done in [Wolff 94]) that can be found in [Wille 92, Davey 90].

The central idea is the *formal concept* which is a mathematical abstraction consisting of two parts, the extension and the intension. The extension covers all the objects belonging to a concept while the intension comprises all the attributes valid for all those objects. When the objects and attributes of a domain are fixed we called this a formal context. For a better understanding of the idea of formal concept we propose the following example. [Tab. 1] shows a context where some Unix commands are described by some keywords or descriptors (obtained from the command documentation). In this case the objects are a subset of Unix commands, the attributes are a subset of keywords used to describe the commands and the crosses in the table hold a "has a" relationship between a Unix command and a specific descriptor. An empty cell in [Tab. 1] indicates that the corresponding descriptor does not describe or does not apply to the corresponding command.

The basis of the most widely understanding of a concept is the function of collecting individuals into a group with certain common properties. Keeping this idea in mind we will consider the attributes corresponding to the object "lpr" and ask for those commands (within the context) which share attributes with the object "lpr". We can see that no object shares all the attributes belonging to "lpr" but the objects "lpq" and "lprm" share the attributes "printer" and "job" with it. Hence we get the set A consisting of {"lpr", "lprm", "lpq"}. This set of objects is closely connected to the set B consisting of the attributes {"printer", "job"}. It is possible to conclude that the set A is the set of all objects having all the attributes of B, and B is the set of all attributes which are valid for all the objects in A. In FCA each of these pairs (A, B) is called a formal concept.

	file	*printer*	*directory*	*job*	*copy*	*change*	*send*	*display*	*remove*
rm	x		x						x
cd			x			x			
cp	x		x		x				
ls	x		x					x	
lpq		x		x				x	
lpr		x		x			x		
lprm		x		x					x

Table 1: Formal context produced by seven Unix commands and their descriptions

Concepts of a given context are naturally ordered by the generalization-specialization relation (subconcept-superconcept) producing a hierarchy for the given context. At the top will be the more general concepts that have a smaller intention and larger extension that any of the more specialised concepts below. If we look again at our example we can see that the concept A1 = ({"lpr"}, {"printer", "job", "send"}) is a subconcept of the concept A2 = ({"lpr", "lpq", "lprm"}, {"printer", "job"}).

Particular kind of formal concepts are those concepts generated by an only attribute or object belonging to the context. These concepts are called attribute and object concepts respectively; they are useful because an object concept represents the smallest concept with this object in its extension while an attribute concept represent the largest concept with this attribute in its intension. In our example, the concept ({"lpr"}, {"printer", "job", "send"}) is an object concept and it can be considered as the most specific concept with the object "lpr" in its extension. On the other hand, the concept ({"rm", "lprm"}, {"remove"}) is the attribute concept corresponding to the attribute "remove". This attribute concept is the most general concept with the attribute "remove" in its intension.

Moreover, hierarchies of formal concepts can be represented graphically by line (or Hasse) diagrams. These diagrams are composed of nodes representing formal concepts and links representing the subconcept-superconcept relationships (notice that this hierarchy is not limited to be a tree). Object concepts are named with the object that produces the concept; attribute concepts are labeled with the attribute that generates the concept. A diagram contains all the context information; an object has an attribute if and only if there is an upwards leading path from its object concept to this attribute concept ([Fig. 1] shows the diagram of the Unix example). That means that most of the FCA applications can be supported by graphical representations that simplify the presentation of information and the interaction with users.

4. FCA as a Learning Tool: Information Retrieval, Browsing and Application Design

There are several learning alternatives that can be implemented to exploit the organization of the information around the domain formal concepts provided by the FCA. We analyze three different uses: information retrieval, browsing and application design.

The domain structuring provided by FCA can be used to support an easy and effective retrieval of information. For instance, in the Unix example, the problem of a user looking for information about an specific command can be focused to FCA terms as a process of helping users to obtain the smallest concept that has this command in its extension (i.e. the object concept).

As FCA gives us all the formal concepts of the domain and their organization within the conceptual hierarchy it is possible to implement different retrieval interactions with the following common characteristics. The user does not need a previous knowledge of the domain, it is not necessary to know the keywords or structure used to index the information and; the searching process is driven in a quick and incremental way. In order to construct the "queries" that define the search path to the object concept requested two kind of interfaces may be implemented: a table based interface and a hierarchy diagram based interface. Table based interfaces show a set of selectable descriptors that the user can incrementally choose in order to describe his needs; as another separate column the interface presents the set keywords selected by the user and; as a third column, the interface shows the items selected by the system as possible objects to be retrieved. This way of presenting hierarchical information allows the user to obtain at least one object in his searching process [Lindig 95].

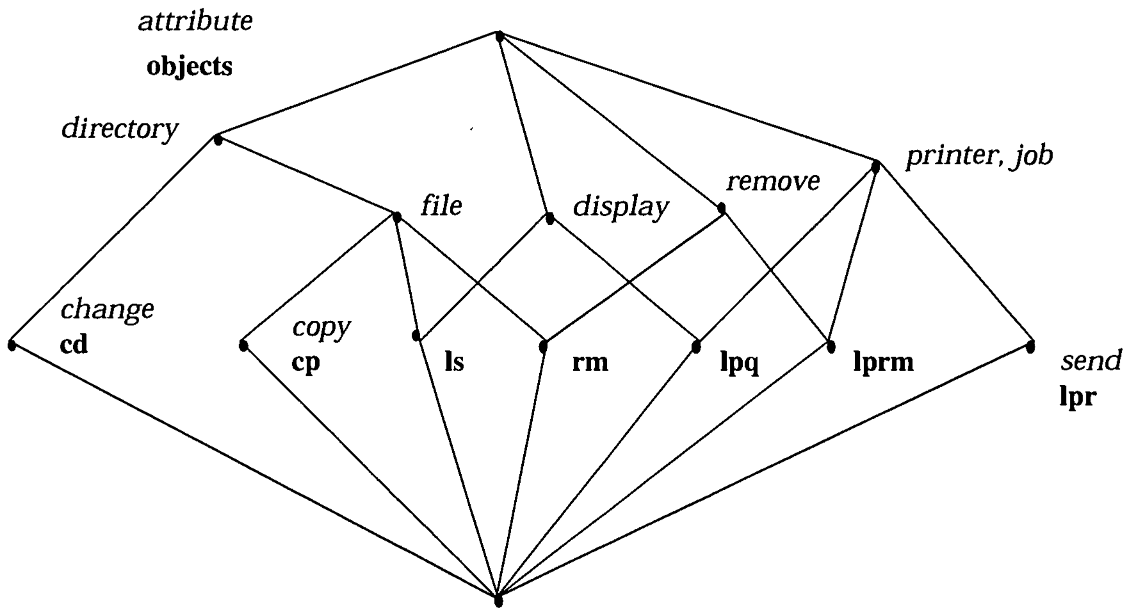

Figure 1: Line diagram of the context presented in [Tab. 1].

An example of this approach is presented in [Tab. 2]. In this example the user needs to find information about the commands used to change the working directory in Unix. To do his first choice the system will present as selectable descriptors all the descriptors available in the conceptual network allowing the user to select the keyword "directory". Then the system will show as possible items to retrieve the objects "rm", "ls", "cp" and "cd" and it will update the list of selectable descriptors to those keywords related with the attribute "directory" (i.e. "copy", "remove", "file", "change", "display"). Next interaction will refine the searching path adding the descriptor "change" to the incremental query. This last selection drives the search to the object concept {("cd"), ("directory", "change")} that will be used to retrieve the information related with the command "cd".

Step	Selected Descriptors	Commands	Selectable Descriptors
1	--	all	all
2	*directory*	cd, cp, ls, rm	copy, remove, file, change, display
3	*directory, change*	cd	--

Table 2: Incremental query construction where the user specifies the keywords "directory" and "change". The commands and the descriptors compatible with the partial query specification are also shown.

On the other hand, a second approach to the construction of information retrieval interfaces based on concept networks is to present the hierarchy diagram in a graphical way. This approach would arrange the formal concepts around a graphical diagram where users could access directly to the indexed information. In this case, if the domain were complex, problems could arise making very difficult the visualization of the complete set of concepts. Solutions to this problem should avoid presenting the whole diagram focusing the view in the sub-hierarchies related with the user´s interests [Carpineto 95] or merging the tabular representation with a graphical representation of sub-hierarchies. The above approach to graphical concept hierarchy representation is closely related to a domain browsing approach.

Domain browsing is an approach to the exploration of indexed domains that allows the user to interact with the domain without knowing precisely the contents of the domain or the way it is organized. Relations between concepts obtained using FCA define structures suitable for browsing. Conceptual networks appeal to the browser´s intuitive notions of distance, closeness and dimensions clustering similar concepts within the concept diagrams. Also, browsing methods not only can be used in a domain exploration way but also they can be exploited as powerful learning tools that allow users to solve their direct needs of information (short term learning process) and finally acquire a global view of the domain where browsing is applied (long term learning process). This is the reason because the way browsing is going to be done and how it is going to present the domain concepts and their relations are going to clearly determine the domain users´ learning process.

We will explain a typical browsing session within a conceptual network implemented using FCA and we will try to observe how the learning process is going to be done. Coming back to the Unix example, suppose that the user explores the domain in order to obtain information related with the commands used to manage the printer. He will browse to the node "printer" unfolding the part of the domain corresponding to the subdiagram shown in [Fig. 2]. This subdiagram only contains as object concepts those related with printing actions such as "lpq", "lprm" and "lpr". The selection of a specific descriptor reduces the number of navigational concepts within the diagram to those concepts that are especialisations of the attribute concept "printer". The application of a browsing technique over the concept hierarchy makes that the system does not show commands such as "ls" or "rm" that are related with typical file and directory actions but that are described by the keywords "display" and "remove" respectively. As a consequence, the user´s attention will concentrate only in the information that he wants to know about and, at the same time, he will acquire a global notion of all the commands that can be used to manage a printer in Unix by inspecting its electronic information related. The following user´s interactions will refine the learning objectives browsing down in the diagram in an incremental way until the browsing process obtain an object concept.

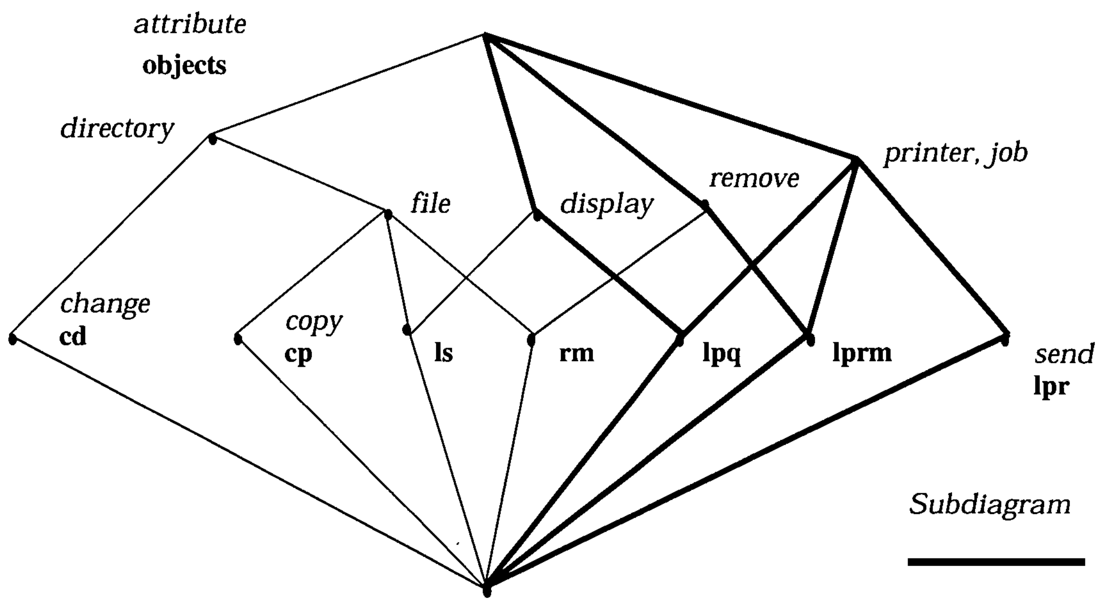

Figure 2: Subdiagram corresponding to the user´s selection of the keyword "printer".

Finally, FCA can be used as a previous step in the design of educational applications. The automatically extracted formal concepts can be latter refined by the domain experts in order to manually construct the definitive conceptual network. The number and the quality of the concepts obtained by FCA are variable because it depends on the objects and the description of these objects (that is the formal context). But we have the warranty that all the information is indexed.

Also it is necessary to notice that FCA permits a more labored analysis of the data and even to create different views of the same domain as described in [Wille 92, Wolff 94, Godin 95]., One of the possibilities is that the analysis of the domain can be done taking into account which are the relationships between the attributes and not only considering those as a simple and independent characteristics. For example, we could also include in the analysis of the domain the experts' perception that the "display" and "list" actions are particular instances of a more general action that is "inform". That will also produce an automatic organization of the domain information but taking into account the experts' view of the area.

5. Conclusions

In this paper we have introduced formal concept analysis as a tool to develop educational software reusing pre-existing electronic information. Systems that implement this technique have low development costs and are easy to maintain. This is possible due to FCA feature able to process the electronic information automatically.

We have compared FCA with other approaches used to construct the same kind of systems and we can conclude that the conceptual networks created using FCA may improve the effectiveness of hierarchy navigation for interactive searches and the general learning process of a specific domain. The main reason is that concept relations generated by FCA theory provide a conceptual structure that can smoothly integrate different methods to manage and to present information without changing the domain structure created. We do not propose AFC as an information extracting and structuring standalone method. Nevertheless, conceptual networks usually have no relevant or nonsense concepts that should be discarded by a domain expert. FCA should be understood as a first step method able to create a first organization of the domain that considerably reduces the efforts and costs of developing the structure of a domain from scratch.

Presently, we are using FCA as a tool to unfold the domain data supporting the construction of better user interfaces. We are applying this approach not only in the Unix domain but also in a different application for teaching text comprehension in a second language. The next step of the project is the evaluation with real users of the interfaces produced using this technique.

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Designing a Distance Learning Teleproductics System SupportedOn The Web

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Abstract: The current development Internet tools enables the appearance of new challenging fields of applications for global network. A particular technology, the WWW, has been acted as the central explosion spot for new application areas and better system integration using the Internet infrastructure and tools. One of these new auspicious fields is teleproductics, which is the remote access and control of industrial devices/facilities through a telecommunications network, in this case the Internet. This paper describes the project, design and development of an Internet supported teleproductics system aimed for interactive distance learning of mechanical engineering. The current result of this project was the implementation of a virtual mechanics laboratory, used to demonstrate the Internet technologies applied to teleproductics.

1 Introduction

The subjects described on this paper are built around the teleproductics [Firmeza 1997] concept. Teleproductics is the interaction among industrial facilities, shop floor devices, computer systems and telecommunications networks. The main idea of application of teleproductics system, is the remote control of self-contained highly automated industrial plants. In despite of the apparent concept's limitation related to more wide application fields, in fact, many applications can be imagined. An example is the projected and developed system, designed to be applied to teaching mechanical engineering by using virtual laboratories (enabling cost reductions due to the overcome of multiplication of similar facilities), using the Internet benefits such as accessibility, easy of use and globalization.

Figure 1 illustrates the concept of teleproductics applied to IDL[1] [Minoli 1996].

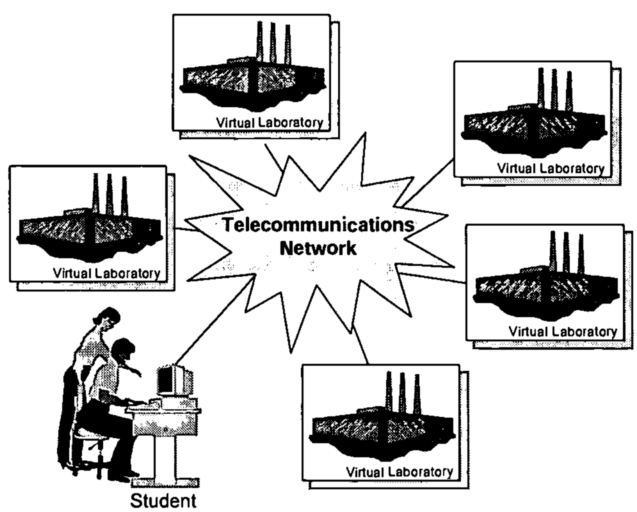

Figure 1: Teleproductics applied to IDL concept.

[1] IDL: Interactive Distance Learning

2 System's Design And Architecture

From this point on, this paper will describe the project and implementation approach of a Web based teleproductics system, developed to demonstrate the capabilities and potentialities of the general concept.

On our particular design, the system will have the following main modules:

- A virtual Control and Operation Platform, designated COP.
- A Manufacturing Integration Platform, designated MIP.
- The Manufacturing Platform, which includes a shop floor containing its specific devices and custom industrial network.
- Feedback circuits, which includes return video data and alarm/event notification.

The next figure presents a simplified diagram presenting an architecture obtained from this specific design:

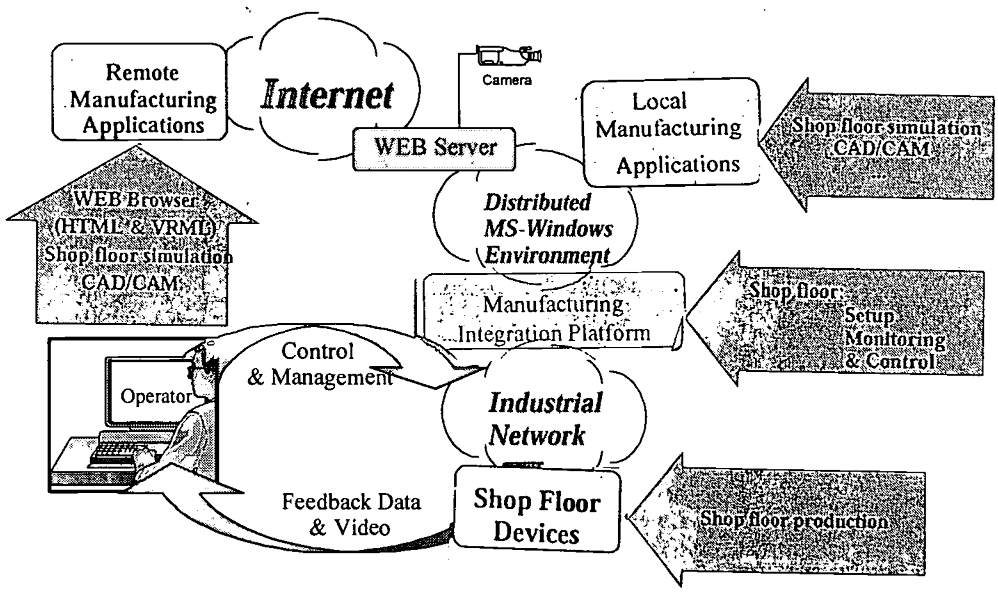

Figure 2: Architecture of an Internet based teleproductics system.

2.1 The Control and Operation Platform

The control and operation platform includes applications for shop floor simulation, CAD/CAM tools and a container for all the tasks related to remote device control, operation and configuration.

In this design proposal, this container is essentially an HTTP[2] client. Obviously, we are talking about an ordinary Web browser, such as Netscape Navigator or Microsoft Internet Explorer. In fact, these are currently the only two solutions available which fill the system's requirements (JAVA support, installable plug-ins, etc). The use of a browser as the container for the user interface improves the architectural independence of this important module, allowing users to access the virtual laboratories using different machines and operating systems. This feature is a key role on the system's portability and accessibility.

When thinking about a Web browser acting as the virtual interface to the system, we may think that everything was built using the HTML[3] language. Although HTML is used, it has a minor paper on the interface functionality, since it was implemented mostly by using virtual reality models constructed using VRML[4], and JAVA applets to do the "real" job of operating the system.

To better understand how the system is remotely accessed, using the Web browser, let's look at the operations from a top-down perspective (Figure 3):

[2] HTTP: HyperText Transfer Protocol

[3] HTML: HyperText Markup Language

[4] VRML: Virtual Reality Modeling Language

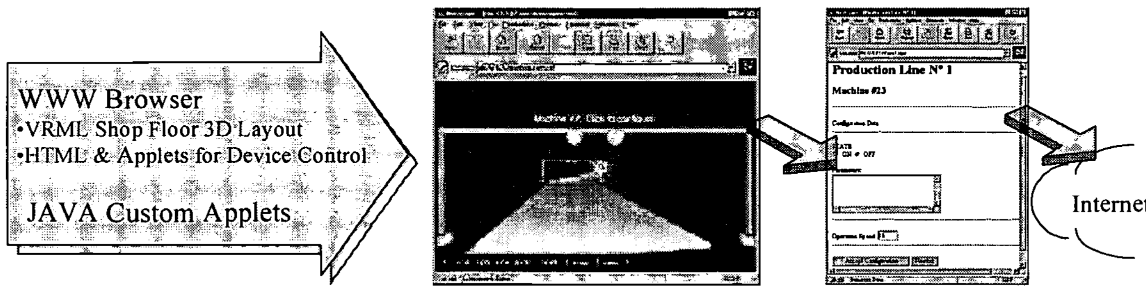

Figure 3: Virtual laboratory and device interaction.

When a user accesses the system by using the Web browser, we gets a VRML 3D model of the virtual laboratory, allowing him to "walk" inside it just by using a pointing device (usually the mouse). When approaching the model of a lab's element or manufacturing device, the user can access a page allowing him to operate or configure the specified device, just by clicking it.

After completion of control data modification, user returns to VRML model, allowing to operate/configure another device. The complete user interaction process is represented on the following diagram (Figure 4):

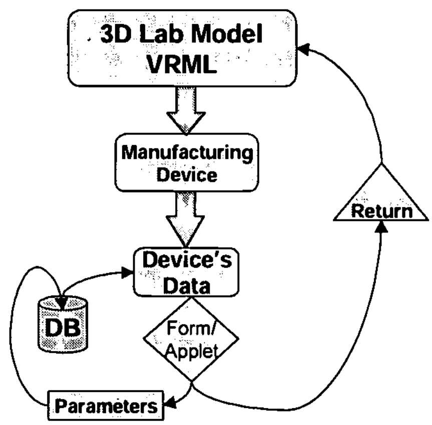

Figure 4: User interaction's top-down diagram.

All the configuration and state data is stored on a database placed on a lab's server. This database has an essential role on the entire system, since it acts like a common point of access for both the user modules, and the control and operation services running on the lab.

2.1.1 Control and Operation Modules

These modules can be implemented either by using HTML forms associated with server CGI applications or ISAs[5], or by using JAVA applets with remote database connectivity.

On the first approach, all the processing and database access occurs on the lab's side, by remotely launching specific database access applications on HTTP server. Their functions are retrieving device configuration or state data, and modify specified parameters. The second solution conducts to a more distributed system, since the clients connected to the system do part of the processing work. This JAVA based solution, remotely accesses the database managed by a SQL server placed on the lab, using, for instance, a JBDC[6] connection [Thomas 1996]. This solution conducts to a more user-friendly system, containing better features and functionality.

[5] ISA: Internet Server Application. Microsoft's standard for HTTP server applications, built over the Internet Server API (ISAPI).

[6] JBDC: JAVA Database connectivity

2.1.2 Device's Native Programs Upload

Most of the available manufacturing devices need to be programmed to do a specific job. Many allow users to load manufacturing programs, either by using a storage media, or by communicating with the device using a communications network. In the case being studied, we need to upload programs to manufacturing devices remotely over the Internet, using the browser. One of the solutions for this problem, and the one being adopted, relays one more time on using JAVA applets. Their task is to upload a user's manufacturing program into a lab's server, and then notify a server's service to deliver the code to the specified device.

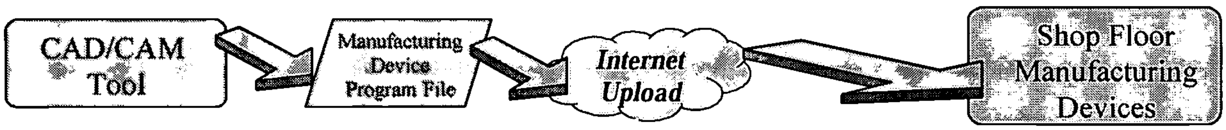

Figure 5: Program file upload process.

2.1.3 Additional Modules to the Control and Operation Platform

Integrated, or coexisting with the Web browser, the user needs some additional features. On systems like this one, two additional modules are quite important: an alarms & events reception module, and a video reception module [Wolf 1996].

The alarms & events module is needed to receive alarm messages generated on the lab whenever abnormal or error situations occur on the real manufacturing process.

The video reception module is needed to show the real flow of the process, using monitoring cameras installed on strategic placed spots of the lab.

Figure 6: Video and alarms modules.

2.2 The Manufacturing Integration Platform

The Manufacturing Integration Platform (MIP) is one of the main system's components. Its mission is to place a bridge between the control and operation clients connected to the lab and the lab itself, comprising its manufacturing devices and equipment.

On a logic approach, the MIP must contain a set of services, allowing the setup, control and monitoring of the labs shop floor.

A general MIP usually contains several communication interfaces, like the interface to the connected users (the Internet), and interfaces to specific devices (MAP[7], serial, Ethernet, etc), to support the data flow to all its inner services.

The Figure 7 represents the logic architecture of the MIP.

[7] MAP: Manufacturing Automation Protocol

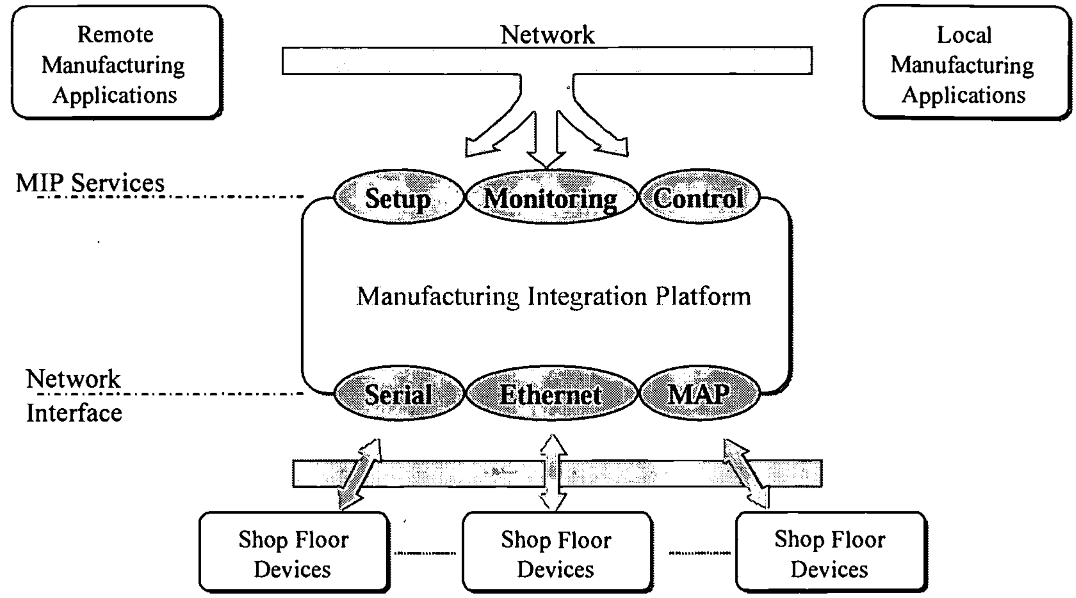

Figure 7: MIP - Logic architecture.

2.2.1 The Lab: A Windows NT Based System

At the lab the interface everything will be implemented through a server (Figure 8). This server, that we'll call *Lab's Server*, will provide access to text files containing HTML and VRML scripts. Additionally the server is used to store specific applications required to manage the processing of data received from the configuration forms, and other applications such as monitoring and communication tasks. Some of those applications are CGI applications, which are launched by the HTTP service.

Coexisting with the services and associated applications, this machine (or another machine on lab's network) will be the host for a database. The function of this database is the storage and management of the configuration data of the production unit's components. On the proposed implementation this database is based on a SQL Server, for increased functionality and modularity of the system.

To enable the coexistence of all those services, the operating system to be used on this server must be a multitask operating system, with integrated network support. The proposed solution is based on *Windows NT Server*, which includes the entire network functionality required embedded. Furthermore its version 4.0 includes also the IIS[8] which includes an HTTP server with support for CGIs, direct access to databases and an API called ISAPI[9], that allows to write applications for the WEB service, with some advantage over CGI applications.

Using the *Microsoft SQL Server* for *Windows NT* the connectivity and access to the database problem is also solved.

This machine also hosts a service to process and transmit/receive the control data from/to a central control unit which direct controls specific devices, and also a service to handle the feedback video signals, including its transmission to all the connected management and operation units.

[8] IIS: *Internet Information Server*, from *Microsoft Corporation*

[9] ISAPI: Internet Server Application Programming Interface

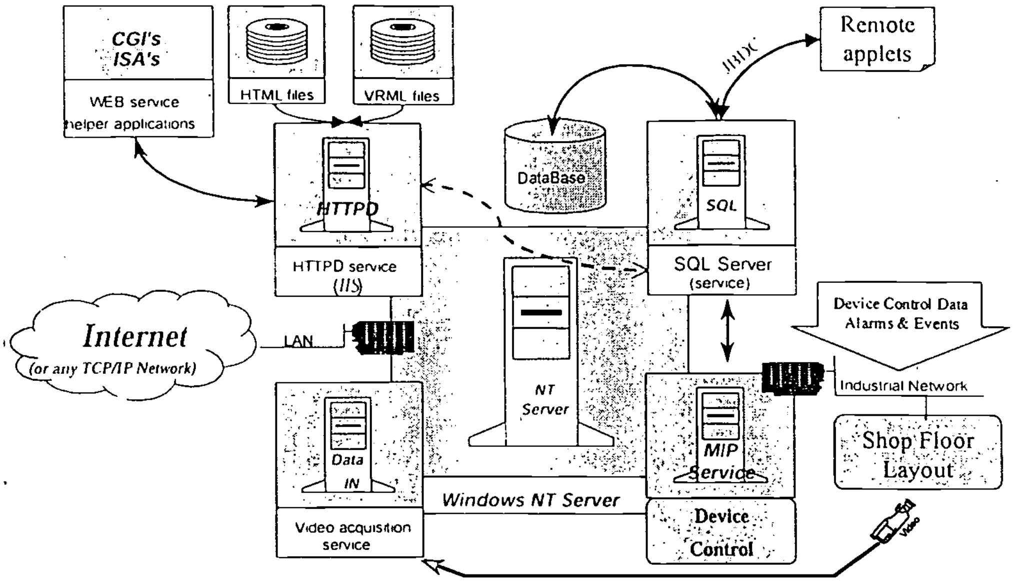

Figure 8: NT Server based MIP.

2.2.2 Device Control Service & Interfaces

Manufacturing devices can present several types of external control interfaces, being the most common serial, MAP/MMS[10] [Messina 1994] or Ethernet interfaces, excluding some proprietary solutions.

A clear issue arises when comparing these and other kinds of interfaces: The addressable ones, and the non-addressable ones. In the first case fits MAP or Ethernet, while serial fits the second case.

The main differences between these two cases are relating to the delivery process to a specified device. While data on addressable devices is kept attached to messages or commands transmitted or received encapsulated on the network protocol used, on non-addressable devices we must have an additional module responsible to data delivery from/to specified devices.

The device control module, named Central Control Unit (CCU), is implemented as a Windows NT service that runs on the server and is always listening to changes on the system's database. Whenever a user on a control and operation platform performs a database modification, this service receives a message from that client containing a device's identifier. Then, this service requests a SQL database query reading the specified device configuration and state. Finally, using that data, the service constructs a frame and delivers a message to the device using the appropriate physical connection, and data encoding.

2.2.3 Lab's Integration

With such architecture, we walk to true manufacturing integration, with a common interaction point on the entire process, accomplished by the shop floor server. This is an open architecture allowing to distribute the several processing modules over several machines on the lab's network, including the SQL database, All the remote COPs input/output is accomplished by tunneling data to the lab's server. (with the eventual exception, depending on the implementation approach, of the video delivery service).

The following figure represents an example of the concept of shop floor integration with a common point of access.

[10] MMS: Manufacturing Message Specification

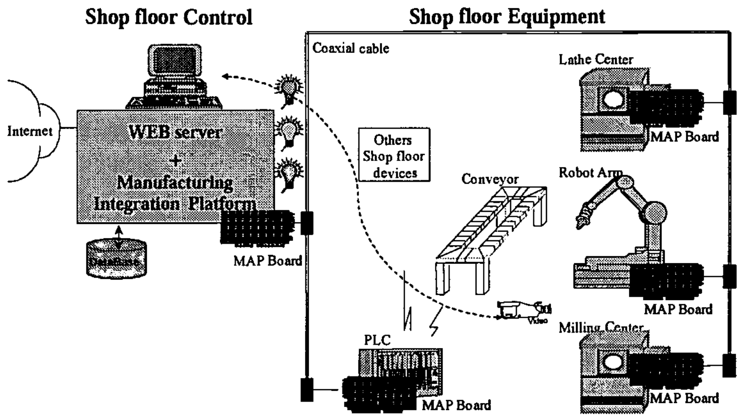

Figure 9: Example of shop floor and system integration.

3 TELEPROD: A Demonstration Laboratory

TeleProd is the name of a demonstration project, created to apply and test the architecture and some of the techniques developed. TeleProd project consists of a virtual laboratory built using some resources and devices, such as light bulbs, sensors, actuators, step-motors and cameras, available at the project's work lab. Although these devices may not seem the more appropriate ones to simulate a real mechanical engineering lab's shop floor, they are suitable for testing the most important issues of the system, like remote database interaction, control and monitoring services and global system's integration. This system includes all the main modules and platforms described on the proposed architecture, although having some limitations related to the work environment present on the lab, like the lack of real programmable manufacturing devices.

On this prototype demo, the control and operation platform was completely built over a Web browser. Users can access the lab by navigating on its 3D model, built using VRML, then they can access each of the individual controllable devices by clicking the mouse. On each case, a specific control page containing remote database access JAVA applets is downloaded from the lab's server. Alarms and events are received using a JAVA reception module that uses TCP/IP sockets. Even the feedback real time video acquired from several sources is presented on the browser client area.

Figure **10** shows the general look of the virtual lab graphical interface.

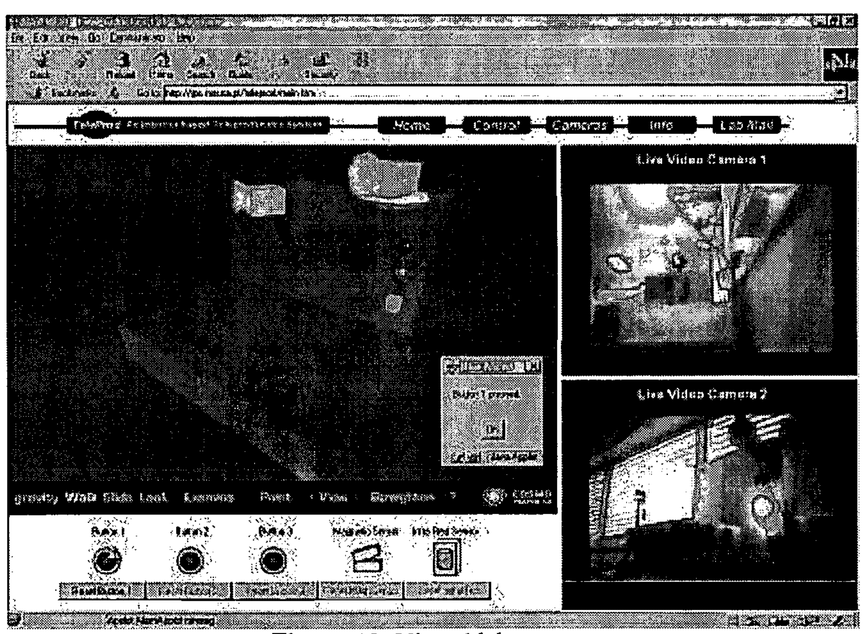

Figure 10: Virtual laboratory.

On the middle left frame we can see the lab's 3D model, live video is presented on the right frames and on the bottom frame we can see an alarm reception applet.

Each of the device types is associated with a control applet allowing controlling and changing its parameters. These applets do their job by querying and changing corresponding device's configuration parameters on the database, and then sending a message, using TCP/IP, to a service running on the lab's server.

On the real lab, all control data and messages are managed using a central control unit (CCU) built using a PC with several I/O cards, which is connected to the lab's server using a serial RS-232 connection. On this demonstration system, the CCU has two main functions:

1. Receiving all the messages from the server, decoding them and then sending control commands to specified devices.
2. Listening for alarms and events. When one of them occurs, a message is sent to the lab's server.

The next diagram represents the main TeleProd lab modules and its relationships:

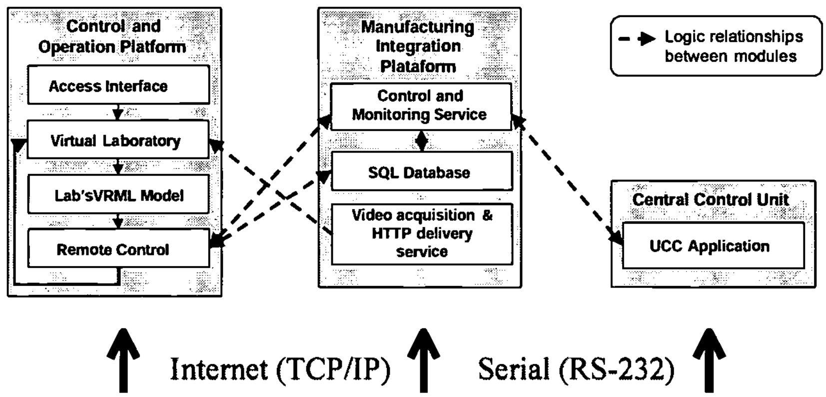

Figure 11: TeleProd Lab modules.

4 Conclusion

Current information and communications technologies built over the Internet, enable the development of new distance learning applications that may contribute to wider information access/diffusion and substantial cost reductions to institutions: staff costs through the possibility of reusing infrastructures by remotely control existing facilities and investment costs through the capability to increase resource's sharing.

Teleproductics is a potential example of this, because it will enable remote access to expensive manufacturing laboratories, used in most cases to teach mechanics and manufacturing related engineering.

This paper discussed how current technologies could be used to implement a Teleproductics system based on the Web, presenting a running project related to a specific area of application. The system under development is focused to implement virtual laboratories for teaching mechanical engineering.

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Multimedia Training in Classroom Observation: Pathways to Proficiency

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Abstract: This paper reports the results of observation skills training via an interactive multimedia training program for preservice teachers. The training program provides multiple videos for users to practice six types of observation methodologies, comparisons to "expert" data, and on-line access to procedural information. The study provides an analysis of audit trail records, user surveys, and pre/post testing of observer reliability to ascertain relationships between prior computer experience, prior classroom experience, learning strategies, engagement time, and program efficiency.

1 Background to the Study

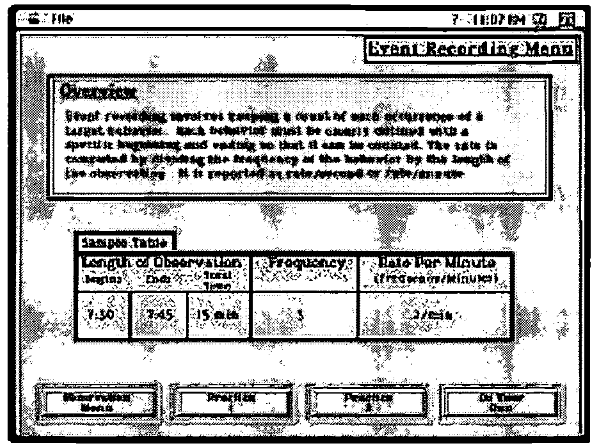
The purpose of this study was to examine the effectiveness of a multimedia training program to develop proficiency in classroom observation skills of preservice teachers. The training program was delivered through an interactive videodisc format which offers multiple videos for teachers to practice six types of observational methodologies: event recording, duration recording, latency recording, interval recording, time sampling, and A-B-C analysis [Fitzgerald 96] [Semrau 96]. For each video-based practice, the computer program controlled the start and stop frames, provided a timer, and provided user control over practice sequence. Users entered their observation results into the computer program and compared their data to that of "experts." Two unique features in the design of the multimedia training program are: 1) one video is "saved" to provide a constructivist experience for the user to define behaviors for each of the observational methodologies, and 2) procedural information for the six observational methodologies is available on-line for easy review.

Training in classroom observation skills is a complex and time-consuming process. To learn to code behavior reliably, an observer must learn to identify behaviors accurately, watch and code multiple behaviors in real-time, and apply these skills to varied and dissimilar settings. The usual training method involves an apprenticeship model where a teacher explains the procedure, demonstrates via videotapes, provides practices through videotapes and field assignments, and undertakes reliability testing with tapes, if at all. It is not feasible to spend the necessary amount of practice time for classroom observation training within most teacher education programs; thus mastery of methodology or reliability is rarely documented [Fitzgerald, 1995].

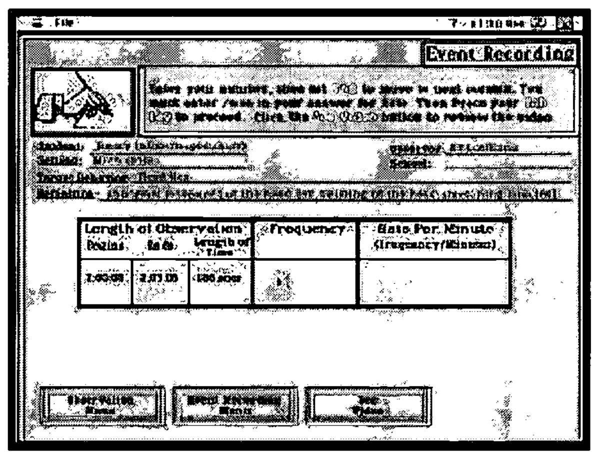
Interactive multimedia training provides one solution to the problem of observation training, practice, and reliability testing. Through repeated practice with videos and "expert" comparisons, a novice can practice until proficient and establish coding reliability. With the capability of accessing procedural information regarding observation methodologies, a novice can review procedures if questions arise during practice. Since a hypermedia format allows users to make personalized decisions regarding practice sequences and strategies, the format may provide an effective training alternative to the typical apprenticeship model in observation training.

2 Description of the Multimedia Training Program

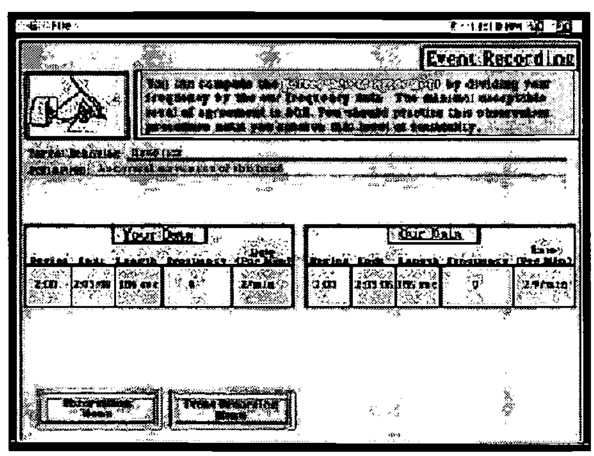
This screen introduces the user to the particular observational methodology to be practiced. In this example, the user is practicing Event Recording. A brief description of the methodology provides general information necessary to begin the practice. If the user requires further information, he/she may access procedural information from the on-line resource section of the program. A sample table gives the user an example of how event data are recorded. The user chooses from three possible videos for practice, two which include expert observation results and one that does not. The observation practice "Do Your Own" can be used as a constructivist activity for defining behaviors of interest to the user.



After the user runs the video and collects his/her observation data, the data entry screen appears. At this step, the user can elect to run the video again or enter the data which he/she has collected into the program. The computer screen provides the exact length of the observation period to enable the user to compute rate data for the observed behavior. These data entry screens are matched to each type of observation methodology which vary in the number of children and behaviors observed and the method for computing rate data.



After the user enters his/her data into the computer, the expert comparison data screen provides comparative results. The screen displays both the user's results and the results of experts who observed the same observation video. Information at the top of the screen explains how the user can compute his/her "percentage of agreement" (reliability) between the two sets of data. At this point, the user may go back and practice this observation segment again, select another segment to practice, or return to the main menu and select a new methodology for practice.



Audit Trail

The program records embedded data paths that are invisible to the user. These paths collect information such as the overall length of time the user engages in the program, the length of time spent in each methodological section, the number of times a video is accessed, and the observation results entered by the user for each practice. For example, in the above practice, the computer records the frequency and rate data entered by the user for that particular practice semester. The audit trail provides a cumulative record of all practices and observational results and enables the researcher to examine factors which may relate to successful learning.

3 Description of the Research Study

3.1 Research Questions

The study was designed to address the following research questions about the use of hypermedia-design practice materials for learning classroom observation skills:

(1) What effect does a hypermedia-designed practice program have on performance outcomes for preservice teachers learning classroom observation skills?

(2) Do performance outcomes for preservice teachers relate to differences in prior computer experience, prior hypermedia experience, prior teaching experience, learning style preferences, or semester?

(3) What practice strategies predict successful performance outcomes for preservice teachers learning classroom observation skills through a hypermedia-designed practice program?

3.2 Methodology for Implementing the Multimedia Training Program

The observation training program was integrated into special education methods courses during three semesters at Lincoln University. Following pre-testing, the instructor provided instruction in observation skills prior to the students' use of the multimedia program. The instruction included content and procedural information and a demonstration of each methodology. During these introductory sessions, students could ask questions about the observation procedure and clarify the required observation steps. Students were then required to practice the observation methodologies using the multimedia training program in the computer lab. The basic expectation was that each student use all available practices with the suggestion that practices be repeated if the user's data did not match the expert data by 80% agreement. Students received extra credit for their participation, but their level of proficiency was not used in computing the course grade.

3.3 Participants

Subjects included 29 preservice teachers enrolled in special education methods courses. All students were undertaking foundational coursework prior to student teaching; students in the summer session had prior knowledge of special education methodology; fall and spring session students had little prior knowledge. Demographic information was collected via user surveys and served as independent variables.

Prior Computer Experience. All but two participants had a moderate level of experience using computers across a number of areas of computer applications; the remaining two had minimal experience. Based on a scale where students rated their experience from 0 = "no knowledge" to 9 = "expert knowledge" on 9 categories of computer applications (total score possible = 81), the mean prior computer experience score = 29.7, standard deviation = 14.6 , range = 2 to 53. Most students had never experienced hypermedia, and those that had, indicated they had limited knowledge of hypermedia. Using the sub-scale for rating experience with hypermedia (item score possible = 9), the mean prior hypermedia experience score = 0.9, standard deviation = 1.4, range = 0 to 5.

Prior Teaching Experience. Since the subjects were enrolled in an initial teaching certification program, few had direct, salaried, classroom teaching experience. Of the seven with teaching experience, they had been primarily employed as teacher aides or substitute teachers. The mean years of prior teaching = .88, standard deviation = 2.03, and range = 0 to 7 years.

Learning Styles. Participants represented a mix of learning styles as assessed with the Kolb *Learning Style Inventory* (McBer & Company, 1981). Using the 4 learning style types defined on this instrument, there were 9 students identified as assimilators, 9 as divergers, 8 as accommodators, and 3 as convergers.

Semester. Participants were included in the study over a three-semester duration. The numbers of students for the semesters are: summer = 7, fall = 16, and spring = 6. There were some implementation differences across the semesters particularly affecting the duration of practice time prior to post-testing.

4 Data Collection for the Dependent Variable

The dependent variable for the study was observation proficiency measured by *pre- and post-testing* on two different types of observation methodologies—event recording and interval recording. Matched pre- and post-tests were administered using original videos controlled by the computer to standardize test administration. In the event recording test, subjects watched 5-minute videos and recorded the frequency of occurrence of a defined behavior. In the interval recording test, subjects watched 5-minute videos and recorded on-task in each of 50 six-second intervals. Percentage of agreement scores (reliability) were computed for each of the pre- and post-tests.

Path analysis data were compiled from the on-line audit trails and user practice logs. Through these logs, practice strategies were examined by analyzing each user's number of repeated practices, total practice time in the program, number of times the procedural information module was accessed, total time spent reviewing procedural information, and proficiency on two related observation practices: *interval practice #2* and *time sampling practice #2.* These two internal practices were used to ascertain proficiency of users during practice.

5 Data Analysis, Results, and Interpretation

5.1 Question 1: Performance Outcomes

A paired t-test was applied to the pre- and post-test results to determine the effect of the hypermedia-design practice program on observation skill proficiency. The scores represented the percentage of agreement (reliability) to expert data. Pre-to-post test results were not significant for event recording (t (24) = .959; p = .35) but were found to be significant for the interval recording methodology (t (24) = 3.88; p =.001). Table 1 displays the means and standard deviations for the reliability scores.

The small variation found in pre- and post-scores for both event and interval tests suggests the difficulty level of these tests is not high enough to provide accurate assessment of observational ability by the participants in these areas. In addition, the narrow range of scores exhibited limits the effectiveness of the regression analysis. In the future, more robust pre/post measures might ensure greater assessment of proficiency.

Further recommendations include increasing the number of practices available to users within the program. The ability to check one's scores with the results of the "experts" is an integral and essential part of the program; however, once these results are seen, repeat practices are compromised, essentially allowing for only two "unique" practices in each observational method. Additional practices would increase the amount of unique experiences available.

	Pre-test Reliability		Post-test Reliability	
	Mean	S.D.	Mean	S.D.
Event Recording	79.74	20.16	85.78	14.14
Interval Recording	78.98	7.02	84.32	5.06

Table 1. Observation Reliability Score Outcomes for Two Observational Methodologies

5.2 Question 2: Relationships between Post-test Outcomes and Learner Differences

Simple regressions were run to evaluate whether outcomes of the observation training program were related to learner differences. Table 2 presents the regression results for the post-test outcome scores related to three independent variables. No significant relationships were found to indicate that prior computer experience, prior hypermedia experience, or prior teaching experience with children predicted the outcomes for learning observation skills.

	Post Event Recording			Post Interval Recording		
	r	*F*-value	*p*	*r*	*F-value*	*p*
Prior Computer Experience	.115	.293	.59	.088	.173	.68
Prior Hypermedia Experience	.195	.271	.36	.112	.281	.60
Prior Direct Teaching Experience	.241	1.361	.26	.176	.704	.41

Table 2. Relationships between Outcomes and Learner Differences

To evaluate whether outcomes were related to learning styles or differences across the three semesters, ANOVAs were run learning style and semester as factors. As shown in Table 3, no significant differences in learning outcomes were related to learning styles of the participants or to semester.

		Post Event Recording			Post Interval Recording		
	n	Mean	*F*-value	*p*	Mean	*F*-value	*p*
<u>Learning Style Type</u>			1.303	.30		.443	.72
Assimilator	8	87.94			84.75		
Diverger	8	79.69			83.50		
Accommodator	7	88.50			83.71		
Converger	2	100.00			88.00		
Semester			1.78	.19		1.37	.27
Summer	7	92.86			86.57		
Fall	12	80.79			84.17		
Spring	6	87.50			82.00		

Table 3. Relationships between Outcomes, Learning Style Differences, and Semester

The subject pool for this study exhibited a high level of homogeneity in prior computer experience, prior hypermedia experience, and prior teaching experience. As a whole, most subjects had a moderate amount of computer experience, minimal hypermedia experience, and little, if any prior teaching experience. This limited range of experiences negatively impacts the effectiveness of the regression analysis. The small number of subjects also limits accurate evaluation, particularly with regard to subjects' learning styles. Further studies, therefore, would greatly benefit from a larger and more diverse subject pool.

5.3 Question 3: Relationships between Outcomes and Practice Strategies

Path analysis data were used to examine relationships between successful learning outcomes on the <u>interval post-test</u> and strategies used during practice on the multimedia program. Simple regressions were run to evaluate whether outcomes of the observation training program were related to differences among the subjects in how they utilized the program capabilities, amount of practice time, and proficiency levels during practice on the more rigorous methodologies. Table 4 presents the regression results pertaining to audit trail data. No significant relationships were found to indicate that different ways subjects utilized the program affected their performance outcomes.

The number of practices and amount of total time spent in the program exhibited a better distribution among the subject group. However, both were found to be insignificant to successful learning outcomes.

The available review section in the hypermedia program was largely unused by the subjects because of the amount of procedural knowledge provided by the instructor. This reduced the importance of such a knowledge source in the hypermedia program. Therefore, it is recommended that hypermedia developers consider the environment in which the program is to be used and determine the necessity of such a

	Post Interval Recording		
	r	F-*value*	*p*
Number of Repeated Practices	.233	.974	.34
Total Practice Time	.091	.143	.71
Number of Accesses to Procedural Information	.082	.155	.70
Total Time Accessing Procedural Information	.028	.018	.89
Proficiency on Interval #2 Practice	.226	1.243	.28
Proficiency on Time Sampling #2 Practice	.057	.055	.82

Table 4. Relationships between Outcomes and Practice Strategy Differences

6 Summary

Interesting questions emerge regarding the effectiveness of an interactive multimedia training program for developing observation skills. Because the program allows users nonlinear access to practice segments, expert comparisons, and access to procedural resource information; the learning strategies of users differ. The findings from this study provide multiple data points from audit trail records, user surveys, and pre/post testing in observation skills to examine the correlates of observation proficiency: prior computer experience, prior classroom experience, learning strategies during training, and total engagement time with the program.

Students utilizing this program appeared to learn observation skills equally well, regardless of different learning styles or their prior experiences with computers or in the classroom. Given the limiting factors of a small and homogeneous subject pool, this study nevertheless suggests that a hypermedia-based practice environment minimizes the effect of learning style and experience differences between users in terms of overall outcome of observation proficiency. This study therefore lays the groundwork necessary for further study of the equalizing potential of hypermedia-based learning.

The study is important in establishing how preservice teachers utilize an interactive multimedia learning environment for observation skills training, the resulting outcomes for observation proficiency, and overall training efficiency of the multimedia program.

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Educational Human Computer Interaction Methodology: Interfacing Multimedia with Art Criticism Experience of Form, Metaphor, and Context in Chinese Painting

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Abstract: The study will utilize two empirical research directions: applied and basic researches. It offers sample strategies for experiencing art teaching in a classroom based on multimedia settings. Both the classroom section and the foundation section focus on the following objectives: 1) to ascertain which instructional methods and technologies have the greatest effects on the artistic learning; 2) to look at the theoretical way of how multimedia and critical inquiry accelerate perceptions and analytical capacities in art teaching; 3) to explore the feasibility of using Human Computer Interaction Methodology approach as they relate to Instructional strategies for metacognitive development; 4) to address the transformation of Eastern and Western Educational Reform in Context by suggesting a Contructivist category and framework; 5) to examine how Eastern and Western beliefs and value assumptions can suggest vigor applications for future research initiatives in comparative multimedia studies.

Toward An Authentic Metacognitive Learning Approach

This paper involves a variation of a conceptual sequence of methodological strategies: It is built as related IMM to the particular art criticism sequence instruction. It also stressed to bring the students to be accompanied the sequential addition of the concepts of metacognitive learning processes. To explore how these processes are affected by theme and strategy variables from three perspectives: 1) knowing with feeling; 2) feeling of knowing; and 3) feeling with knowing. These three empirical models are correlated to one another. In the three studies, students received almost the same media presentation but through different instructional objectives, contents and pedagogy. Besides sequence of pictorial cues and art critical dialogue, a comparison of the three models may be made by the different treatment of Description Stage: The treatment without description stage; description is not the first stage of the treatment; description is the first stage of the treatment.

New Hypothesis of Cognitive and Cultural Self in Current Context

New social and technological structure has introduced a new metaphor for thinking of the self. It not only reconstructs meaning, but also reconstructs the definition of identity. As a multiple, plastic and permeable system, multimedia instruction may offer new avenues and context for self-understanding. Such understanding is always challenged by the cultural accumulation that we belong to. In respect of Chinese Confucian and Taoist philosophy, they both emphasized on the sentimental intuition correlated with the artistic rhythm of mind and learning behavior. The neo-Confucianist, had even figured out the power of inner thoughts in driving actions. However, they all left a methodological gap between knowing and practical intelligence.

From the point of view of the Structuralism, the "art of the intelligible" indicates that the activity of creating and recognizing intelligibility. It is a matter not only of theory but also of praxis, that no formal program or effective procedure will generate it automatically. It arises out of acquaintance with cases and consequent insight (namely, "cognitive intuition") into problems. It is a case of structural transformation that all understanding, no matter how variable, to the subject who understands, is somewhere along the same continuum [Caw 1988, pp.7]. Psychologically, the matrix will include the inner world of teaching by transforming self-doubt into self-confidence. As regards

Zen Mental shock appeal, it was usually to the student's intuition faculty rather than to his reasoning mind. Being entranced by external cues, inner awareness is inspired by a sudden, striking realization the phenomenon, the learners awake to their identity. Calm sympathy with the world of nature was very characteristic of both Taoism and Buddhism. Their theories when applied to education, words are used as symbols or blinds. Either *see the world with pure eyes* or *open the third eyes*, to arouse the creative imagination, was the main purpose of instruction.

This study emerges a view that internal consistency in learning is not enough. It raises a methodological note in the pattern of relationships between outer clues and inner consciousness. On the instructional and psychological conceptions, a person's cognitive self would actively transformed by the interactive rhythms of discussion and revealing connections with how the peers perceive. Expanding Polanyi's theory (1964), the IMM instructural design will develop strategies based on a principal hypothesis: Through the interaction sequence consists of art criticism stages, learners can combine the subsidiary factors (formal, affective, manipulative, expressive, conceptual, and technical categories) with the focal aspects (confidence and sense of the whole)of an experience [Moustakas 1990, 21]. When both of them are in rhythm, converging true intelligent thinking and behavior, along with cultural belief and value, students can construct their own identities and narratives.

The Study's Design: Methods and Strategies

I have designed three modes of traditional Chinese painting inquiry: the intuitive, the normative, and the anthropological. It will focus on the microethnographic study built on the continuous case instruction in the classroom designed for In-Service Part-time Course for Training of Teachers in Primary School (ICTT) students in the Hong Kong Institute of Education. The length of the course was ten hours. Five two hours class sessions were held once a week during December 1996 to January 1997. In both systemic and systematic process, my research methodology consists of three phases: descriptive, experimental, and theoretical. Descriptive research includes longitudinal and cross-sectional observation. Experimental research is about what will occur under controlled conditions. I shall collect data through questionnaire, note-taking and tape-recording. Coding will occur by sorting data into conceptual categories. I shall use both semiotic and heuristic approaches for visual and dialogue analysis to form tentative insights. Collected from various data sources, I shall conduct internal and external comparison of concepts and theories. Findings will compel possible and meaningful research questions in arts education by philosophical and psychological evaluation.

This paper describes only the evaluation process of Model 1 (Knowing with Feeling, KWF). Unstructured observation of written and verbal records will be used for prescriptive analysis. This *Knowing with Feeling* instruction method is based on new insights from instructional psychology and Chinese philosophy. Monitoring the presence of sequential matrix makes its methodological analysis. Such matrix is displayed in the learner's art criticism categories. The results will suggest that self-regulated learners should construct their own self-chosen sequence as a learning strategy via the teacher's instructional design matrix.

Observation Analysis

This phase focuses on comprehensive record of a classroom journey between causality and continuity of the multimedia environment; and a practical experience of the multiple and contradictory "self" and "no-self" in artistic and cognitive classroom context. It will suggest an Art IMM instruction that pushes students to produce or to perform by clearly defining the paths.

Media Statics and Natural Calm Sympathy--Aesthetic Cues in Mindlessness process

This step tries to generate hypotheses, to see how the presence of minimal forms setting brings to intuitive inquiry; how the manipulated and structured media environment provides an cue encounter to convey existential validity to the viewer. Being located in a quiet and static visual environment of a slide show, the learners could access the overall information regarding the target theme and medium without any direct instruction for about five minutes. The considerations try to make apparent that the appreciation of the simple Chinese landscape painting is not merely sensory qualities. Toward pure aesthetic attraction, a tacit message would come to the learner's mind in the pattern beyond words. The preparation of mind in inner quietude and harmony was ready for mental or spiritual purification before the early stage of heuristic processes. It functioned like many painters and calligraphers in Chinese tradition, they used the inkstone grinding the ink, intended to focus their thoughts, to loosen their body, and to be free from any external disturbance.

Initial perception When the learners start from what and where they are, they would naturally shape their interactive way towards a world of senses and images which experience itself is initially rooted. Students would find it easier to start learning from simplicity and innocence. The problem is, a typical Chinese painting is not a record of a particular experience. Its form refers not only to human subjectivity but also to human development of spiritual knowledge as a whole. Art is only a kind of means, postures of practice toward the inner nature of persons. The paintings fill with symbols which the artists alone are capable of understanding. Although the students seemed confident of being surrounded by the calm environment, they might continue to leave it "bland" and bring nothing to mind. At that time the learners might experience the media phenomena from a particular centrist and egocentric view. From philosophical dimension of Buddha nature, such "thus-ness" or "such-ness" will prevent the learners from seeing into the reality.

Media Flexibility and Internal Locus Control-- Methodological Cues in Responding Process
Initial Attention The second instruction focused on a logical exposition of variables related to collective approach. Students were required to distinguish various strokes they encountered in the painting, and illustrated them into classified groups by drawing activities. Based on structural sense of visual elements, some of the semantic differential was showed. They successfully sketched an analogy. The pictorial cues stood out and attract immediate attention of the learner.

Interactive motivation This analogy was developed to be a conceptual view of information as hierarchy during class discussion. Participants tried to guess various features by the accessible words. The elements of perception entered into *conscious awareness* for its "addressable" quality. In the class I observed, such hierarchical clues helped students to attribute elements to proper categories. It supported an analytic inference and thus associated the focal sense of the wholeness.

Initial impression The choice of black and white copies from model Chinese paintings increased clarity and readability of contour line drawing or cun (strokes depicting various geographical features commonly used in Chinese landscape painting). They were utilized for practical understanding underlying properties, based on nonanalytic inference, in applying stenciling and collage techniques.

Observative concentration The computer assisted transparencies interfaced with processes of analytic criticism was eventually lead to an interior landscape emerged. On the basis of clues accumulated during the initial stages of search and retrieval, the transparencies were easier to apply different colours to facilitate discrimination between the functional areas on the painting. Eye fixation could be restricted to a certain part of the painting. A hidden pattern presented in the media flexible and multiple structuring and re-structuring demonstration. The dialogue further encouraged visual structuring of ideas and signs. Many students could speak out the different effects and functions of the lines, and jotted down the characteristics of the space. They yielded the categories of concrete and abstract sequences, visual and invisual connections, and obtained new aesthetic experience of natural and coherent movement actualized in every single stroke.

Media Dynamic and Cognitive Focal Factor -- Cultural Cues in Determining Process
Dynamic attention Interpretation criticism was drawn by the sequential motion of the computer assisted animation. On the comprehension of presented form fragments, students were able to view the different aesthetic ideas of Chinese and Western painting in abstract and structural patterns. They were aware of cultures code knowledge in perplexing and *Tension State*. With the visual support presented on the screen, students could see how forms in Chinese painting were related and gave birth to each other. The aesthetic balance could be judged by the drifting and dynamic equilibrium within the painting, not the reality. The instruction gave new meaning of making form: The multiple perspective structure of Chinese landscape painting conveyed an authentic sense of inner structure. It was different from the objective and psychological sense of western idea of space.

Transformations of executive processes and skills Setting out to a computer-assisted producing package, the first step was to identify the objective. It targeted to integrate Chinese and Western ideas of space into 2-D Pattern Design. The students were required to join the two dynamic structures of cultural view in multiple harmonies. Selecting the appropriate stroke structures from the colour copies did it firstly. The form was then determined by specific requirements of the computer learning environment. In the evaluation criticism, I observed that productions were organized by what was adapted to the situation constraints imposed by the task. When interacting with computer software, logical procedures of cut and paste, drop and add, structure and restructure were temporary attended. The student who benefited from this method was capable of improving judgments and decisions in variety of choices. In situations of uncertainty, this process convinced students that they could be able to regulate their self-chosen sequence of producing. Most of the learners facilitated the acquisition and creativity of skills. But it had moderated affective aspects of personality. Many works were controlled by rationally combining the two different cultural logic.

Preliminary Conclusion

The interplay of the two mental activities: affective and cognitive intuition has not really been investigated in existing researches. This study is not just a correlation but evidence of an empirical based, causal connection between feeling and knowing. Although the students would find it hard to create meaning from a Chinese landscape painting, but they could cluster the intuitive categories, not just with a pure form but with the structural sense of the forms. The forms structure in a sense a metaphor. It directs cultural continuity and certainty between the painting and the viewer. The exposition and comparison of criteria of intent will give the right encouragement of multimedia teaching. It has created new awareness and understanding of the transcendent thought of the artifact. Students will see more the philosophical value behind the visual sitting, thus internalize their human consciousness, explore and reaffirm their own webs of philosophical values and beliefs.

The analyses are based on a suggestion that the learners' concept and knowledge is inferential and heuristic in nature. My tendency is to depict the CAI based upon human perspective. Participants' responses indicated that the awareness aspects of their metacognition were related to media exhibiting. The better various combinations of art criticism stages could also evidence better self-regulation habits. Based on feedback about their production, metacognitve control was evidenced as a "reactive" thinking process in this study. This research will go on validating the quality of people's feeling and belief about their proactive control. What do they feel before or when they know: They feel they know or they feel they should know. If students believe that they know, believe what they know were proved to be motivating to actions, what would make such subjective feelings valid in learning performance? The research will be a continuous process, which is designed flexibly influenced by any changing dimension of independent variables. Consequently, it will achieve its real potential when it is utilized toward an integration of both externally paced instruction and internally paced instruction. The subjective conviction will contribute significantly to students' learning achievement, by adhering to the following instructional shifts:

1. A shift from Mindlessness to mental shock, processing to Metacognition determining;
2. A shift from Sensory to Control Dimension, toward intelligible Dimension as a whole;
3. A shift from the technical, to the reflective activities of Form, Metaphor and cultural context.

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Appendix

Media of Presentation	ID Models	Aesthetic qualities: Sequence of Pictorial cues	Structure: Art Critical dialogue Sequences	Designated Objectives					
				Content/ Theme	**Infom-ation**	**Idea**	**Multi-skill**	**Learning Process**	**Partici-pants**
original works Prints Xerox-copies B/w copies Colour copies	**Model 1** *Knowing with Feeling*	Formal ↓ Expressive ↓ Technical	Analysis ↓ Interpretation ↓ Judgment	Landscapes	Form	pattern of Cun & space	Pattern Design	Determining ↓ Responding	ICTT1
Transparencies Slides TV feature film* Computer Assisted: Animation Prints Transparencies	**Model 2** *Feeling of Knowing* [Miner & Reder 1994]	Literal ↓ Expressive ↓ Formal ↓ Technical	Description ↓ Analysis ↓ Interpretation ↓ Judgment	Human Figures & Animals	Meta-phor	Meta-morph-osis	Painting	Mindlessness ↓ Determining	ICTT2
* for **Model 2** only	**Model 3** *Feeling with Knowing*	Expressive ↓ Formal ↓ Technical [Lenten etc. 1986]	Description ↓ Analysis ↓ Judgment [Feldman 1971]	Buildings	Cultural Cont-ext	Mont-age	Printing-making	Responding ↓ Determining [Salomon, 1983]	ICTT3

Table1: Three Art Critical Dialogue Sequences Based Models

On Multimedia Signatures, an Enabling Technology for Web-supported Instruction

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Abstract

World Wide Web sites have become a common mechanism for instructional management and resource distribution. Tools to authenticate the source and validity of multimedia information is vital, especially in the case of distance learning. *Multimedia signatures*[1] are hidden and encoded information signals inserted in a media document (e.g., an image, video, or audio file) for the purpose of copyright protection and proof of ownership. This paper considers multimedia signatures as a mechanism for legal protection of educational resources.

1 Introduction

There has been a vast proliferation of educational World Wide Web sites which are now being used for a multitude of applications: supporting a traditional printed text, providing communication among students and teachers, supporting lab and library functions, and providing additional teaching and research support. In parallel, there has been a growing use, and also abuse, of digital materials on the Web, with extensive "borrowing" of Web documents, especially images.

Enforcement of copyright laws in this environment is a growing problem. Digital materials are extremely easy to copy, and copies can be modified with very simple techniques (e.g., brightness adjustments in images) so that the copying is not detectable using simple file comparisons.

Multimedia signatures are a new enabling technology that can help in establishing ownership of originals and derivations for digital media. Signatures are an imperceptible but robust signal added to existing data, allowing owners of digital media to prove the origin of copies and modified copies of their work. While not preventing theft of an image document, signatures promote the idea of an ethical and honorable Web by building the power of proof into documents.

Similar methods are also being used with *detectable* signatures. IBM's "visible watermarking technique" [Gladney et al. 97] [Mintzer et al. 96] and the built-in watermarking feature of the Hyperwave next-generation World Wide Web system [Hyperwave] add perceptible but difficult-to-remove patterns to images. Although not as secure as imperceptible multimedia signatures, visible watermarks have the advantage of giving users a readily apparent notice about the status of a particular image. The combination of visible watermarks with multimedia signatures can be quite powerful. A visible watermark provides a straightforward way for users to identify a document's source and copyright status,

[1] Some authors prefer the terms "labels", "digital signatures", or "digital watermarks" for multimedia signatures. We prefer the term "multimedia signatures" because, respectively: it suggests more focus on security than "labels"; it is not as easily confused with cryptographic signatures as "digital signatures"; and it does not seem to imply easily perceptible changes in documents, or a limitation to digital images, as "watermarks" may.

while accompanying multimedia signatures can give distributors some assurance of proving misuse even if malicious users remove all visible watermarks.

Applications of this idea include proofs of ownership, traces of distribution paths, and inclusion of public information like copyright notices or private information like copy prohibition tags in a "format-independent" way. Podilchuk and Zeng use the terms "destination-based" and "source-based" to distinguish signatures used for tracking different copies of a document after distribution from those used for authenticating the source of a particular document. [Podilchuk & Zeng 97]

2 Multimedia Signatures

The problem of inserting signatures is conceptually simple: encode an undetectable signal in an existing media document (generally an image, audio, or video document in digital format) in such a way that it is recoverable only by parties in possession of its "key". All signature techniques work by introducing a signal that appears as noise into a media document. In some techniques, this signal only resembles noise as a side effect; in others, the signal is deliberately designed to resemble "natural" noise. Unfortunately, the task of devising signatures that are robust to compression, common document manipulations, and outright attacks is not easy. The signature signal should resist degradation, both from ordinary media manipulations and from purposeful efforts to erase it.

Multimedia signatures are similar in spirit to traditional paper-based watermarks: both are intended as nearly imperceptible superposings of additional information on a document. The difference is that traditional watermarks are attached to a particular *document*, while multimedia signatures are attached to the *information* itself. Traditional watermarks are not transferred by most copies—whether a scribe's copy of an ancient manuscript, or a photocopier's copy of typewritten document on watermarked paper. Multimedia signatures, referred to simply as "signatures" for the remainder of this paper, are designed to be transferred by all copies.

Multimedia signatures are a sub-area of *steganography*, or data hiding, in which secret signals are embedded into public ones. The defining factor is the lack of secrecy concerning the existence of the signature signal, or "covert channel" in the terminology of the cryptographic community. Since it is not assumed to be known only by those using it, ensuring the robustness of the signal is as important as hiding it well. [Cox & Miller 97] [Zhao 97] The general intention is to make the signature signal inseparable from the data it accompanies, at least without special knowledge initially available only to the signature's creator.

Existing signature techniques, despite sharing the same basic goal, exhibit tremendous variety in their design. These differences can make direct comparisons difficult. There are, however, some basic issues that all methods must address. This paper gives an overview of the constraints and technical issues in applying this technology to educational Web sites. We consider the need for multiple methods (Section 3), issues of integration and ease-of-use (Section 4), and potential difficulties with using multimedia signatures to prove ownership (Section 5). A survey of existing techniques for multimedia signatures can be found in [Ford, Makedon, and Owen 98].

3 The Need for Multiple Methods

The fundamental nature of the media is important in the design of a signature technique. A technique that works well for images may not necessarily work well on video or audio. Furthermore, a given technique should ideally be insensitive to specific document formats within its media type. We present in this section the two primary media considerations.

Inserting signatures in temporal media—media that change with time, like audio and video—is a newer and more challenging area in multimedia signatures. There are important considerations in designing signature algorithms for temporal media that make them more complex than algorithms for static media. For example, since digital video can be viewed as a sequence of static images, it might seem natural to apply image signature techniques to each image in the sequence. The problem with this approach is that small changes used to encode a signature in a single image may become much easier to find when other images in the sequence are available to provide statistical correlations. Also, signatures

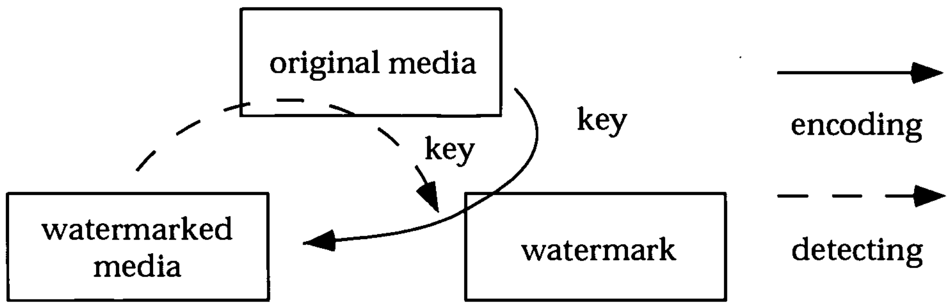

Figure 1: Key plus original detection. Encoding uses the original document (optionally) and a key to generate a multimedia signature, which is combined with the original document to produce a new version for distribution. Detection uses the original document to extract a potential signature from a suspected derivative of the distribution version; this is then analyzed with the key to determine if it is the expected signature.

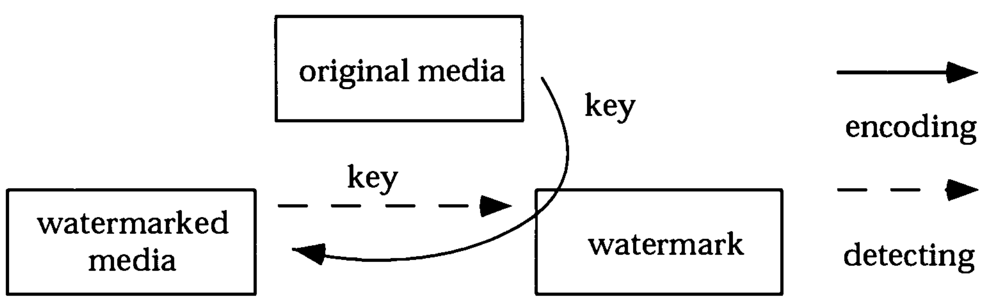

Figure 2: Key only detection. Encoding uses the original document (optionally) and a key to generate a multimedia signature, which is combined with the original document to make a distribution version. Detection uses only the key to determine if a document contains a signature corresponding to that key.

in temporal media need to be resistant to additional transformations; for example, interpolation between video frames may eliminate signatures encoded using image signature techniques on each frame.

In general, it is not possible to insert signatures successfully in different media using the same algorithm. The degree to which a given document transformation affects perceptibility in one domain may not correspond to its effect in any other. A signature designed to survive image transformations may not have the same success in the audio domain, where the effects of transformations on perceptibility is different. For example, time expansion or dilation of audio without shifting its pitch is a common audio transformation that has no obvious analogy in images.

The necessity of having multiple methods for inserting multimedia signatures into different media does not have to affect ease-of-use, as covered Section 4.

4 Integration and Ease-of-Use

As discussed in Section 3, inserting digital signatures into different media requires different techniques tailored to the media to be effective. In order to prevent this requirement from burdening users of multimedia signatures, different algorithms can be integrated into a single package that will use the correct method to insert each signature.

We envision a "smart" web server like Hyperwave [Hyperwave] being used to provide multimedia signatures transparently to content providers. The system could automatically add identifying signatures appropriate to the system, institution, and/or publishing individual when that person adds a document to the server. Under this arrangement, users never need to deal with signatures directly, other than to provide the server with any identifying information they wish to have included in the signatures it inserts. Hyperwave presently provides this service for automatic visible watermarking of images.

Content providers often desire to have some indication of who has made copies of their materials. Using the World Wide Web for dissemination of information makes this difficult. Even if users are authenticated and tracked, there is no way to distinguish a Web client that downloads an image for viewing and then discards it from one that retains a copy. Tracking all accesses is difficult for this reason, and may be objectionable to those accessing the material as well. One solution is to modify the server to provide lower-resolution, smaller or shorter versions of multimedia documents without signatures by default. Clients that wish to download full-quality versions can then do so, with the expectation that their access will be tracked and digital signatures will be inserted.

5 False Positives and the Invertibility Problem

An important legal problem for any inserting signatures system is the degree to which a signature it encodes can be "trusted". For example, if the odds of a particular signature pattern occurring by chance are not acceptably small, then the system may suffer from "false positive" detections of signatures that were not inserted. Systems can be tuned so that false positives are not a likely explanation in any proof of ownership, but the best way to rule out the possibility of false positive detections will be to have multiple simultaneous documents where multimedia signatures can be detected.

The "invertibility problem" presented by [Craver et al. 96, Craver et al. 97] is a high-level problem with signature authentication. If a signature can be encoded with an easily reversible transform, and if there are no restrictions on the format of the signature, then anyone can claim any random noise in any data is a "signature" by simply computing the inverse of the signature encoding transform on that noise.

The problem can be minimized (eventually to an acceptable level) by requiring non-random signature strings and by increasing the complexity of the encoding: this reduces the fraction of combinations in "signature space" that are legal encodings. Another alternative is to require using an official registry of signatures if they are to be admitted as legal proofs [Craver et al. 96].

6 Conclusion

The trend towards the distribution of digital media documents stimulates research towards the development of methods for protecting copyrights. Multimedia signatures are a promising technology for ensuring that these rights are protected. There have been many approaches to digital signatures, and new ones are introduced regularly, but all techniques need to address certain core goals and concerns to be useful in education. Similar requirements will apply for multimedia signatures used in related areas like museums, which are gradually making many exhibits available to the public through the World Wide Web..

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Learning Engines - a Functional Object Model for Developing Learning Resources for the WWW

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Abstract: The Learning Engines model is about the integration of rich learning activities into the WWW. It is concerned with the practical design, educational value and re-useability of software components. The model is focused on the academic teacher who is in the best position to conceive and apply novel learning objects to meet particular discipline learning requirements. A key component of the model is the ability to engage the learner in tutorial-style dialogue. By incorporating into this other content resources and customised interface objects, the learning environment can be effectively extended. Learning Engine objects operate within an open, scalable technical framework that provides mechanisms for inter-object communication, database management, delivery and authoring.

Background

The University of Melbourne is, like many other institutions around the world, re-thinking its approach to teaching in the light of changing economic and societal factors. There is a particular focus on restructuring whole curricula, supported in part by funding incentives for projects integrating educational technology into courses. The Multimedia Education Unit plays a central role in this process providing academic and technical support to departments and faculties. It is from this position that we perceive a need to enhance the often rather didactic delivery of information often associated with the World Wide Web (WWW). We are particularly interested in developing conditions for the active involvement of students, the process of 'doing', reflecting and of iterative adjustment of understandings. In this light we are seeking to extend the conversational nature of the teaching-learning process with some form of dialogue between the student and teacher, in this case by way of intermediary WWW-based software objects. The purpose of the model is not to provide the complete on-line interactive system. Rather, it is a practical opportunity for teaching staff to add rich and customised activities to their courses to complement existing on-line and traditional modes of learning. There are many solutions already available to efficiently deliver banks of multiple choice questions for example. The activities we are proposing however, with careful design and application, do have the potential to provide the student with a more engaging experience than might otherwise occur.

Despite an expanding collection of interactive WWW resources such as visualisations, simulations and tutorial systems, we see the continued need to customise on-line activities to meet the cultural, institutional and pedagogical positions of local teaching staff. From the technical development viewpoint, many challenges also remain. Appropriate cross-platform development systems are few in number and relatively immature, the foremost contenders being Java and Macromedia Shockwave. In the light of the traditional CAL approach within the University environment, we have initially employed, but are not restricted to, Shockwave for Director. Shockwave objects operate within a standard WWW browser page by way of an extension 'plugin'. They can offer a high degree of interactivity, control over various forms of media and are compact in size making them ideal for on-line delivery [Macromedia 1997].

The Learning Engines model

The Learning Engines (LE) model is an object-based approach to thinking about, constructing and interconnecting educational objects. By 'object-based' we mean here modular software objects that can be independently developed to certain technical and functional standards and set up to operate collaboratively. The model is not dependent on any single object, any object can be replaced, with the value coming from the combination. This value is both in effectiveness of learning and the ability to reuse resources in different teaching contexts.

Four broad classes of object in the LE model have been described [Fritze & McTigue 1997]. These include client-side *visualisations* such as animations, hyperlinked data sets, movies or other representations of information. *Simulations* may be pieces of virtual equipment or graphic representations of more complex relationships in which parameters can be adjusted, providing a higher degree of intrinsic feedback and in which there are multiple 'dimensions' for the student to explore. For both these types of resource, consideration should be given as to how they are employed in teaching. Unless a learning context is made clear, the student experience may well be one of knowledge reception or simply unfocussed exploration, rather than constructive engagement in learning activity. This context may be established by direct involvement of the teacher, by integrating the resource into other classroom activities or by providing guidance in some form of supplementary instructions. In the LE model, we introduce the idea of constructing an on-line dialogue between the student and the resource using a third class of object, the *dialogue shell*. A dialogue can be constructed by each teacher to provide an extended sequence of tutorial-style learning interactions to guide the student through a graded set of activities, provide immediate remedial feedback and give the teacher indication of problems and progress of the student. The 'shell' object is configured with content information by the teacher using a separate script template described below. Input or *interface objects* can extend the capabilities of a dialogue shell with customised and novel forms of interface to the subject matter. They could, for example, provide virtual 'pens' and 'papers' optimised for different subjects. It is worth briefly describing the main dialogue shell object and how it can be applied to other LE objects to create rich learning activities.

The Tutorial Itemset - a dialogue shell

The Tutorial Itemset is an instance of a dialogue shell with which we can create a sequence of question items for the student [Fig. 1]. It is based on the TutorialTools instructional authoring system used since 1993 to create over 80 hours of undergraduate CAL workshop materials for the School of Chemistry [McTigue et al 1995]. An earlier version of the WWW dialogue shell was described in [Fritze 1996]. It supports a variety of question styles and multiple levels of student feedback. Students can also register comments at any stage. Multiple assessment criteria can direct feedback according to subtleties in a student's response and the interaction styles have been extended to address the difficulty of open-ended responses.

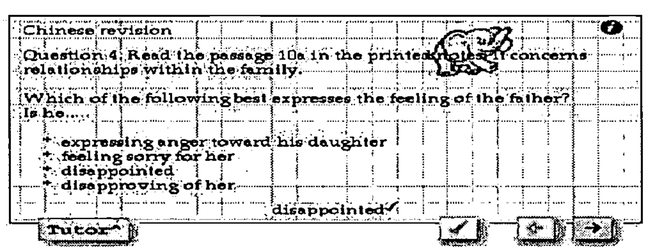

Figure 1: The Tutorial Itemset object displaying one of a set of question items

In this example the Itemset object is operating as an independent object, under the direction of a question script. The real power of the LE model is in being able to extend this interaction with other LE objects to provide a richer and more customised environment. This has been described in [Fritze & McTigue 1997] and [Kennedy et al 1997] but it is worth summarising with two examples.

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The example in [Fig. 2] illustrates how a very simple resource in veterinary anatomy can be used as the focus of a tutorial dialogue. The WWW page contains two LE objects, on the left a simple object, essentially a digital video of a leg that the student can position to various angles, and on the right, the regular Itemset dialogue object. The first question item requires that the leg is moved to full extension, subsequently the position of the leg is read by the Itemset as the answer to the question. The next question item not shown here will physically position the leg to a particular angle and pose a standard multiple choice or text entry question based on the indicated circumstance. As a simple visualisation of a body function the Leg resource is probably of limited value by itself. By using it as an extension interface to the Itemset, we have the ability to more fully explore the issues concerning this particular body system.

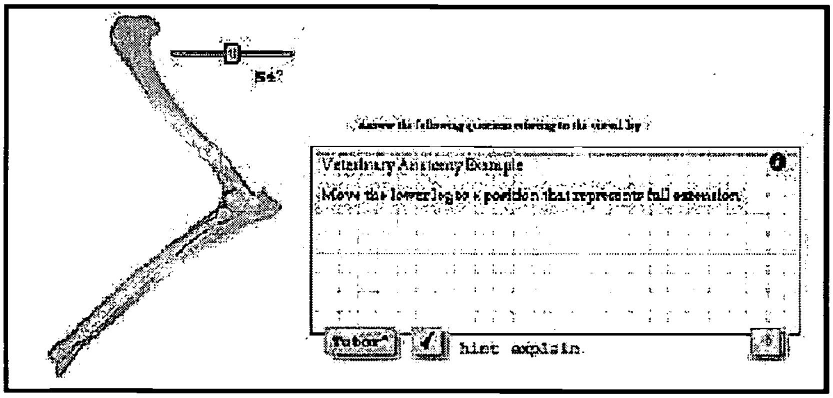

Figure 2: Objects combined to created a tutorial dialogue centred around a simple visualisation

The Interactive Graphing Object in [fig. 3] is another example of an interface component that extends the capacities of the general purpose tutorial object [Kennedy & Fritze 1997]. With this the student can sketch a curve on 'graph paper'. The attempt is also classified using a three point Bezier interpretation and reported to the Itemset. The Itemset can also specify curves to be plotted in the graph.
In the example below, the Itemset and Graph object have been combined within a WWW page. A curve has been displayed on the graph as directed by the script of the Itemset. The student's sketched response has failed one of the Itemset criteria conditions which returns an appropriate comment in response. The level of detailed question and response using such combined objects is potentially very high and applicable across a wide variety of disciplines.

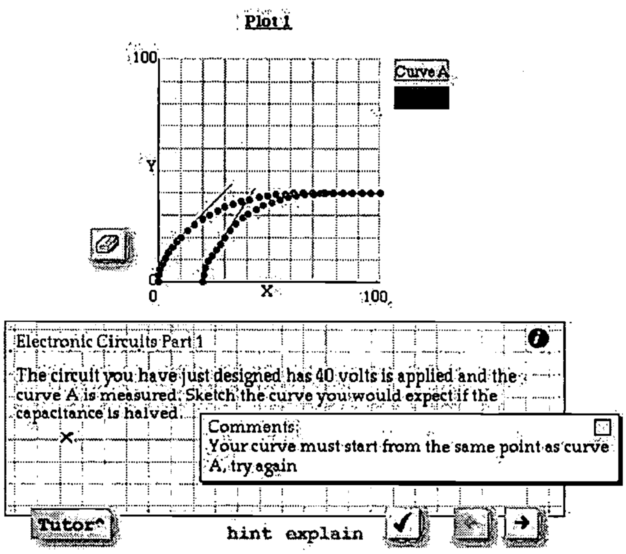

Figure 3: Graphing Engine input device as focus of a tutorial dialogue

Additional components under development in 1998 include interfaces and objects for open-ended text, simple algebraic input, image labelling, constructing images from picture elements, concept mapping, simple film storyboarding, a virtual dog for veterinary anatomy, a digital video front end and various language exercises.

Design Issues

The main focus of LE object design is directed at the educational level, but supported by an underlying technical and broader course-level framework. This focus addresses most directly the curriculum requirements and it is our intention that the content teacher plays a central role in the conception, functional design, implementation and evaluation of these objects. There are a number of reasons why the LE approach makes this practical. Firstly, as relatively simple resources or extensions to the dialogue shell, LE objects are finite in their functionality. Their purpose and operation are clearly understood by teaching staff who can discuss their requirements with programmers without the need for involved software development or detailed technical specifications. Secondly, the delivery of LE activities and navigation through the course is handled by broader scale WWW course delivery systems, whether a basic WWW server or a commercial delivery system such as WebCT, CREATOR or TopClass. The focus of the teacher remains on the 'coal-face' learning interaction. Thirdly, the construction and operation of LE objects is supported by an underlying communication framework and a library of standard software functions described below.

With smaller, modular constructions has come the opportunity to create objects suiting the purposes of multiple disciplines. The graphing object for example has applications in medicine, economics and the sciences. Techniques for working with open-ended questions apply across all faculties. Consequently we have been conscious of the need for a design methodology to draw together educational ideas and requirements from a wide range of interests. This has involved discussion and negotiation with academic staff from different discipline areas. Although it is beyond the scope of this paper, we draw attention to the technique of scenario-based design. This software design approach is centred on the use of brief descriptions of representative usage sequences as a catalyst in this process. This form of documentation is concise, couched in plain English and can represent the ideas from those with even a minor interest in a project. For more details refer to [Carroll 1995].

We have also found that the attempt to translate existing standalone tutorial exercises into the new Web-based object format, despite an apparent similarity of function, has highlighted differences in the nature of the two approaches. Most obviously, current WWW browsers struggle to run the on-line components as quickly and as seamlessly as their standalone counterparts written in HyperCard, ToolBook or Director etc. Despite having scrolling windows, browsers running on small monitors make it difficult to organise screen layout, with the increase in modularity and generic function also leading to a loss of ability to fine tune and optimise the display. The time to load a page and associated objects across the WWW can be highly variable and is generally much slower than the standalone. Activity grain size is something that should be considered in examining the dynamics of a student's passage through the course materials. In the case of LE components, we have found it most satisfactory when a page contains an extended sequence of activities, rather than just a single question.

Learning Engines Technical Structure

While the main thrust of this paper has been to present a teacher's view of the model and nature of LE objects, a brief summary of the technical structure is given here in terms of the supporting communications framework, the object content script and software core libraries.

Communication Framework

At present LE objects are Director Shockwave movies embedded within an HTML page. Each object has the ability to receive and send commands to and from other LE objects, to report a student response, set a simulation to a particular state or to demonstrate a correct answer. There are two methods in which this is implemented. Initially communication between LE objects as Shockwave movies was achieved using preferences files of the browser plugin and simple JavaScript functions. A more scalable communication framework is now employed which is described elsewhere [IP et al, 1997]. The VA framework provides the lower level mechanisms for inter-object communication, server database connection and management of object scripts. A key component here is the VAmessenger in the form of Javascript on the enclosing browser page which directs messages between objects, even those created in different development systems, for example, in Shockwave, Java, Javascript or ActiveX. This underlying framework also provides the glue for integrating LE objects with Web servers, databases and independent course delivery systems.

LE script

Many objects such as the Itemset can be pre-configured with content data. These objects can parse an external script file to update their structure [Fritze, 1996]. The script can be loaded either from a local file or remote database during startup, providing a means of separating and storing content data and for basic authoring. Each object has its own 'vocabulary' of commands and parameters but follows a common syntax. Currently two script formats are supported. The original version is illustrated by the following script extract from the above charting object:

```
graphset
  plot "Plot 1"
    curve "Curve A", "type=growth1, y2=40"
  plot "Plot 2"
    curve "Curve B", "type=line, x1 = 50, y2=50, x2 = 100, y2=100"
  ...
```

The object is therefore able to be 'authored' in relatively plain English language, couched in terms of the teacher's view of the object. In adopting the VA framework as mentioned above and in anticipation of a move to Extended Markup Language (XML) as a standard for WWW communication, we are adapting the parser to the VAscript format described in [Ip & Fritze 1998].

LE Director Core Libraries

LE objects are currently constructed in Director 'Lingo' using an object orientated programming approach. The artefacts seen on screen and the underlying information structure are in fact created at runtime, as the content script is parsed. The software to support this exists in a library of core behaviours common to all LE objects. Creating an entirely new LE object then is greatly simplified and focuses on the creation of parent scripts and special behaviours for the new sub-components of the object. In the above example this would involve the parent scripts for the 'graphset', 'plot' and 'curve' sub-objects, defining their properties, behaviours and screen rendering characteristics. In addition to the parser, the core libraries support inter-object communications and other standard interface functions.

Future directions

The LE model has evolved out of the experiences of working with a number of projects in different disciplines including Physiology, Psychology, English, Chinese, Dentistry, Pharmacology, Economics and Commerce, Genetics, Chemistry, Veterinary Anatomy, Medicine and others. It is intended that departments will use the pool of LE objects as a shared resource and be able to develop at least simple additional objects to meet their own requirements. Evaluation of LE content materials for a number of these projects is being undertaken.

Administrative supports such as improved authoring tools, feedback and progress reports are being developed in conjunction with the VA framework and will be extended as the projects are implemented during 1998. The development of authoring layers with which components can be more easily configured by teaching staff remains a top priority and the subject of current work.

Integration into WWW-based courseware systems will provide more generalised solutions for whole course delivery, computer mediated communication, administration and assessment etc. We will be able to report progress on work with MelbourneIT and their CREATOR course delivery system to incorporate LE components and the VA specification as extensions to that particular delivery system.

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KBS-HYPERBOOK - An Open Hyperbook System for Education

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Abstract. Educators are currently investing much effort into the conversion of their tex t-books and lectures into hypertext documents. Within our KBS Virtual Classroom project, we have recently developed a data-base oriented method for systematically designing such hyperbooks.

However, converting theoretical material into a hyperbook is only the first step towards a modern, project-oriented, computer-supported learning environment. To realise such an environment, the static course materials (regardless whether they are printed textbooks or hyperbooks) should be replaced by an open hypermedia information system, to which both the educators and the students contribute. In this spirit we have redesigned our hyperbook modeling technique to make it suitable for both capturing theoretical lecture material and providing a structure for the student projects.

Introduction

In our KBS Virtual Classroom Project we work on providing students with complete teaching and learning environments for several subjects of computer science (artificial intelligence, software engineering and introduction to computer science I (CS1)). To encourage project-oriented education, our lecture notes consist of a complete project accompanied by the necessary theoretical background. The structure and content of these lecture notes are described by a set of hyperbook data models forming a skeleton for the presented project and the accompanying theoretical background and providing a documentation of content and structure of our hyperbook. Additionally, these models serve as a skeleton for the student projects, leading to an open hyperbook knowledge base which is continuously enhanced and extended each year by student projects.

Previous Modeling Approaches

The most frequently used approach to hypermedia modeling is to use no models at all. Web pages are written and hyperlinks are hard coded among them. Hypertext documents designed in this way have a poor structure, in which users get lost quickly. Recently, the structured design of hyperbooks (and hypermedia in general) has received increasing attention. We identify two research directions relevant for the design of educational hyperbooks:

1. Systematic object-oriented modeling techniques developed for generic hypermedia systems like web servers and database front-ends. The Hypertext Design Method (HDM) [Garzotto et al. 93], the Relationship Management Methodology (RMM) [Isakowitz et al. 95], and the Object-Oriented Hypermedia Design Model (OOHDM) [Barbosa et al. 96] are the most prominent examples. These methods structure a domain into a set of types or classes and their relationships. By classifying the pages into these types, navigation links can be inferred automatically from the relationships.
2. Specific approaches for educational systems have been investigated by the adaptive hypertext community [Brusilovsky et al. 96a,b], [Kay et al. 94], [Dale et al. 96], [Cleary et al. 94]. Usually the lecture pages, which can have an arbitrary structure, are indexed by the high level concepts of a user model. The knowledge derived from the user model can either modify the basic navigation structure of the document, e.g. the

system proposes suitable pages for the student; or it can be used to annotate the navigation structure. An overview of the different techniques used can be found in [Brusilovsky et al. 94].

Our own previous work [Fröhlich et al 96a,b,c] can be seen as an instantiation and extension of the approaches under 1. for educational purposes. Let us now assess the suitability of the above approaches as the basis of an open hyperbook system. In principle, being offsprings of object-oriented design methods, the approaches under 1. support extension and maintenance of hypermedia by their systematic models, in particular by automatically deriving links from relationships between several objects. On the other hand, the approaches under 2. usually lack declarative domain models. Indexing book pages with user model concepts has the advantage that the book structure itself is not affected. Any book can be turned into a hyperbook using these techniques.

However, we think that this paradigm does not provide enough guidance for the students. If the student projects can be documented in any form and are then simply indexed by the topics of the lecture, the resulting book will not stay coherent and consistent. Furthermore, without an explicit domain model students have more difficulties to become aware of the structure of the domain. Our framework in KBS-HYPERBOOK for designing open hyperbooks for education is less strict than the formalisms under 1. but nonetheless provides the structure for student projects by an explicit domain model. Its very rich domain modeling language allows to structure the domain of a hyperbook in a meaningful way. As we will describe in detail in this paper, the domain model provides the basic structure both for the theoretical material and for the student projects, but does not dictate the actual relationships between the pages.

Domain Modeling for Educational Hyperbook Systems

Our KBS-HYPERBOOK domain modeling language provides the hypermedia designer with the full expressiveness of an object model based on the widely used Object Modeling Technique OMT [Rumbaugh et al. 1991]. Its concepts are domain objects, relationships and attributes, inheritance, instantiation, and aggregation. In contrast to software engineering there is no distinction between the different concepts of meta-class, class and object are meaningful, because all domain objects are finally implemented as pages. Each modeling concept has a semantics which is documented in a meta model that consists of a conceptual model accompanied by rules and constraints.

In this section we will motivate each concept and the semantics we assign to it. We will also introduce a part of the model for our CS1 lecture, in which all our domain modeling and navigational concepts are used. The lecture consists of a simplified software process and an introduction to the JAVA language as well as a large Java programming project which serves as example for the application of the language and our software process. As their course work, the students work on a similarly large programming project in groups of 3 to 4 students.

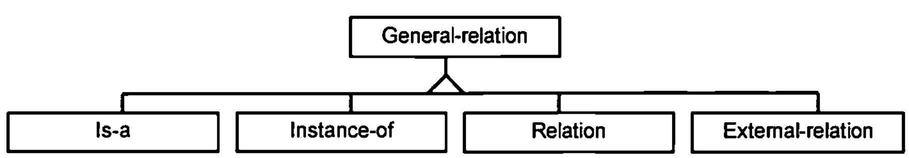

Figure 1: Types of relationships

As in most object-oriented software engineering methods, we start designing our domain model for the hyperbook by identifying domain objects relevant to the application e.g. Java Applet or Applet User Interface. Existing documents can support the construction of the domain model e.g. software engineering books for our software process domain model or the Java reference manuals for the CS1 Java lecture. Having identified the domain objects, we move on to the identification of relationships among them. Our domain modeling language supports a wide variety of relationships, as shown in [Fig. 1].

The is-a relationship conceptualizes the specialization of a concept e.g. the user interface is a specialization of a Java applet. The instance-of relationship denotes that a concept or object is an instance of a more abstract concept or object (-class). Although instance-of relations are less common in software models, we found this concept indispensable for all educational hyperbooks we have designed so far (CS1, software engineering and (a small part of) artificial intelligence). Especially in software engineering and artificial intelligence it is often the case that the lecture talks about abstract concepts (like „software process“ in software engineering or „reasoning“ in artificial intelligence) and then moves to some prototypical instance (like waterfall model as an instance of software process or diagnosis as an instance of reasoning). The KBS-relation qualifies the relation of two concepts therefore providing the ability to connect (and link) two otherwise not related concepts. We provide the ability to link to WWW-pages outside the hyperbook by using the external-relation concept.

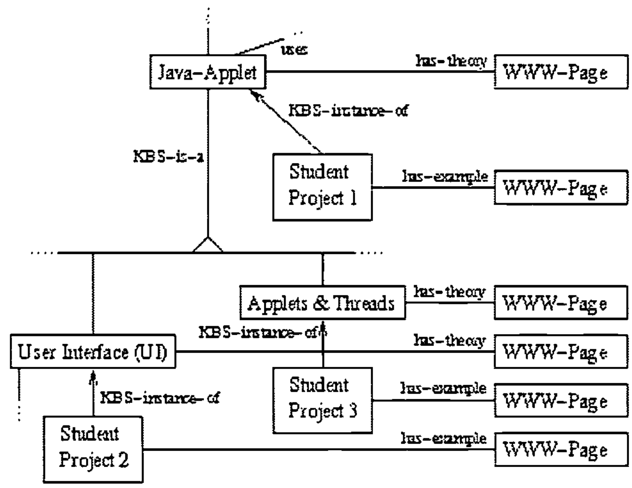

Figure 2: Small part of our CS 1 domain model

[Fig 2] shows a small part of the domain model for our lecture CS1. The domain model consists of a short introduction to software engineering concepts and the object oriented programming concepts in Java. The hyperbook we are currently writing contains both the theoretical knowledge needed, as well as a one semester programming project. The student groups (we have currently 21 groups of 3 to 4 students) implement another project, whose solutions will also be included in the hyperbook. Additionally, student groups add hints concerning the concepts discussed during the course, which are also included in the hyperbook.

Systematic Navigation Support

The hyperbook contains several pages describing each object in the domain model. We distinguish two kinds of pages:

1. Concept Pages are pages which provide theoretical background, give practical hints, etc. concerning the domain object.
2. Instance Pages are instances of the domain object, e.g. a method declaration from a student project is an instance of the domain object "method declaration".

The navigation among pages belonging to the same domain object is made possible through the instance directory. This is a listing (menu) which contains all pages for a given domain object in some user-configurable order (based on attribute sequences).

To avoid spaghetti structures, the navigation among pages belonging to different domain objects is restricted by the domain model. A hyper link may only exist between two pages, if the corresponding domain objects are connected by a relationship. A concept page, e.g. a theoretical explanation of a topic may (or may not) refer to a dedicated concept page explaining a related topic. Other concept pages under the related topic can be reached via the instance directory.

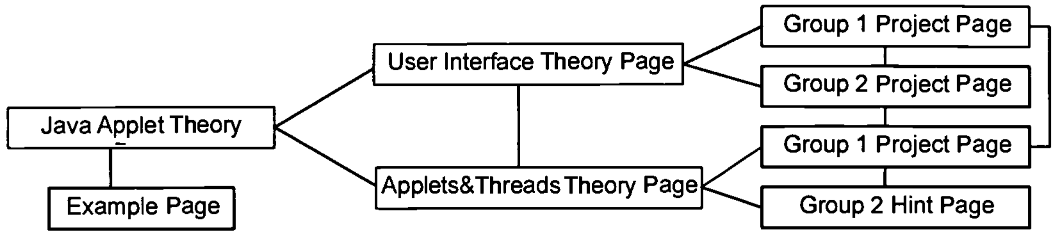

Figure 3: Some pages for a small part of the CS 1 domain model

To see how the domain model explained so far defines a skeleton for the book, consider the scenario in [Fig 3]. Some pages have been added: Each domain object is described by a theory page. For the Java Applet concept there is a longer example on a separate page. The student group 1 has contributed an example, consisting of a User Interface page and an Applets&Threads page. Student group 2 has created a project page for a user interface and a hint page for Applets&Threads. Note how the links (lines between the pages) represent the several different relationships.

The domain model provides the core structure for the book and the possibilities of navigation. The actual hyperlinks between the pages must obey the constraints imposed by the domain model. As we described in [Fröhlich et al. 97a], KBS-HYPERBOOK is embedded in a deductive database environment. This environment allows to specify hyperlinks by deductive rules based on attributes of the pages, e.g. we let the system automatically link a page for an activity to all corresponding student group documents.

Visualization of Pages

The domain model describes the semantic relationships between different domain objects and thus the possible links. It serves as a guide to the whole book, both for the authors extending the book and for the readers by giving them a coherent and consistent navigational structure. Note, that the domain model specifies the possible links between two pages. The actual links are a subset of these plus links between pages connected by the instance directory.

Each page is displayed as a WWW page and associated links. The links have a uniform appearance: 1:1 links (like the normal relationships) are displayed as page1 related-to page2, where page1 is the page title of the current page, page2 is the title of the linked page, and related-to is the name of the relation. 1:n links (like is-a or instance-of relationships) are displayed as page1 related-to, followed by a vertical list of the page titles of the referenced pages. The page title of the referenced page can be accompanied by a short page description.

A trail is an arbitrary sequence of pages connected by relations or an instance directory. Additionally, a set of pages can be included by using a query on the attributes and type of the pages. A page can belong to more than one trail. The user follows a trail using dedicated next/previous buttons. At any point of the trail the user can leave the trail using any of the links present on the page, and can return to this trail by using a back button. The user can view all trails which include the current page and switch to another one of these trails. A set of trails covering the book completely can be used to obtain a sequential version of the hyperbook which can be printed. We are currently implementing a function, which displays (part of) the domain model or the link structure centered around the current page. This aims to provide a spatial concept of where the user currently is, and to provide the possibility to jump to other pages visualized on this display.

User Model

As space is limited, let us only note, that our full hyperbook system architecture also includes a user model. Within the user model, we specify topics and their relationships. These topics partially overlap with domain objects. Not all domain objects need to be included as user model topics, and not all topics are present in the book as domain objects (e.g. prerequisite knowledge). Additionally, a page may be relevant for more than one user model topic and a topic can be discussed on more than one page. Therefore we have a m:n relationship between user model topics and pages.

The relationships specified in the user model represent the learning dependencies using Bayes' nets. Grading projects (which are similar in structure to examples and programs within the hyperbook) are classified similarly. Finally, the knowledge vector describing each user consists of a set of user model topics (and their values such as knows-nothing, knows-a-bit, knows-much, knows-all).

The performance of a student on such a grading project can be represented by assigning the appropriate value to each concept needed for this project. Using the update procedure of Bayes' networks, the knowledge vector of the student can be upgraded appropriately (both for these specific concepts and related ones, as specified by the learning dependencies within the user model). Using the values for the concepts within the knowledge vector the system can adapt the presentation of pages and links to specific users.

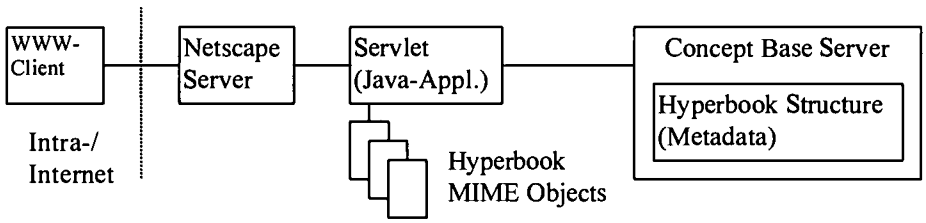

Figure 4: System Architecture

Current Status

The KBS-HYPERBOOK architecture described in this paper has been implemented in a first prototype. [Fig 4] shows the system architecture which is based on standard components complemented by a server-side JAVA program (Servlet) and the deductive database manager Concept Base [Jarke et al. 95]. The Concept Base system stores the hyperbook structure while the actual web-page content is referenced by the database objects and stored in the server's file system.

The user navigates the hyperbook by activating links. Via the HTTP-Get method the links cause the servlet to query the database. The database is queried for the fragments of the page representing the domain object and its navigational links. The JAVA program constructs a user specific page from this information and returns it as a WWW page. We are currently writing the lecture notes for our course "Introduction to Computer Science I" using the KBS-HYPERBOOK.

Summary

We have discussed our hyperbook system KBS-HYPERBOOK focusing on how to construct and use a domain model for a hyperbook. We think that the methodology described in this paper is the first one which is expressive enough to describe both contents and structure of an educational hyperbook without enforcing a database-like link structure on the hyperbook. Our approach contrasts to existing methodologies and systems, which either describe only the contents of a book (such as adaptive hypertext systems) or specify all links in a database like domain model (like RMM or OOHDM). The first results are very promising, and we hope to have a complete set of lecture notes (including student projects) for our CS1 course on the WWW at the end of this semester.

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Online instruction system for Chinese character handwriting using vector information and stroke-speed information

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Abstract: In recent years, the number of non-Japanese learning Japanese has increased. Japanese characters are divided into three types: hiragana, katakana and kanji (Chinese characters). Kanji are the most difficult to learn; the number of kanji is great and their glyphs are complex. What we have developed is software for kanji learning software with vector and stroke speed evaluation capability.

1. Introduction

Multimedia--the synthesis of text, pictures, sounds, etc.--has become a widely-used term as information technology progresses. This is not an exception in the field of education, for much research is being conducted in making use of multimedia in computer-assisted learning (CAL) systems.

For many non-East Asians, learning kanji in their study of Japanese can be a difficult experience because of the sheer number of kanji; while the Latin alphabet has only about 50 characters, a Japanese twelve year old is expected to have mastered over 1,000 kanji. Another factor is the complexity of kanji glyphs (see fig. 1).

下化火加可仮何花
餓介回灰会快戒改
郭覚較隔閣確穫嚇
乾勘患貫寒喚堪換
課蚊嘉霞伽茄袈我
該概亥凱垣各角拡
干刊甘汗缶完肝官
艦鑑侃莞丸含岸岩

Figure 1: Some of widely-used Japanese kanji

For a student of Japanese to learn kanji, repetitive drills similar to those conducted in Japanese elementary schools is often considered necessary. However, such drills are tedious and it is often difficult to allocate needed time in classroom situations. We feel that by utilizing multimedia we can create an improved method of kanji learning.

Writing kanji beautifully is difficult even for those who have mastered Japanese. The following are important factors in writing kanji beautifully:

- Correct stroke order
- Suitable part balance
- Distinction between leaps, stops, sweeps, breaks and curves (see fig. 2)

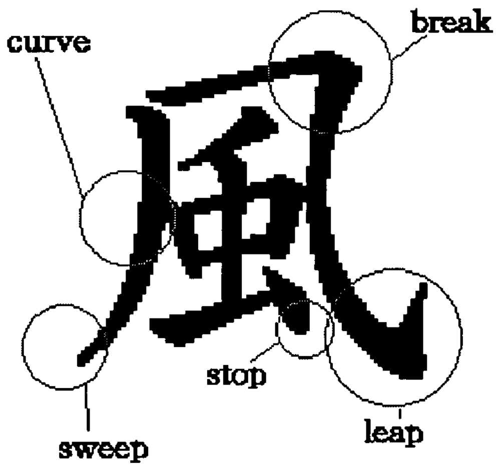


Figure 2: Stop, break, sweep, curve and leap

Kanji recognition system technology has shown progress and many reliable techniques have been developed. Our system, which we have named "Terakoya-Kanta," is based on vector and stroke speed evaluation.

There already exists software for kanji instruction; however, these tend to evaluate kanji characters by comparing written kanji with type. While this method may have the ability to evaluate glyph balance, they cannot evaluate stroke order, leaps, sweeps, breaks, stops or curves. Our system evaluates stroke order, leaps, breaks, sweeps, stops and curves to make possible higher accuracy in online kanji instruction.

2. System scheme

"Terakoya-Kanta" has two interfaces: one for making exemplary data and the other for learning.

2.1 Making exemplary data mode

Necessary data is prepared automatically when the user writes a kanji. The user can create data by scanning a piece of paper with a kanji written on it and tracing over the scanned graphic (see fig. 3). This will be help for making good exemplary data.

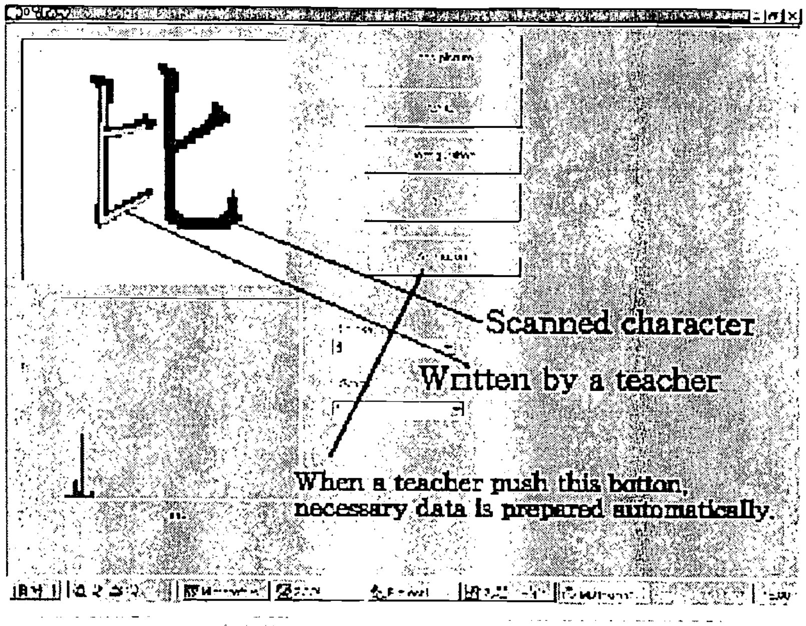


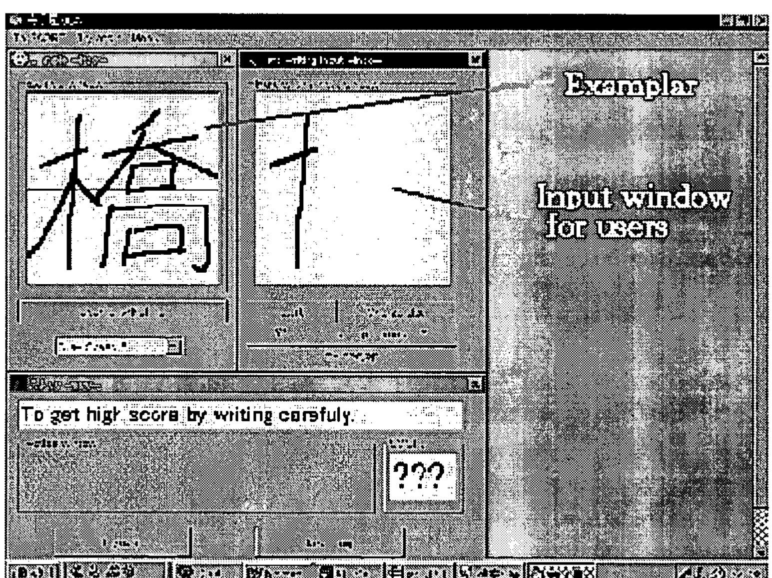
Figure3: Data preparation mode

2.2 Learning mode

When the user finishes writing a kanji and clicks the mark button, the system starts evaluating the input kanji. We have prepared four learning modes based on user level.

Beginners can select Tracing Mode. In this mode, an exemplary animation sequence in shown in the example window while the first stroke is displayed in the input window. When the user traces the first stroke, the system displays the next stroke (see fig. 4). The user can learn correct stroke orders and we feel this is a good way for beginners to get used to kanji.

Figure4: Learning mode



The next level is Seeing Mode. As in Tracing Mode, the system displays an exemplary animation sequence; however, the user is expected to write kanji in a blank input window without being shown an example. In this mode the user can learn suitable glyph balance.

For advanced users, there is Without Seeing Mode. In this mode, the system does display an exemplary animation sequences. Instead, the system displays type in the example window; no information about stroke order is displayed and many times the user is asked to write kanji of which type and handwritten glyphs differ. In this mode the user can learn good kanji handwriting.

Experts can select Kanji Quiz Mode. In this mode the user is shown only the meaning of a kanji and is expected to remember the glyph. This mode calls for mastery of kanji.

In all modes sounds and pictures help create an enjoyable learning experience.

3. Evaluation and Direction Classification Method

3.1 Preparation for Evaluation

Before evaluation, input data must be converted to appropriate form. The following is an explanation of our system's method of data preparation.

3.1.1 Normalization of input field

The input data written in the input window will vary in size. Because of this, the system unifies the size of input data before evaluation. Input data is converted to 256 x 256 pixel size while retaining the aspect ratio. While it is possible to fix the input window at a certain size, this approach was avoided because the resolution of users' monitors will vary.

The system cannot evaluate kanji correctly if the written glyph deviates from the center; to avoid this, the system will correct such deviations.

3.1.2 Normalization of scattered data

Input data written by a mouse or a graphic tablet will contain noise, while a user who writes slowly or a user with a high-performance computer will cause blurring. Since noise will cause evaluation inaccuracies, the system normalizes scattered data. The system does this by first analyzing coordinate information of the input character. Then, the system calculates the average coordinates of a few successive points, and saves such data while deleting others. Analyzing filtered data reduces evaluation errors and makes it possible to minimize the amount of the data to be evaluated.

3.2 Evaluation routines

The system evaluates written kanji in accordance with the following factors. These evaluation routines are now being reexamined and further developments are expected in the future.

3.2.1 Stroke evaluation

The system checks each stroke the user writes. Checkpoints are as follows:

- The start and end positions of the stroke

The system checks the distance between exemplar and data written by the user about the start and end positions.

- Vector direction

The system checks the direction of the each vector, with emphasis on the start and end vectors. These are calculated by the cosine theorem.

- Stroke length

The system checks stroke length.

If the input data differs greatly from the exemplar data on the basis of these three checkpoints, the system judges that the user wrote the kanji in the wrong stroke order.

- Distinction of breaks and curves

The system finds curves and breaks by evaluating the vector and the stroke speed of the stroke (see fig. 5). When a vector direction of a stoke changes, if the speed of that point is almost zero, the system judges that it is a break, and in other cases, the system judges that it is a curve. And the system checks their angle.

- Distinction of leaps, stops, sweeps.

At first, breaks near the end of the stroke are regarded as leaps. The system checks the stroke speed of the end of the each stroke, and distinguishes between stops and sweeps. If the stroke speed is faster and faster, the system judges that it is a sweep, and otherwise the system judges that it is s stop.

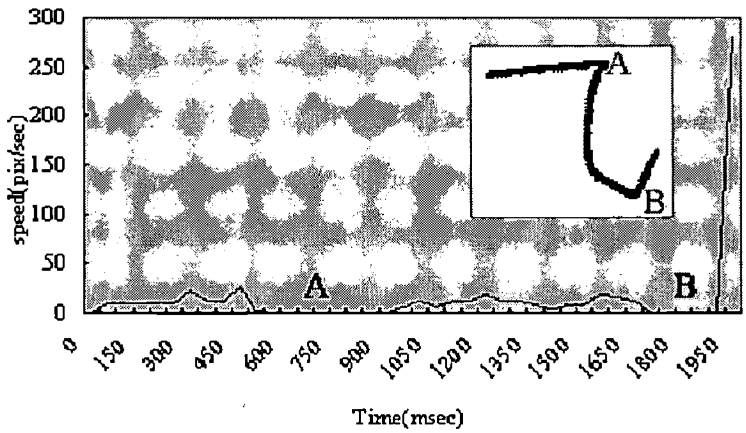


Figure5: Speed-time curve of a stroke

3.2.2 Glyph balance

A kanji with its strokes written accurately does not suffice as a beautifully-written kanji. Glyph balance is an important factor in good kanji writing. A kanji glyph consists of line segments that can be divided into parts, which in turn can be classified into basic strokes (see fig. 6). The system checks the balance between the glyph and its parts.

Checkpoints are as follows:

- Position of the center of gravity

The system compares the center of gravity of the glyph and its parts with exemplary data

- Aspect ratio

The system compares the aspect ratio of the glyph and its parts with exemplary data.

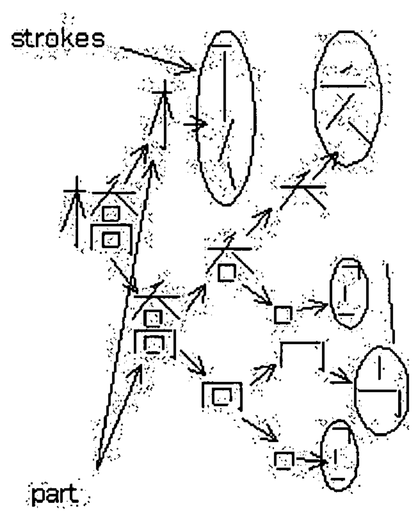


Figure6: Separation of a kanji into basic strokes

4. Conclusion

Many non-Japanese have studied Japanese and many have mastered hiragana and katakana; however, only a small number have mastered kanji. To master kanji, repetitive drills are usually considered necessary. Because of the large number of kanji and the complexity of the glyphs, this kind of learning is not only very difficult, but also tedious. We feel computer software utilizing multimedia can be effective in making kanji learning more enjoyable. However, the number of satisfactory software is limited; extant software may offer sounds and/or pictures but many can evaluate written glyphs only roughly. We feel such software cannot teach kanji correctly. The system we have developed not only makes use of multimedia but is also interactive. Our system can also offer appropriate advice based vector and stroke speed evaluation -- in short, it can act as a virtual Japanese language teacher. A student using our system can master correct and beautiful kanji writing enjoyably. (Our system was rated highly by the Portland State University.)

5. Future plans

To allow wider use, we are preparing a version for use on the World Wide Web. This system will be implemented at the Japanese Language Center of Waseda University and also at Portland State University for further modification.

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Teaching Business Writing on the Internet: How an Electronic Conference Environment Can Be Used in Lieu of Traditional Face-to-Face Peer Editing Groups

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Abstract: This presentation discusses using an Internet/World Wide Web-based conference environment called WELL Engaged as a tool to take the place of traditional peer editing groups in an on-line version of an advanced business classroom. A pedagogical objective of using the Internet conferencing environment is to emulate the group interaction that grounds classroom-based peer editing groups. A second is to encourage and enable spontaneous on-line student conversations about writing issues without the direct intervention of the teacher.

There are several tentative findings. First, many students report that they benefit from the on-line discussions about writing. Second, students say that the feedback from group members helps their writing improve, although there may be an adjustment period as students adjust written communication. Third, students find that they can easily adapt to interacting about their writing in an electronic environment. Finally, outcomes in the form of test scores, writing quality and course evaluations compare with those of the traditional classroom, which supports the idea that online conferencing environments are viable teaching tools.

Introduction

This paper discusses using an Internet/WWW-based conferencing environment called WELL Engaged as a tool to take the place of traditional peer editing groups in an on-line version of a business writing classroom.

The primary research questions are these: what are effective uses of Internet conferencing as a vehicle for creating on-line group interaction and peer writing evaluation and feedback? And, how do the educational outcomes of courses characterized by these on-line practices compare with outcomes in traditional classrooms?

The author's traditional business writing classroom is structured around groups interacting with writing in various stages of execution, driven pedagogically by what are generally called process models of writing. A primary objective of using the Internet conferencing environment is to emulate online the sort of group interaction found in classroom-based peer editing groups.

While many people are using electronic conferencing for discussions of course material and topics, it is less common to use conferencing for student groups to interact with each other directly about their writings-in-process. This leads to the second pedagogical objective, that of encouraging on-line student interactions about meta and local writing matters without the direct intervention of the teacher.

Setting

Golden Gate University is a private university in San Francisco that provides education in law, tax, liberal arts and business, from undergraduate through doctoral level. Our students are diverse, ranging from international and traditional students to working professionals, ranging in age from the early 20's up. Most students are working toward degrees and certificates; many of them attend school in the evenings, and during intensive weekend programs.

The University offers courses at a number of satellite campuses in California. On-line courses are of particular interest to the University because they offer the opportunity to increase enrollment; for students, they offer a degree of convenience, particularly to complete courses that are regularly taught at the San Francisco campus, but may be rarely offered at other campuses. For teachers, on-line education is (for some) challenging and exciting; however, competition from other institutions that offer on-line coursework as well as pressure from the university's accrediting agency require that on-line education be carefully considered so as to be considered viable for students, teachers, and administrators.

Instructor Background

The researcher is an Assistant Professor in School of Technology and Industry; until January of 1997, I held the same position in the School of Arts and Sciences. I have strong interest and some experience in using technology in the classroom and as a medium for distance teaching and learning. My current interest is to continue to successfully translate traditional face-to-face course materials and approaches into high quality on-line formats, and to make the on-line experience as substantive and satisfying to my students as a high quality traditional classroom experience.

The course under discussion in this paper is titled English 120, Advanced Business Writing, which I've taught traditionally and online. The course is a required junior-level course that is writing intensive, so translating the process-oriented components of a contemporary writing classroom (prewriting, drafting, revising, peer editing/reviewing and feedback) into the on-line format is important.

The instructional medium

English 120 has been taught traditionally for years, and more recently via two electronic formats, SoftArc's First Class conferencing software, and, currently, in a World Wide Web environment. The writer has taught the course twice in the First Class environment and once in the Cybercampus / WWW environment.

First Class is a conferencing system that can provide a graphic interface whether used on campus or through an Internet connection. It uses the familiar desktop/folder metaphor, familiar to most people who use Macintosh and Windows machines. From our student point of view, the software is ubiquitous, and is used primarily as a campus email and public communication system. From an instructor's point of view, First Class provides ease of use and management, along with reasonable security. A teacher can easily create a hierarchically-arranged set of folders to contain class material. Given the proper permissions, the teacher is able to control overall access of students to course material, as well as to determine particular students' access to folders, for facilitation of group activities.

During the Fall of 1997, an entity named Cybercampus came into being, dedicated to creating instruction in a World Wide Web environment. Using a conferencing environment named WELL Engaged provided by San Francisco's The Well, university instructors are offering a variety of classes in Management, Computer Information Systems, Business, Public Service and English. Fewer instructors are using the First Class environment, although they can if they choose.

Course materials for all Cybercampus courses are created and posted on World Wide Web pages, all of which feature common design features such as logos and interactive links. Moving from the University's Cybercampus environment to the Well Engaged conferencing environment requires an electronic jump to another server and system, but it is designed to appear relatively seamless to the student.

WELL Engaged and on-line conferencing

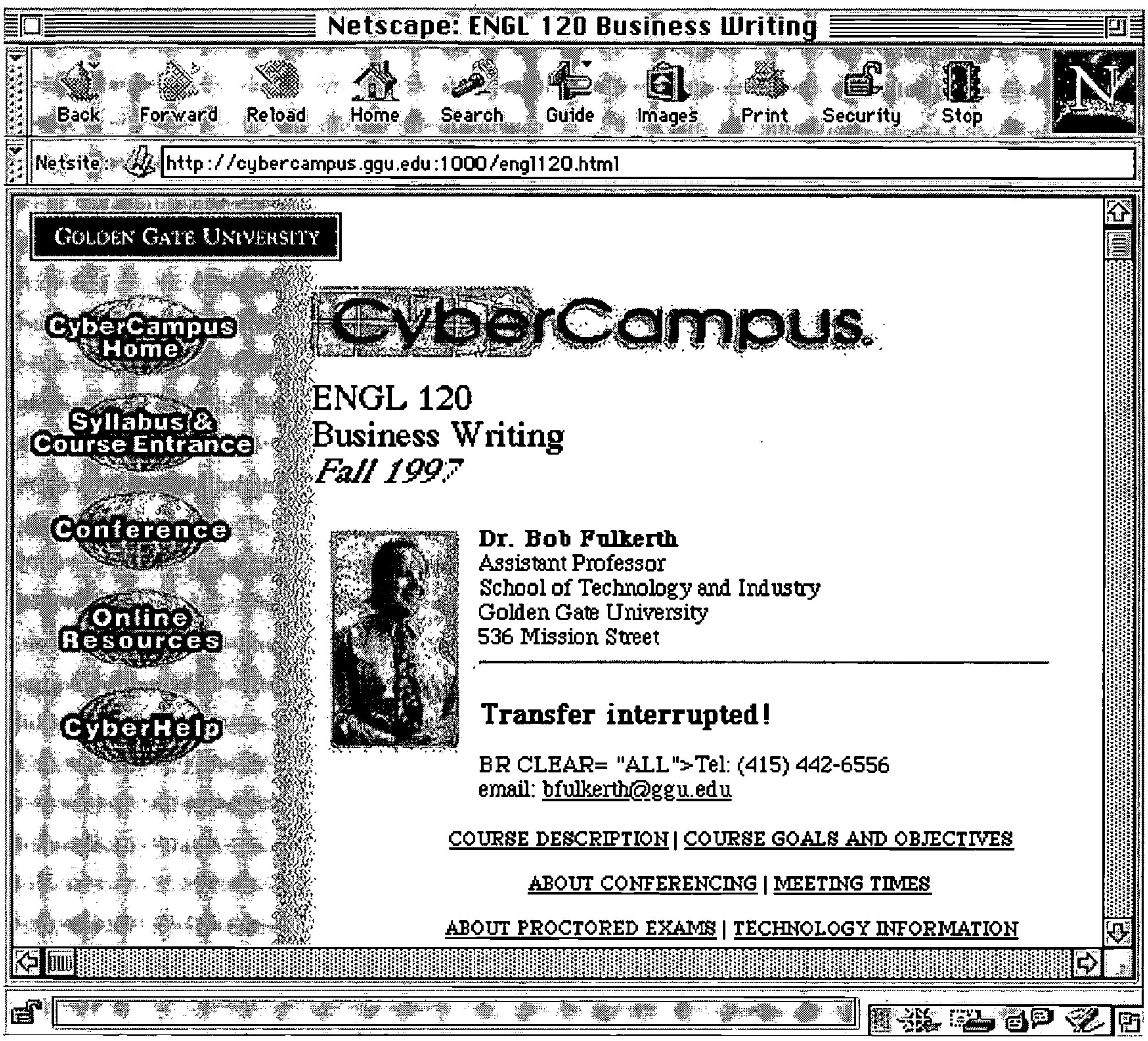
The Well is an Internet Service Provider that has been a pioneer in providing an open electronic conferencing environment on a variety of topics.

A prominent feature of their service is a conferencing protocol called WELL Engaged. WELL Engaged provides a discussion environment which people can enter at will, can control viewing of entries and can create and participate in discussions of new topics. Spellchecking and hyperlinks are supported.

In the Cybercampus/WELL Engaged environment, topics within courses can be created by the teacher and/or students, depending on access level and purpose. Topics are characterized by numbers of entries posted by each participant. The entries appear in linear order, giving the sense of a conversation, and they can be "scribbled" (removed by the writer) or "hidden" (archived) by the teacher. This allows a reasonable degree of control and a sense of communication, although currently topics cannot be easily rearranged, nor can entries be removed.

Since WELL Engaged operates in an HTML environment, it is also possible to include and follow hypertext links. This flexibility is helpful for students because it does not require a particular software; all class interactions can occur in the World Wide Web environment, which means that the Web can become part of the class.

English 120 students enter the classroom environment by connecting to the Cybercampus course site (illustration #1). All students have access to course overviews, but actual course syllabi or assignments are password protected. After entering, registered students can view and download assignment and syllabus material.



Figure/ Illustration #1

To enter the WELL Engaged conference area, students choose a Conference link, and must again provide a password. Upon entering the Well Engaged area, participants can see a number of topics, which will differ according to the instructor's and students' needs. (illustration #2). In the illustration, the Hoo's Hoo? area is for student biography material, Practice is intended for cut-and-paste practice, Read Me First is for news and feedback, and the weekly course material is found in appropriate folders. Groups are also found under the Week area.

Total Topics: 20

	Topic Title	Last Post	Unread	Total
	Hoo's Hoo?	(10/05/97)	0	39
	Practice	(09/15/97)	0	12
	Read Me First	(10/18/97)	0	30
	Week 1	(09/05/97)	0	6
	Week 2	(09/17/97)	0	10
	Week 3	(09/19/97)	0	7
	Week 4	(09/27/97)	0	6
	Week 5	(10/17/97)	0	10
	Week 6	(10/11/97)	0	7
	Week 7	(10/03/97)	0	4
	Week 8	(08/27/97)	0	1
New	Week 9	(08/27/97)	1	1
New	Week 10	(08/27/97)	1	1
New	Week 11	(08/27/97)	1	1
New	Week 12	(08/27/97)	1	1
New	Week 13	(08/27/97)	1	1
New	Week 14	(08/27/97)	1	1
New	Week 15	(08/27/97)	1	1
New	Group 1.1	(10/17/97)	7	15
	Group 2.1	(10/17/97)	0	13
New	Group 3.1	(10/20/97)	5	9

Figure/Illustration #2

Taken together, the topics in the English 120 WELL Engaged environment provide discussion areas that allow the students to find out about each other, to practice cutting and pasting skills necessary to interact in groups, to find out about work in progress, to get weekly assignments, and to interact in their groups and with the entire class. More traditional means of communication such as the telephone, email and face-to-face contact can be utilized as well, but accessing assignments and interacting in groups, the two major parts of the English 120 course under discussion, occur in the conferencing environment.

The Cybercampus and WELL Engaged environments have a consistent look and feel, so students report that the environment feels comfortable to them. From an instructor's point of view, the Cybercampus/WELL Engaged overall design provides ease of use, barely adequate flexibility and a reasonable amount of security, at the cost of a moderate learning curve and some experimentation.

Structure of the Online Advanced Business Writing Class

When students enter the English 120 conference section of the course from a Cybercampus "front end" page, they see their topic list containing topics as weekly assignments, hints for success in online classes, classmate biographies, and group folders. Currently, group folders are open to all students; a premise of peer editing is that students will have a safe group to interact with, so it was anticipated that having non-secure folders might be an issue, but students do not seem to be bothered by the open environment. It is within the group folders that students interact in the online peer editing exercises.

Course materials are highly structured as to expectations and due dates. Mini-lectures direct students to text materials, and they complete regular quizzes that are submitted via email. Letter writing and a research proposal assignment form the bulk of the course work, although a proctored in-person midterm is given to address concerns of security, and to allow the instructor to meet those students who take the course on the San Francisco campus.

The major paper of the course is a research proposal that attempts to solve a specific problem encountered in the students' work environment. This assignment carries a substantial number of points and completion is required to receive credit for the course. There are a number of checkpoints and discussions about the paper as it progresses during the trimester, many of which are carried on via email. A formal draft is submitted during the 11th week, and the instructor and student then conference via phone or email to discuss the paper.

The overall course is designed around a simulation in which students and the instructor work for the hypothetical XZY Corporation. A student can "work" in an area that reflects his or her real job, such as management or sales. If the student does not work in real life, he or she can choose a generic job that reflects the student's interest. Thus topics for the research proposal reflect contemporary business matters such as choosing a business database, using email effectively or introducing a new product in the marketplace. In addition to researching a topic, students are expected to place the topic within an effective, persuasive proposal.

While the proposal is not subject to group interaction in the same way as the letters, students in groups tend to extend their peer-editing and information sharing relationships to extensive discussions of the proposal.

Peer editing in online groups

At the beginning of the trimester, students are placed in an on-line group consisting of two other fellow students and the instructor, who participates in all groups.

The letter writing assignments follow a 3-step process. Assignments in the form of memos and letters are presented in a weekly assignment area in Well Engaged, accompanied by a mini-lecture and perhaps a quiz. Students then create drafts of these assignments; they usually have about a week to do this.

On a designated date, students post letters or memos to their group topic area, with a heading indicating clearly what the work is, such as this: Jones/draft/good news. During a 3 day period, other group members and the instructor interact with the draft, providing on-line feedback on the work. Each student enters the conference, enters the proper group, cuts-and-pastes group members' work into a word processor, provides feedback, and then reenters the feedback into the group area with an appropriate heading: Smith/feedbackonJones/good news (for an example of feedback, see illustration #3). Currently WELL Engaged supports only all caps for text formatting, so group members' feedback is limited to that feature.

Beginning of Illustration #3:

Dear Ray,

I would like to take this opportunity to congratulate you on your new sales manager position with XYZ Corporation. We are all very pleased that you accepted the job and I am sure you will be very happy working for this company. You came very qualified and with strong recommendations.

I have been with XYZ Corporation for 16 years and have enjoyed every moment of it. Our company has a strong relationship with our employees and an open door policy which we like to stand by. There are two

main company functions which the company TRY USING ANOTHER WORD BESIDEs COMPANY, YOU'VE ALREADY USED IT ONCE IN THE SENTENCE, CONSIDER DELETING THE FIRST COMPANY puts on SPONSORS? to show their thanks for all our hard work, the Christmas party in December and the summer BBQ at the
CEO's home in July. CONSIDER SPLITING THIS LONG SENTENCE IN TWO.

There are ALSO a few non-company sponsored sport leagues, if you are interested please contact me for the names of the organizers.

I am sure you are anxious to begin your employment with XYZ Corporation, so I will see you at 8:30 am Monday October. 20th in my office in building 2 on the 3rd floor, to finalize the mandatory company paperwork i.e. benefits. I look forward to meeting you in person.

Sincerely,
Carl K. Banks
Vice President of Human Resources

CARL, THIS IS AN EXCELLENT LETTER! THERE REALLY IS NOT MUCH TO SAY ABOUT IT. HOPE MY FEW SMALL COMMENTS HELP.MOSTLY IT"S JUST STYLE MATTERS! TOM.

Figure/Illustration #3

At the end of the feedback period, students are then given several days to revise the letter before submitting it. Letters are submitted to the instructor by fax, so that formatting can be considered in evaluation. There are 5 letter/memo assignments during the trimester, ensuring that group members experience at least that many sets of formal group interaction.

Managing online groups

Managing online groups for success requires several things of the teacher and participants. It is necessary to clearly state the purpose and structure of the groups in the initial course material; to encourage use of the group, the teacher should communicate with group members in the online environment. This should not preclude personal, phone or email communication, but there are many interactions that can be done online, particularly those that affect all members of the group.

During the initial assignment, the teacher will probably spend time modeling online responses for group members. Some students tend to be confused about the multistep cut-paste process, and the teacher will have to spend encouraging group members until everyone is up to speed.

Group members are required to participate in their groups. The objective of using the group is to provide an online peer-editing community, and students should be directly encouraged to be active members. Although I don't require a number of interactions, students are expected to interact with each others' work at least one time per assignment, and a minimal number of assignment points are taken away for those who do not. This requirement is clearly stated in the course syllabus, and is enforced consistently. However, if a supportive atmosphere is created early on, students do interact consistently on their own initiative.

Conclusions, suggestions

There are several tentative findings regarding the use of groups online. First, many students indicate that they benefit from the on-line discussions about writing. They enjoy the process of having a group and working within it, although if students are not sympathetically paired, the group experience is less satisfying. Many enjoy (or learn to enjoy) the freedom of discussing writing online, and, overall, group members tend to create positive environments that last for the duration of the class.

Second, students overall report that the feedback from group members helps their writing improve. The nature of the feedback can be different than that overheard in face to face sessions. Depending on the students' personalities and natures, written feedback can be considered somewhat harsh, although students can be seen modulating the content of the interchange much as they do in speech, in an attempt to adjust to the needs and comfort levels of other group members. For example, they may begin a conference entry with a straightforward discussion of another's writing, and end with queries about possible weekend activities and trips, much as people do in face to face environments.

Third, students can adapt to studying about, talking about, practicing, editing and proofreading their writing and general coursework in a variety of ways in an electronic environment. Because writing is so personal, I had questioned whether, even with a high degree of interaction, such an environment would encourage students to meaningfully discuss the many problems that are exhibited in business letters. To my surprise, students discuss writing matters, the text, the relationship of course material to real life, all of those elements we take as signs of successful learning in a traditional class.

This has been a surprising finding to the researcher. I originally doubted that a university level writing course could be effectively taught on-line; having taught Advanced Business Writing in bulletin board and Internet environments, I now believe that it is possible to teach an on-line hands-on writing course whose curricular quality and student outcomes match that of the same course taught face to face (See Schutte for a control/pilot study on a similar topic).

Finally, the role of the teacher changes substantially in the electronic classroom. Teaching takes on a new role, directed more toward participation and facilitation than delivery. For teachers who view themselves as in some way controlling the writing growth of students, this may be disconcerting. For others, being a director and facilitator, as well as a true group member, can be comfortable.

Web-based conferencing as an instructional tool

The subjective elements of the electronic learning space are important factors in the success of this particular environment. The Cybercampus/WWW environment has been professionally designed, with links to other University sites and support information. It has a "look and feel" that is carried through all pages at all levels, extending into the conferencing environment. In short, this particular virtual environment seems like a real place, at least to contemporary students who are comfortable interacting online.

Students are responding favorably to the Web courses, and that dynamic, combined with the consistent growth of the University's Internet/Intranet, suggest that conferencing-oriented classes offered via the World Wide Web are the wave of the future at this University. Indeed, during the first semester of Cybercampus's existence, 13 classes were offered; during this, the second trimester, over 30 are offered, and it is projected that during summer of 1998, nearly 50 classes will be offered online. Certificates are being offered, and degrees offered entirely via online courses are in the planning stage.

After acknowledging the additional learning curve of working on the web, and as an ongoing participant in the process with a group of like-minded educators, the benefits of membership in the seemingly larger community afforded by the Web environment are becoming more tangible to me; even in virtual space, Web locations can be made to offer many of the interpersonal elements that humans expect of their communicative experiences.

The electronic conferencing environment appears to have the potential to be an effective analog to its face-to-face counterpart. As one of the processes in learning to write, working in community environments, regardless of whether they are online or face to face, seems to assist the development of writing skills for many university-level adult students, and also to address their learning needs. Electronic conferencing as part of a carefully designed online course appears to provide an effective tool that can support learning in the contemporary educational environment.

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WorldView: A System for Information Merging and Sharing

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Abstract: The WorldView system proposes a new way for merging and sharing information in workgroups for educational purposes. It offers universal web browser access and complete user interactivity based on interesting information structuring concepts and access permissions. It supports the common document and pictorial information but innovates by offering extended representation and interaction capabilities for users. This system shifts the focus from hypertext documents and hypermedia presentations to a workgroup system allowing interactive users to manage general information items. The user can insert or delete information items but he can also interactively edit, reference, relate and annotate any number of objects. These interactions are kept in a logical structural organization with individual user, workgroup and generic folders. Authenticated users can view, insert, modify or delete objects over the internet relying on an account and security administration. A database engine is used to store, index and search the data. We take advantage of the best ideas from database storage and searching, unix accounting and security, windows directory structure, hypermedia anchoring and linking and some structuring and object extensions of our own to offer a significant improvement in workgroups. The system can be deployed on its own or as a workspace system in any database repository.

1. Introduction

Information exchange and collaborative work are important domains of application for modern database systems [Silberschatz 91]. These applications became especially attractive due to the availability of the Web and the possibility of accessing a database from anywhere using a simple browser. We refer to systems with a large quantity of data that can be shared among people, especially semantically rich data such as pictorial data. Many interesting examples of such usage can be given. A virtual museum can keep images of art objects together with annotations and explanations about the objects. Digital libraries, satellite imaging , medical imaging databases are other examples.

A subset of those applications would benefit from group work and controlled user interaction over the information items so that authenticated users interactively build a information repository. WorldView is a research project in knowledge structuring and hypermedia tools for information merging and sharing. The system described in this paper resulted from the real needs of different professionals in our community to intuitively integrate and share a wealth of information in their group work and from the educational institutions needs to intuitively build and share educational material in their organizations. The common facilities from file systems with information retrieval capabilities, databases and hypermedia authoring tools are applied in an integrated way. The conjunction of database retrieval and hypermedia browsing allows the user to either search or browse and link the information. A prototype of the system will be used in a history department where student and research teams search for all available information on ancient monuments and paintings to reveal their history. They progressively insert their findings in workgroup spaces and decide what to share. A similar system could be deployed in a medical imagiology environment to insert and share image analysis and diagnostics.

WorldView offers a base structure to guide users organizing the information they insert and comprehensive user permissions and object privilege features to allow them to control the access in the web-based system. The basic features of document and image viewing and linking are extended to more general objects called information items. Information items can be inserted, deleted or edited depending on authentication. When integrated into the repository, pieces of documents or pictorial data can become interesting objects on their own. This is called information items within-component referencing. These components or information items can be related to other objects in the database possibly originated from other data sources. The system allows users to reference, link or annotate any information item. The information is all kept in a directory-like structure. The system deals with the necessary security issues and establishes groups to enable users to choose the scope of the audience for their information. It is scalable to serve a community of any size and provides an extended database system which can be applied on top of a regular schema database with application in, among others, the educational, scientific, medical and art domains. The paper is organized as follows. Section 2 shows related work, Section 3 describes the system and Section 4 makes some commentaries about the application prototype. Section 5 concludes the paper.

2. Related Work

The system described here conjugates the philosophy of hypermedia collaborative work with complex semantically rich databases. Hypermedia systems organize and access multimedia information in a very intuitive way, linking all types of information. For a possible taxonomy of Open Hypermedia Systems please refer to [Osterbye96]. Hypermedia models such as the HAM model [Campbell 88] or the Dexter model [Halasz 94] have helped laying the foundations for these systems. For example, the HAM model divides those systems in three functional layers: a storage layer providing persistence, an application layer providing the functionality and a presentation layer for user interaction. Nodes, links and composites are important components of those systems which allow complete information linking. A database engine is used in many of those systems to efficiently implement the storage layer. Systems like HyperStorm [Bapat 96] or HyOctane [Buford 94] use an OODBMS to render hypermedia functionality. A general application framework for hypermedia documents on the VODAK ODBMS of HyperStorm can be seen in [Wasch 95]. WorldView extends typical hypermedia systems features by providing a base structure and access policy to allow users to freely create and integrate information and provides a web browser based access to users.

3.Overview of the System

The WorldView project builds applications incorporating many distinct parts that are assembled to work as a whole. It encompasses the following parts also illustrated in figure 1.

- Users/Groups - *the persons accessing the system. They form workgroups.*
- User Accounts & User and Object Privileges - *logged users can manage their objects and those from groups they belong to.*
- User Interface and Access Structural Organization (folder directories, user/group/generic workspaces,...) - *this flexible system provides an important base structure to organize information.*
- Extending Metadata Objects - *referencing, Relationship objects, their specializations. Annotating objects.*
- Information Items & Schema - *documents, images, arbitrary pieces of both, objects from an existing database schema and database objects inserted by the user.*
- Database Storage & Searching - *a database engine implements the actual storage and indexing.*
- Support External Files & Handling - *information can be stored externally or in the database. SGML documents can be converted to corresponding document image objects and back to files.*

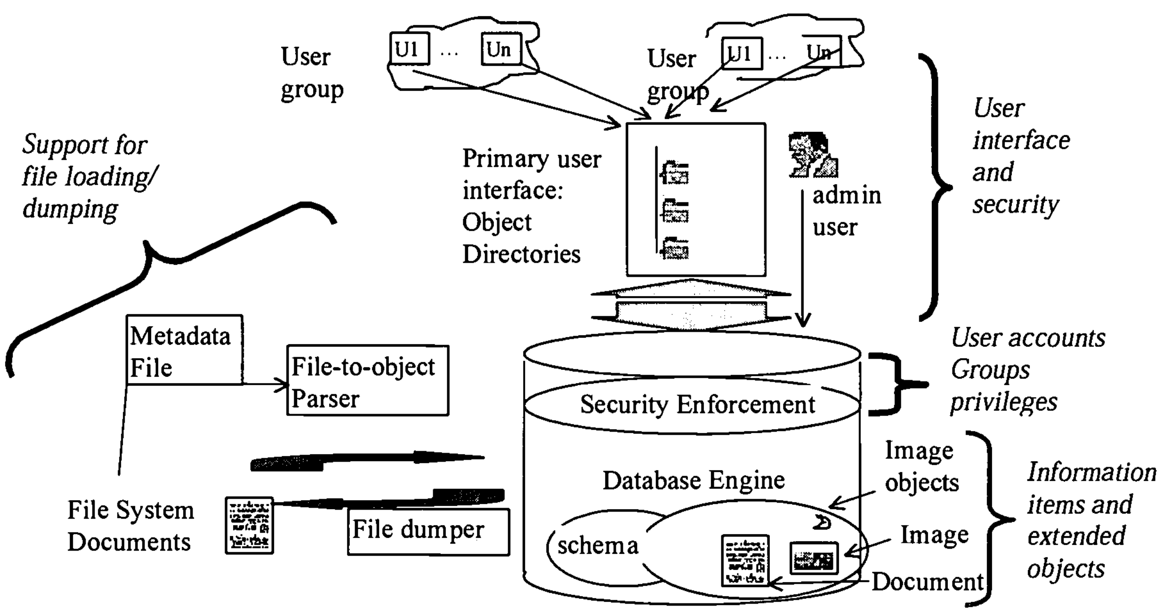

Figure 1- Overview of the WorldView System

The information items and the corresponding database storage and searching capabilities provide the basic functionality to store and retrieve documents and images and to reference external documents. SGML documents can be converted to document image objects by the external files handling part and back to files using a metadata format file. The schema represents possible particular application domain objects. For operation purposes, the information items, schema and extended objects are handled in the same way.

From now on we focus on the new significant parts which provide the facilities for user interaction.

3.1 Information Items

Information items are pieces of information like documents, images, document components (chapters, sections, etc) or video frames. They can be stored as database objects, their URL simply referenced or stored and referenced from the file system. The system offers the tools for referencing, relating and annotating those information items. It also provides the means to interactively define and reference within-components of information items, transforming those components into information items on their own. Image objects are within-components of images and their spatial coordinates or contours build referencing objects. Document anchors are another example of referencing objects. Sets and lists are also important objects. Sets are used to implement the WorldView folders which are the basic structural unit. Lists will be used in the future to create another type of folders called "sequence folders" which keep information items in a specific sequence. Besides those object types, users can also create database objects and relate those objects or objects from a preexistant schema to the information items.

3.2 Data Storage

The information items are stored in a database schema. Images and documents can be stored as BLOBs or simple references to external documents or images can also be stored. The Annotation is another base type. To achieve hypermedia and extended functionality, referencing and generalized relationship types have been added. The referencing object type is further specialized for referencing specific types. These specialized object referencing types include image region contours, image location pointer, text region and text anchor. The generalized relationship type relates any number of objects. One of its specializations is the familiar Hyperlink, but it also relates any number of objects. These relationships are useful when a user is viewing an object and wants to access the objects which are related to it, generalizing the hyperlinking mechanism to any objects.

3.3 Access Interface and User Security Enforcement

The access structure plays an important role in WorldView. The interface configuration is based on the following premises:

- Information items are placed in folders;
- Providing some structuring enforcement and at the same time allowing a reasonable degree of information items handling flexibility;
- The system can be accessed by anyone through a web browser;
- The access structure must be associated with a user accounting and security policy;

Figure 2 illustrates the base structure. Registered users organize information in nested folders according to groupings, subjects or whatever is important. There are three base folders corresponding to possible useful repositories. The "all" folder is a generic workspace for everyone. The "group" folder contains any number of restricted access group folders for group workspaces. It is optionally administered by a user with all privileges over the specific group. Finally, the "user" folder keeps individual optional workspaces for registered users. The folders marked with an "S" label show only one type of information item for direct retrieval of information of a specific type.

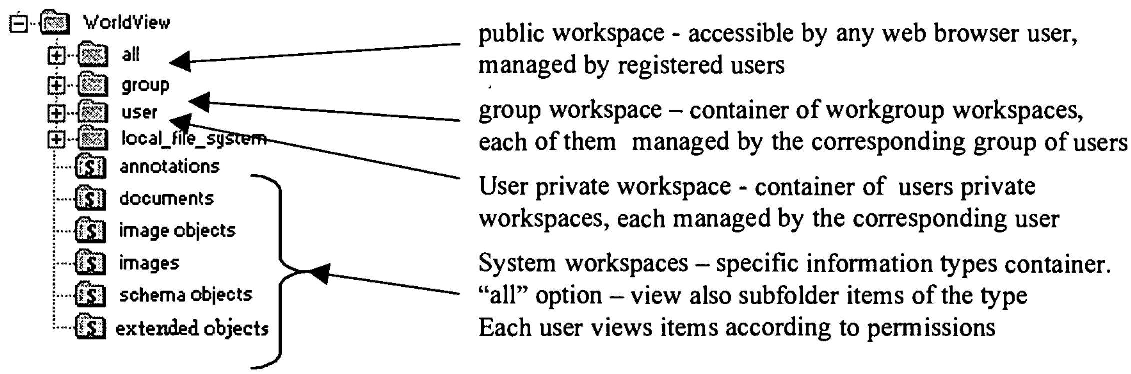

Figure 2- WorldView root folders

Specific groups can only be created by the administrator. Figure 3 shows some group folders access in the prototype implementation[1]. Each group can be public or restricted by default, but members can always access and extend them. User workspaces are private by default.

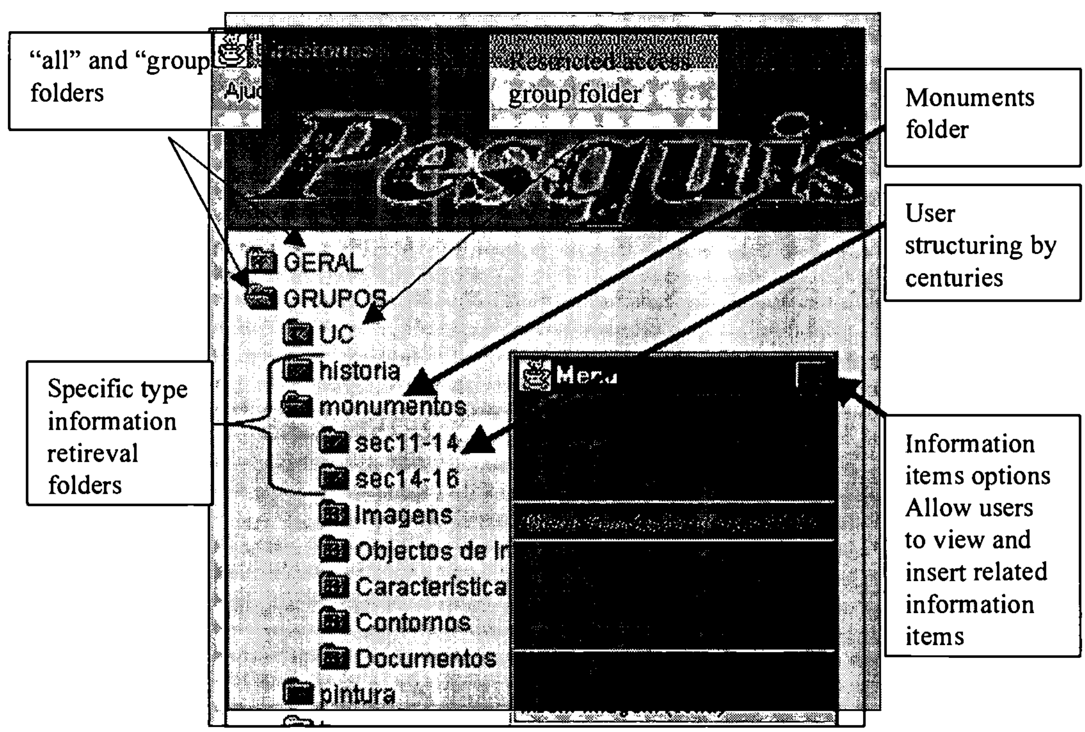

Figure 3 –Screen capture showing group folders

Users can assume several roles, depending on authentication. There are unlogged users, registered users, logged users, the administrator and specific group administrators. Users accessing the system are "unlogged users" until they submit a username and password, which they can do at anytime. A new account proposal is automatically mailed to the administrator for the first login. A user becomes a registered user if he owns an account. By default he will have a certain quota which is adjustable by the administrator. If the user has an account and enters a valid login he becomes a "logged user". Logged users can belong to many user groups (group administrators evaluate the applications). Every object has a owner (the creator), a group and a set of

[1] The protoype is an adapted version for historical monument and painting studies. The examples are displayed in Portuguese but the important points are annotated with an English legend to clarify their meaning.

access permissions for user, group and other. Only the owner and the administrator (or group administrator) can change those permissions. Figure 4 illustrates the notation for object permissions. Access refers to viewing (which includes opening a directory), change refers to editing or modifying. Extending refers to inserting new objects, referencing, relating or annotating and the meaning of delete is immediate.

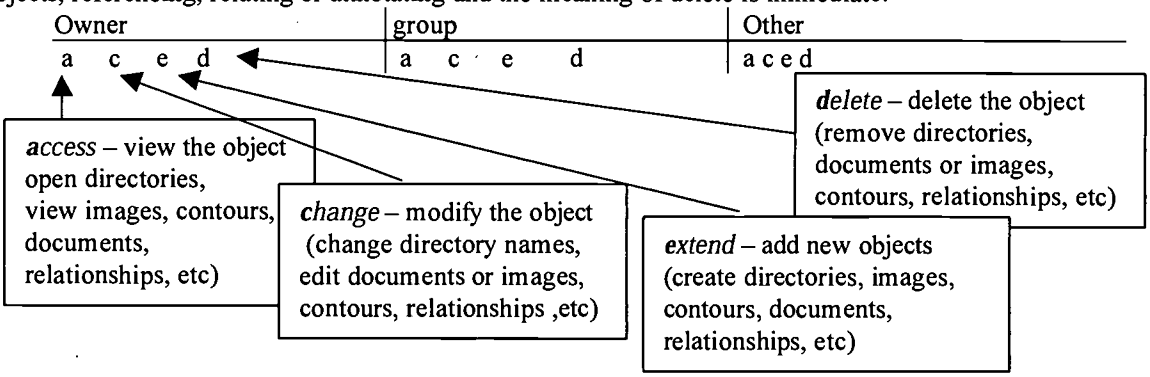

Figure 4 - Object permissions

Default object privileges are applied according to workspaces, as illustrated in Figure 5. Both the administrator and owner of an object can change its privileges. Unlogged users do not belong to any group, so they have "other" privileges. According to default privileges, they can access the information in the "all" workspace (public information) but cannot change anything. Logged users can insert information items, reference, relate and annotate objects, but only the owner and the administrator can delete objects. Figure 6 illustrates relating an image with a document URL.

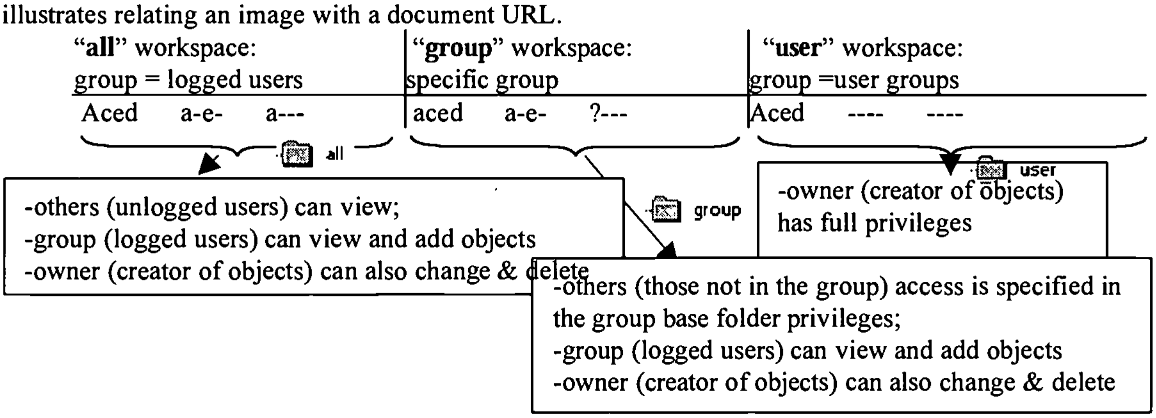

Figure 5- Default Objects permissions

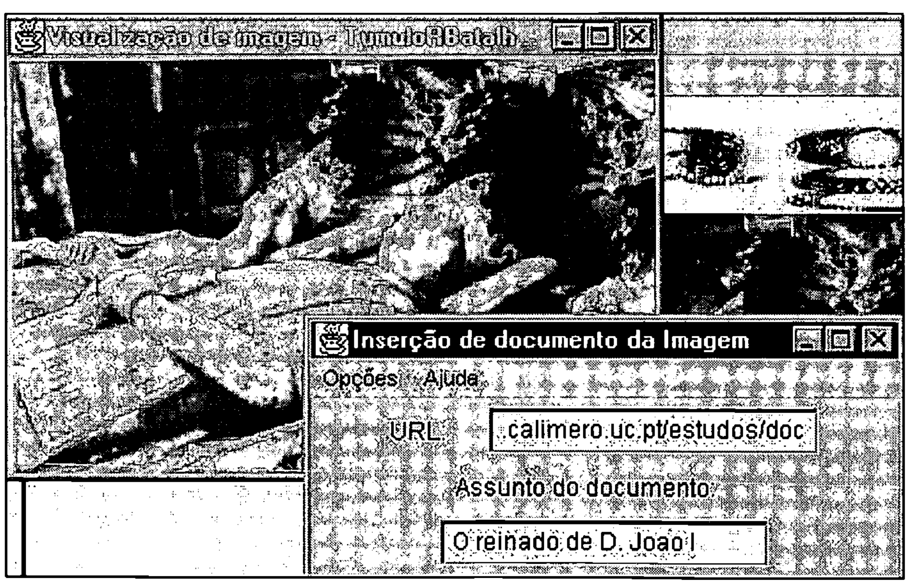

Figure 6- Relating an image with a document

Figure 7 shows the image retrieval screen. It allows the user to search, annotate, relate to any object, create points and regions of interest. The user can also view related information items.

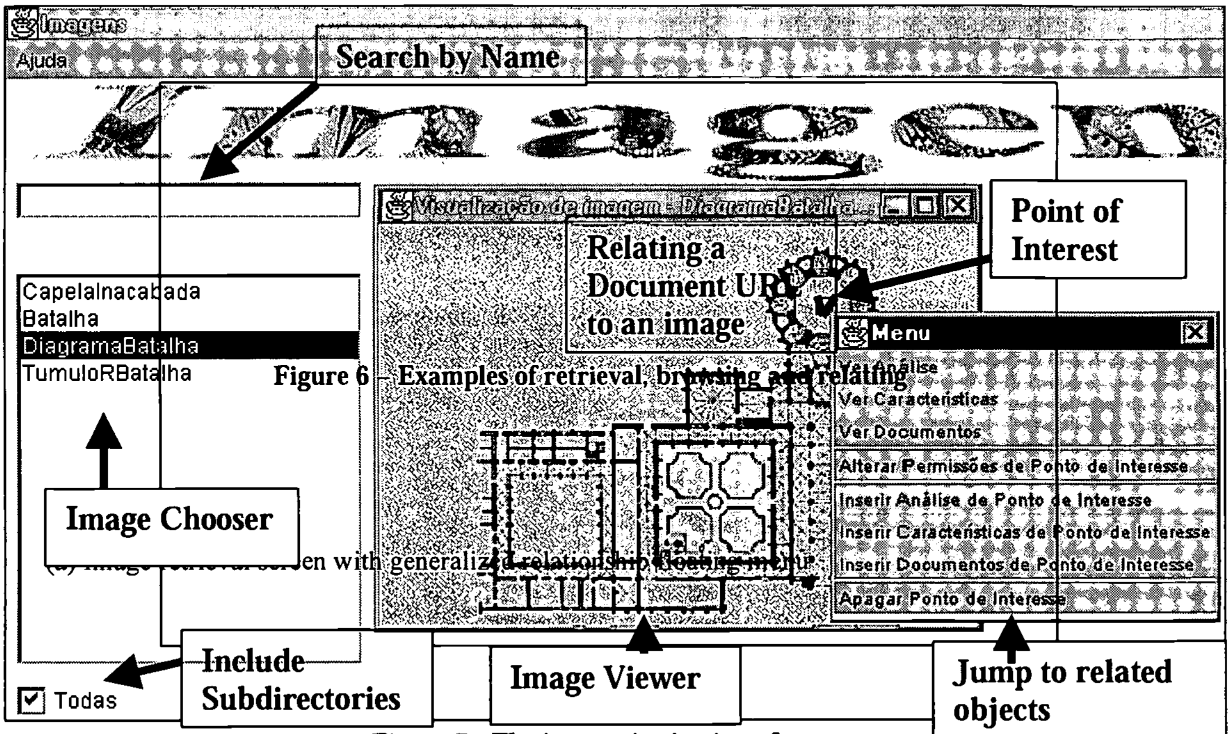

Figure 7 - The image viewing interface

4. WorldView Applications

The WorldView project is currently under progress. From it resulted a first workgroup application to share the material from studies of ancient monuments. This application uses only some features from the system and is centered around images. The administrator installs the WorldView data schema by running an SQL script in any database engine. The JAVA application then uses JDBC to access any database engine.

5. Conclusion

This paper presents the WorldView project. The system proposes a convenient way to share information. It presents a innovative user interface with information organizing structuring elements, user authentication, user and object privileges. It uses any database engine as its storage layer, which is accessed in standard SQL. The system provides the means to integrate any kind of information items. The research and implementation work is still under way to build a system supporting all the intended features.

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VSAT Technologies Applied to a Pan-European Network for Tele-Education

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Abstract: Activities carried out in project TEN aiming to start up a pan-European system for distance learning supported by a satellite communications network and the use of VSAT tec h-nologies are described here. As a major outcome of this project a pilot experience has been carried out involving remote classrooms in 6 different European countries, 30 lecturing courses, and over 700 participants.

1. Introduction

In the very origin of project TEN there is a very simple idea that at the same time can explain in a very easy way the system that was developed. This idea also constitutes the base of any training or learning model, that is, the existing asymmetry between the information flows going from teacher to students and viceversa.

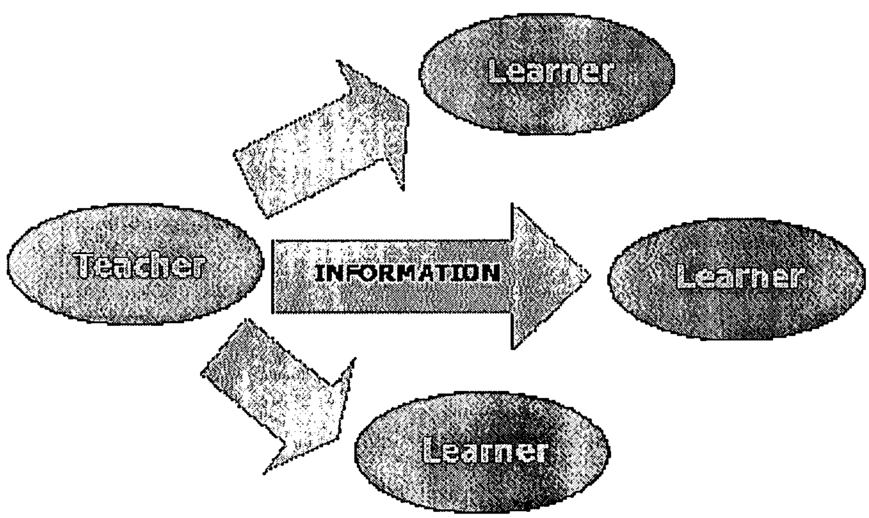

Figure 1: Information flow produced by the lecturer

Although from teacher to student this flow is featured as with huge information content, permanent during the whole class time, and being multi-point; in the opposite direction, from each student to the teacher, the information flow is instead small, occasional and point-to-point.

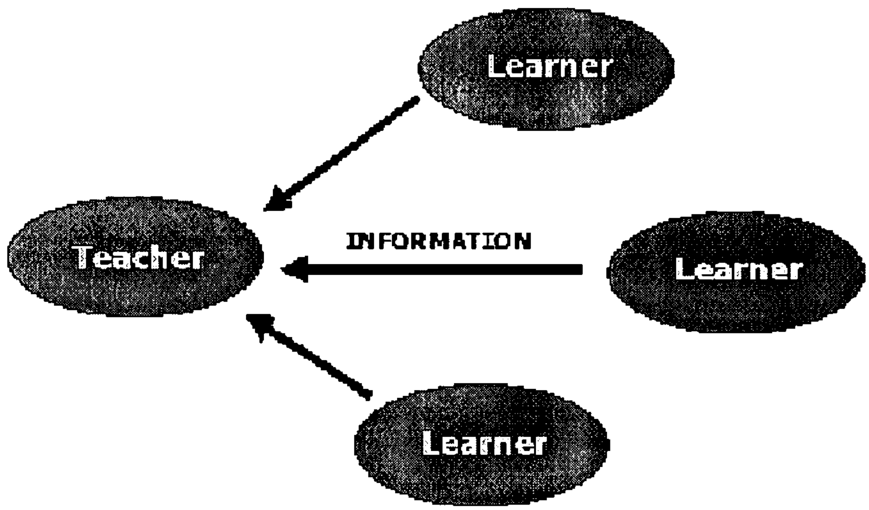

Figure 2: Information flow going to the lecturer

Trying to translate this theoretical communication model into a telematic system, we finally arrived to a technical working scheme that assigns communication resources asymmetrically and according to the information flow to be transported in each sense. Such scheme consists of a star-shaped VSAT network with the teacher classroom in the central node or hub station broadcasting through the satellite and remote stations connected by a return channel at lower speed so that students are allowed to interact on-line and remotely with the teacher.

2. Project TEN within the Telematics Applications Programme

In September 1995, a consortium formed by fifteen universities, companies and institutions from eight EU countries submitted a proposal to the open call in the Telematics Applications Programme within the Education & Training sector. After all evaluation and selection phases, that proposal finally became project TEN (ET 1022) that started in January 1, 1996 and is scheduled to finish in March 27, 1998. There is a web page in Internet where visitors can get more extensive information on the project (http://www.fundesco.es/ten).

During this period the main achievement of TEN has been the creation of a pan-European network for tele-education, based on satellite communications, and with seven nodes scattered over six EU countries. The network has been used to give pilot courses in order to show the system working. This has allowed on the one hand to improve the performance of the initial version and on the other hand to observe the level of user (teacher and learner) acceptance and verify its learning effectiveness.

3. Technical description

The system uses the Co-operative Data Exchange (CODE) network technology that had been previously developed jointly by two partners in the consortium TEN, SIRE and Unisource Satellite Services, for the European Space Agency (ESA). The CODE network is a Very Small Aperture Terminal (VSAT) system that provides interconnections between Local Area Networks (LANs) and remote stations via satellite.

The topology of the system is configured as a star-shaped network where a 512 kbps outbound carrier is used to broadcast through satellite the courses from the hub station or teacher's classroom to all remote stations.

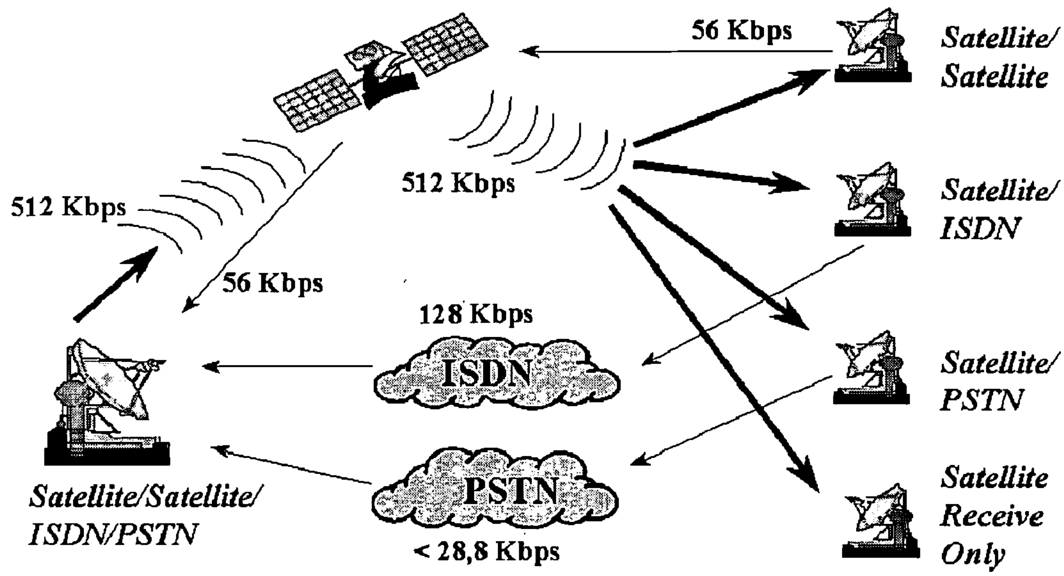

Figure 3: System technical configuration

In order to allow students in the remote stations to participate during classes asking questions to the teacher on-line, the system provides a return channel that can be implemented either with a 56 kbps inbound carrier through the satellite, or with ISDN videoconference at 128 kbps, or with a PSTN connection via a modem. And finally it is also given the choice of a receive-only remote station without return channel, which could be useful in certain applications.

CODE provides the end user with a standard Ethernet interface to a TCP/IP transport which gives it the flexibility to provide other services such as database access, electronic mail, WWW and in general all services supported by Internet.

These are some of the main features of the system implemented by TEN:

- Satellite/Terrestrial Integrated Network: Broadcast/Point-to-Point/Circuit Switching
- Scaleable Stations
- VSAT/ISDN, Full VSAT
- Trunk Network TCP/IP LAN to LAN
- Data Network Interconnection & value-added data services
- Internet Connectivity (FTP, VT, E-mail, WWW, etc)
- Virtual Classrooms, Desk-Classroom
- It integrates and experiments with New Multimedia Developments: enhanced interfaces and facilities, emerging standards (Indeo-PCWG, H.261)
- It integrates and experiments with Distributed Multimedia Applications and Models

Another advantage offered by the system is that it does not need any kind of external help by studio technicians or specialists in its normal working during a course. To work with the TEN multimedia application is very easy to learn and this is based on the development of a friendly teacher/student interface.

The following features are available in the current release of the multimedia tele-education application:

- Full-duplex audio. In the communication between two stations the audio is full duplex, that is, there are two audio channels fully independent between the two stations. In a third station there is a switch that will be dynamically chosen between the different audio signals coming and only one of them will be reproduced. Whenever one of the audio signals is the teacher's one this will have priority over the others. In case of audio from remote stations it will be reproduced the one that first comes.
- PowerPoint viewer interface. This application includes the PowerPoint viewer to show and manage the slides of the presentations. The interface is the standard PowerPoint viewer interface. All the stations will have the same interface and the possibility to take control over the slides when they are interacting.

- Up to two remote stations interacting at the same time. It is possible to have two remote stations (apart from the teacher) interacting (audio, video and control) at the same time. The other stations will be watching and hearing the interaction among the two remotes and the teacher (not only the image and sound of the classrooms/participants but also the presentation slides, drawings, etc).
- Scanner. The application allows the integration of a scanner in the teacher and remote stations in order to show some last-minute information during a session. This information in printout copies can be digitised and sent to the other stations. Also drawings utilities are available to work over the scanned image.
- Use of videotapes. It is possible to broadcast videotapes from the teacher's station. Image and audio coming from the tape during the video play will replace the teacher's.
- VGA resolution. The display resolution used by this application is VGA (640x480) and high-density colour (16 bits). This resolution allows showing the application screen in a big size format without the need to utilise expensive video projectors in the classrooms.
- Application for managing courses and presentations. At the teacher station the software package includes one specific application to manage the presentations (insert, modify, delete, etc.). It offers two management levels: course and session (lecture), thus one course can contain several presentations.
- Teacher Simulator. Within the application software package, it is included an application that simulates the teacher interface in a remote station. Thanks to this a teacher being near a remote station is offered the possibility to have some training locally before the live satellite sessions (the hub station is in Madrid).

The teacher/student interface is the appearance of the screen that can be seen by the teacher in the computer from where he gives his course, and by all students in the big screens or electronic blackboards existing in every classroom connected to the system. This interface is defined in the same application that was developed in project TEN, and it is based on the most usual standards for PC (Windows 95, PowerPoint, TCP/IP).

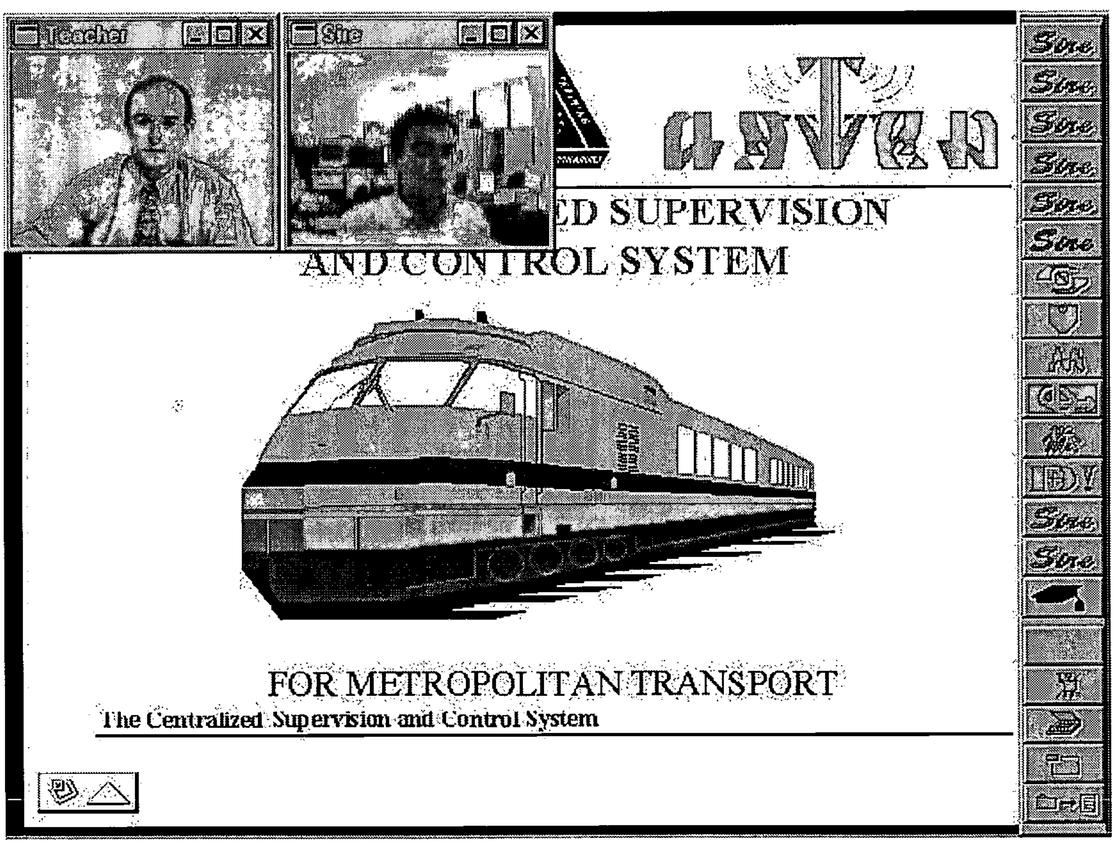

Figure 4: Teacher/learner interface

By clicking the mouse on this interface (application toolbar) the teacher can give a presentation made with PowerPoint and students can see an image of his face in a corner while following his lecturing. He can also occupy the whole screen with his image in order to have all the attention of his students focused on him (possibility to change between small /big size of the teacher image). He can give permission to one or more remote stations to intervene in a discussion during the lesson time, he receives signals indicating that someone in a remote classroom wishes to participate, he can see in every moment which remote stations have logged on, and so on.

4. System validation

As it was said before, the network that was installed in project TEN has been used continuously from December 1996 to February 1998 to give 30 pilot courses, with more than 300 hours of system usage and about 500 students attending them and coming from the countries and areas where the remote stations are located. Students did not pay for attending the TEN courses.

The contents and subjects of the courses have varied a lot, depending on which institution among all the participants in the project was responsible of preparing them. Courses dealt with issues that were considered as interesting for small and medium-sized enterprises, but also with academic subjects and with training of trainers. In any case it was not the case that those courses were prepared having the TEN system in mind, but they were adapted from other systems or platforms to be provided through the TEN network. Furthermore courses were independent from each other and lasted no more than three sessions lasting 150 minutes each, and this was another setback for students that might want longer courses and also structured in a modular way. Our main goal at this stage was just to demonstrate the technical feasibility of the system and to check its pedagogical capabilities.

Future validation plans for the system are included in a project extension scheduled to start before July 1998. In this new phase five new remote stations will be installed in Poland, the Czech Republic, Hungary, Russia and Kazakhstan. Those new countries are going to receive funding from the International Co-operation (INCO) Programme of the European Commission and their participation will be co-ordinated by UNESCO.

Since the purpose now is to validate the idea of using the system for distance learning it has been adopted a completely new approach. First, courses are no longer free and therefore attendants will have to pay fees. In this sense we are increasing the value of the courses to the eyes of the students and also their interest. Second, contents are going to be designed according to students' needs and wants. Academic matters as astrophysics or dynamics of cardiovascular fluids will be dropped, and business administration or software applications in SME's will be preferred. Also it will be followed a modular approach in structuring the courses. Two or three main master courses will be prepared by European institutions of prestige but having the contents organised in totally independent modular courses, so that students are not forced to pay for a whole 9-month master course when they can only attend during three or four weeks a shorter course. Original plans are to start preparing the courses and looking for students in July 1998, and to start classes in October 1998 and until June 1999. Course materials will be provided through Internet and the TEN system will be used in sessions for groupware, tutorials, lectures, and so on, with the purpose of highlighting the contents of the courses.

5. Exploitation costs of the system

System TEN shows several clear advantages over competing solutions, such as how fast a network can be installed or re-configured, not depending of the situation of the local communication infrastructure, and not being limited in terms of the number of remote stations that can be connected to the system.

Furthermore, when we compare its exploitation costs with those of a 384 kbps ISDN videoconferencing system, that can be picked as an example of technological solution alternative to the one proposed in TEN, the advantages of the later can be seen immediately.

While the exploitation costs of a traditional videoconferencing system over ISDN at 384 Kbps increase proportionally with the number of remote classrooms connected to the system and with the number of usage hours, exploitation costs of system TEN are much more unresponsive to fluctuations of both variables, above all if it is considered the particular TEN solution that implements return channel in remote stations via ISDN at 128 Kbps. In this way it is only necessary to connect with the hub station when a question is to be asked to the teacher, therefore, minimising communication costs.

6. Conclusions

Summarising, project TEN is attempting to demonstrate the applicability of satellite communications, and more specifically VSAT technologies, in the area of distance learning and training. The proposed solution offers a great flexibility and adaptability to a lot of different learning environments (university education, training in the workplace, vocational training), and at the same time it constitutes a highly cost effective alternative.

Access Limitations, Educational and Economic Disparity, and Cultural Bias in Online Learning

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Abstract: An unintended effect of Internet-delivered courses is a type of gentrification of the student population into technological haves and have-nots. It is the responsibility of universities and colleges to provide student access and training for the technology required to take these courses. Educators and researchers have been hard at work posing possible solutions to problems of access. Three categories of solutions have resulted from their efforts: public remedies, programs implemented by colleges and universities, and advances in the technology itself.. Colleges and universities must also bear much of the burden to equip students to take advantage of new educational delivery methods. According to experts, they should design and test instruments that measure the technological skills of entering freshman students of color and economically deprived white women; design, develop and instruct an interdisciplinary, introductory course in communication technology that will enhance students of color and women's information processing skills by increasing their computer performance abilities, reduce their technophobia, and increase their critical evaluation of the role of technology in their lives, and design a system for tracking the performance abilities of these students.

Introduction

A minor revolution is taking place in higher education: more and more students are completing courses using the Internet and other distance learning technologies (Corrigan, 1995). Entire online universities have been created to provide learning opportunities for students. For example, the Western Governors' University is coordinating hundreds of courses offered to thousands of students throughout the world (Educom, 1997). Institutions such as the University of Phoenix, University of Colorado, Denver, and Metropolitan State College of Denver are moving much of their curricula online. Corporate America is getting into the act, with companies such as IBM and Ziff-Davis offering online courses (ZDNet University, 1997). These delivery methods offer undeniable benefits, including convenience, increased access in many cases, and the opportunity for a richer learning experience (Germann, 1996). Many educators believe that this trend will continue and that in the near future, all or part of most college courses will incorporate technological components (Corrigan, 1995).

An unintended effect of Internet-delivered courses, however, is a type of gentrification of the student population into technological haves and have-nots. According to the Rand Corporation, "E-Mail is most likely to be used by wealthy, well-educated whites, while those most at risk include people without college degrees, those with below average household incomes, and ethnic minorities—especially Hispanics, African-Americans, and Native Americans" (Rand, 1995).

This paper will examine the problems created by online courses--problems of access, educational disparity, economic disparity, and cultural bias. It will then look at some preliminary data from two area colleges, and finally recommend some possible solutions.

Problems of Access

There is no question about the impact of technology on society. Automated teller machines, cellular telephones, pagers, and other devices are ubiquitous. More and more individuals and businesses are turning to the computer and the Internet for education and training as well (Schrum, 1996). Many organizations support the spread of this technology.

> We find that use of electronic mail is valuable for individuals, for communities, for the practice and spread of democracy and the general development of a viable National Information Infrastructure. Consequently, the nation should support universal access to e-mail through appropriate public and private policies. (Rand, 1995).

Unfortunately, that universal access is more talk than reality. The Rand Corporation study continues:

> An information elite still exists, made up of those with access to and knowledge about computers and e-mail. And as e-mail becomes more pervasive, as more commercial and government transactions in the US take place online, those information haves may leave the have-nots further behind, unless we make concerted efforts today to provide all citizens with access to the technology.

Other researchers have found that many people, regardless of the problems of access, don't have the necessary computing skills and abilities to take advantage of the new educational delivery methods. Krupar (1996) states that minority students are particularly at risk. "An Educational Testing Service Survey conducted in 1993 disclosed that minority K-12 students were considerably less skilled in computer competencies than white students. In particular, Hispanics and African American students registered fewer computer competencies than their white peers" (p. 38). Other research echoes this notion. Stickles (1988) states that many students of color (non-Asians) and poor white women haven't learned communication technologies in their K-12 studies.

Many people denied access to online education simply can't afford the computer, Internet access, and training required to take advantage of the technology. Resta (1992) reports that the average incomes of most families able to purchase a computer for the home is $35,000 while the average income of Black families is $16,786 and Hispanics families $19,027. Shields (1994) also writes that many students of color and white women cannot afford to purchase the technology.

In addition, research also indicates that some cultures hold a bias against computers specifically and technology in general. Stickles (1988) states that there is a strongly held negative prejudice among the black community toward computer technology. He reports that this negative attitude is a result of the perception that technology is a "white male power tool."

The overall effect of this lack of access, educational and economic disparity, and cultural bias is that large numbers of students--often students who could most benefit from the technology--are being denied those opportunities.

Internet-Delivered Courses--Some Preliminary Data

Although there is a large body of research available concerning educational technology in general, there is much less research concerning Internet-delivered courses. This is probably because most institutions only recently have began offering courses via this delivery method to large numbers of students. Front Range Community College is the largest two-year college in Colorado and has been offering online courses since 1994. Data from that college tends to support the conclusions of much of the research cited above. Specifically, in a study of 484 students who completed online courses between 1994 and 1996, data indicates that

--African American, Hispanic, and women students are underrepresented in online courses

--Asian students are not underrepresented

The report indicates that the data has not been checked statistically for significance, that no data was available concerning student income, and that more research is needed (Computer online course data, 1996). In addition, limited, preliminary data from Metropolitan State College of Denver echoes these findings.

Some Recommended Solutions

Educators and researchers have been hard at work posing possible solutions to these problems. Three categories of solutions have resulted from their efforts: public remedies, programs implemented by colleges and universities, and advances in the technology itself. The Rand Corporation wrote that widespread public initiatives need to be undertaken to reach the disadvantaged student:

> Policy interventions should give priority to widespread home access. In addition, and not as a substitute, multiple options for network access located in convenient places (including, for instance, libraries, schools, public buildings, hotel lobbies, business centers, and the like) are important auxiliary access sites. Such common facilities could be considered good locations for help or training centers as well.

The Rand study also states that institutions need to study creative ways to make terminals cheaper; to have them recycled; to provide access in libraries, community centers, and other public venues; and to provide e-mail "vouchers" or support other forms of cross-subsidies.

Schuler (1996) estimates that some 600,000 Americans are now being served by community-based organizations that provide entry to the "information superhighway" at little or no cost. Some of this work is being supported by the Commerce Department's National Telecommunications and Information Administration which has spent $60 million on community initiatives during the past two years.

Colleges and universities must also bear much of the burden to equip students to take advantage of new educational delivery methods. According to Krupar (1996), schools should:

> ...design and test instruments that measure the technological skills of entering freshman students of color and economically deprived white women at Metro; design, develop and instruct an interdisciplinary, introductory course in communication technology that will enhance students of color and women's information processing skills by increasing their computer performance abilities, reduce their technophobia, and increase their critical evaluation of the role of technology in their lives, and design a system for tracking the performance abilities of these students...

She goes on to write that colleges need to provide technology role models for minority and women students. These could come in the form of computer course instructors and computer lab assistants.

Other institutions are offering other programs. The University of Minnesota--Crookston, (University of Minnesota, 1997) Waldorf College, and others are providing notebook computers to all students, and Hunter College is offering a special course for students without previous computer experience, most of them women and minorities (Epstein, 1993).

Finally, computer and related telecommunications technology is becoming cheaper and easier to use. Alternative devices such as "web-tv's", which allow users Interact access through their televisions, went on sale recently. Network computers, which cost less than full featured versions but allow Internet interaction, also recently became available. And inexpensive handheld computers and attachments to video game machines is making access available to a broader audience. In reality, it will take initiatives such these, and many others, to insure a wide access to Internet-delivered courses and other types of educational technology.

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Template-based Web Authoring for Language Teachers

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Abstract. There are currently many possible approaches for creating Web sites for instruction.This paper describes the option of creating Web pages for language learning (or other disciplines) by using one of the many template-based authoring tools now available. Such an approach provides a quick and easy way to create course Web sites and to add interactivity such as discussion forums and drill and practice. A course recently taught by the author using "Web Course in a Box" (WCB) will be demonstrated, along with the WCB authoring tools. WCB has the advantage of creating a highly student-centered, active-learning Web site and allows for a suprising degree of flexibility and creativity in the use of the Web in language instruction. WCB is free to higher education.

Language teachers traditionally make extensive use of handouts in their teaching, in order to extend textbooks and provide a more personalized and customized approach to learning. Creating Web pages out of those handouts is simply an extension into cyperspace of what we all have been doing for a long time. The advantage over paper is the possibility of adding multimedia and interactivity; putting learning materials on the Web also allows for remote and off-hours student access as well as easy updating. For that to become possible for most faculty, however, there needs to be a quick and easy way to author, maintain and post Web documents, as well as to create interactive Web pages. HTML editors and text editors with HTML macros make the process of creating basic Web pages nearly as easy as normal word processing. However, with many of these programs teachers still need to know the basics of uploading files with FTP as well as of setting UNIX permissions for Web access. Macintosh and Windows servers streamline this process considerably, allowing server volumes to be mounted directly on the user's desktop.

An encouraging step in the direction of ease of use is the emergence of a group of products designed to make it much easier for teachers to manage and create Web pages and other Internet-based learning tools. Some are high-end commercial products such as Lotus Notes' *Learning Space* or those available through the Web tools in Asymetrix's *Toolbook II*. These products go considerably beyond the creation of course Web pages and use of collaborative tools -- adding, for example, sophisticated management and tracking capabilities -- but at the cost of some complexity in their use as well as of the required purchase of expensive proprietary software.

Another route has been taken by a number of universities -- the creation of inexpensive Web-based course creation and management tools. Most of these tools were initially developed for in-house use, but a number are being made available (or sold) for external use as well. This include such projects as WebCT (British Columbia), WEST (Dublin), the Instructional Toolkit (Virginia), CyberProf (Illinois), WISH (Penn State), Virtual-U (Simon Fraser) and POLIS (Arizona). They vary considerably in their capabilities and approaches, and some are still in beta testing.

Another of these tools is one co-created by the author, called *Web Course in a Box* (*WCB*). As with most such authoring tools, using *WCB* does not require any knowledge of HTML nor does it require from the user any additional software beyond a Web browser. However, instructors who have learned HTML can use that knowledge to customize their pages beyond the default formats supplied. Using *WCB* involves entering text into form fields on Web pages, either through typing or copying and pasting, then sending the data to the Web server (by clicking on a button) where it is saved and formatted for the Web. As with other template-based systems, *WCB* allows customization of the look if the pages created, but does not allow absolute control over formatting and display options.

Figure 1: Sample course home page created with *WCB*

Typically, there is a short learning curve in learning to use such authoring tools, since users are working in a familiar medium, not learning a new environment. Updating pages once they are created is as easy as creating them in the first place; when forms are called up, the current values for each form field are automatically displayed for the instructor to verify and edit.

Such tools ease the process of creating Web pages in another way. Normally after creating HTML files, the user must then send, or upload the files to the Web server. Since typically the Web server is a UNIX computer, this necessitates learning FTP (file transfer protocol), maneuvering the UNIX directory structure and setting access permissions (with UNIX command line codes). Using *WCB* by-passes this procedure by saving the files in a predetermined and established directory for each course. Saving the files in the proper directory with the correct setting for Web access is accomplished automatically through submitting the *WCB* forms. In addition, the instructor can use the *WCB* forms to set up access control for course Web pages. This allows restricting access of course pages by requiring students to use logins and passwords. Access control is particularly useful if interactive Web pages such as discussion forums are being used, so that users can be tracked and their contributions registered.

Using *WCB* enables the instructor to integrate many types of files into an on-line course. Any type of file, including graphics, audio or video can be copied from the instructor's personal computer to the Web server, automatically uploaded and linked into the course pages. *WCB* does not create multimedia files, but it can help organize those files for student use. One of the greatest strengths of the Web is the ability to use the standard hypertext interface of the Web page to integrate seamlessly local resources with those located half way around the world -- from the student's perspective are all just a mouse click away. Using file uploading and linking, instructors can make available not just text files, but also previously created learning materials such as HyperCard stacks or other language learning programs.

One of the main goals in creating *WCB* has been not just to ease the process of creating and maintaining basic Web pages for classes, but to enable the creation and to encourage the use of interactive Web pages, to help instructors move toward an active-learning, student-centered approach to the use of Web-based learning materials. Especially popular at VCU and at other institutions using *WCB* have been the threaded discussion forms. An example of the format of the forums is shown below:

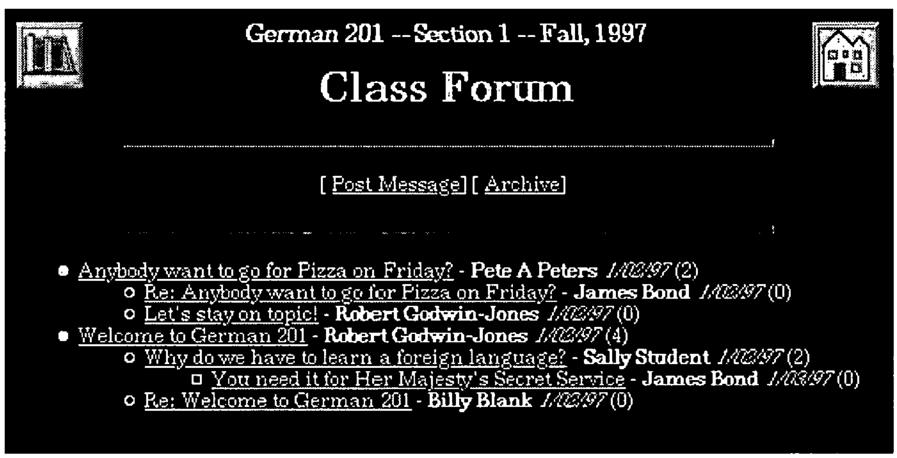

Figure 2: Sample discussion forum

Multiple forums can be created for each class, which allows instructors to assign specific discussion or assignment topics to each forum. Instructors can also use a workgroup approach to the discussion forums, creating sub-groups in classes which then have exclusive access to workgroup--specific forums. Group projects can be done collaboratively in this way and then shared with the rest of the class in an open forum. The forums also allow attaching files, so that students can exchange and work collaboratively on files such as word processing documents.

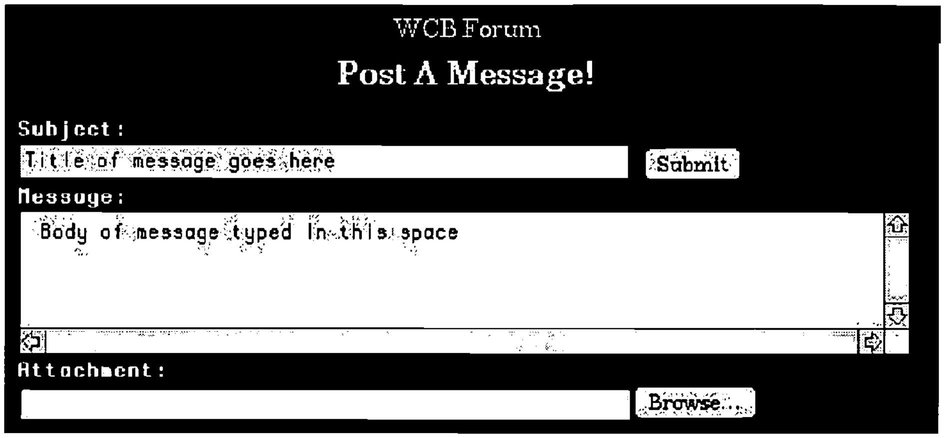

Figure 3: Form for posting message in a discussion forum

The forums also can be archived, which when selected creates a snapshot of the forum at that point, putting all the posted messages and replies into one large file, which can then be viewed, downloaded and/or printed to provide an overview or review of the discussion in its entirety. Instructor-enabled forum management allows individual instructors to delete unwanted messages by author, by date, or by message thread.

Another option being added to the discussion forums is the ability to display thumbnail images of the original poster of a discussion thread next to the title of the message. The Web, as an electronic environment, is impersonal -- personalizing the environment in small ways can help towards humanizing somewhat the medium, as well as contributing towards building a community of learners, an especially important effort if the course is being exclusively taught over the Web. At VCU we will be linking to an already existing database of student images created for student identity cards, which are already in electronic format.

An additional interactive feature of *WCB* is the ability to create self-correcting quizzes and exercises. These can be created by typing in questions and answers or by importing text files containing exercises. There are a variety of formats available. Below is a short answer quiz.

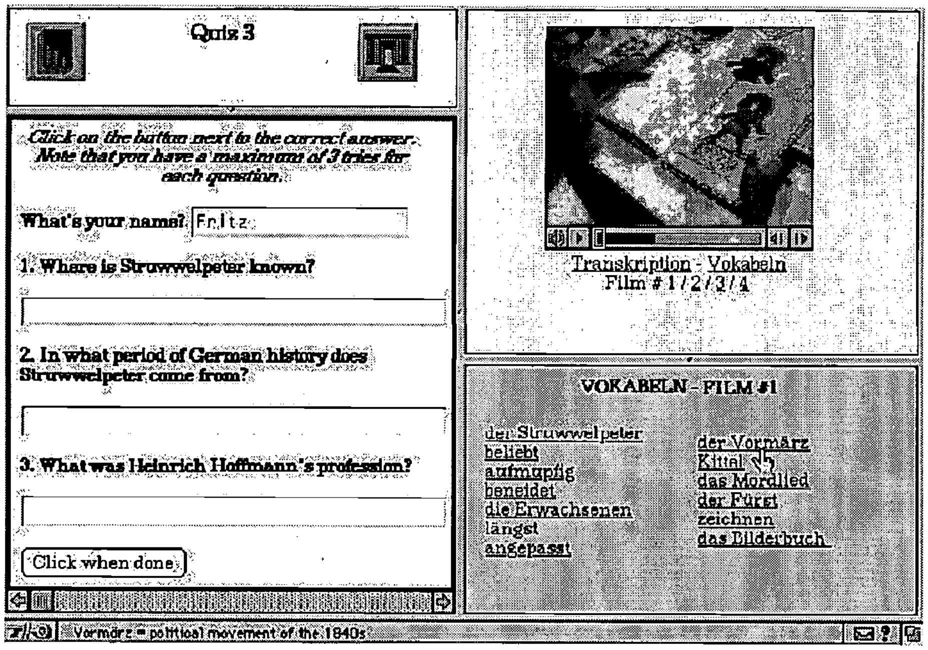

Figure 4
Sample interactive quiz

Of particular interest to language teachers is the fact that any character set can be used (as long as it is supported by the operating system the student is using). Feedback can be provided based on not just right or wrong choices but also on anticipated wrong answers, with in-context remediation help provided based on student performance. Student performance can be optionally monitored and scores reported. Content files -- whether text, graphics, audio, video or Java applets -- can be linked to the exercises or displayed side by side in a separate window (as shown in Figure 4). The next step will be to move toward an increased student-centered approach by asking students optionally to choose feedback, display and remediation options.

Using *Web Course in a Box* as a method for creating course Web pages makes sense for faculty who are not terribly interested in learning the mechanics of Web page creation and management but who want to create Web pages quickly. For faculty who want maximum control over the design and structure of their Web pages, creating Web pages from scratch with a text or HTML editor may be the best choice. However, even for those faculty, using a tool such as *WCB* may provide a good starting point. Or they may simply want to use *WCB* for key features such as access control, creation of discussion forums or interactive quizzes, and use the file upload capability to make available Web pages (or other files) created manually.

Web Course in a Box is an add-on to Web servers running under UNIX, WindowsNT or Macintosh operating systems, is free to higher education, and is available from http://www.wcbinfo.com.

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Introducing Flexibility into Educational Programs: The Macquarie University Experience

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Abstract: Macquarie University's vision is to provide flexible learning options for all students. This will involve the dual development of resource-based curricula and information technology (IT) capacity across the University. This paper highlights major issues underpinning the design, development and delivery of flexible learning and how these relate to the Macquarie context. It introduces a three-stage IT-based developmental model which accommodates both curriculum redesign and the wider institutional changes needed to ensure the delivery of high-quality flexible learning.

1. Introduction

Flexible learning embodies the principles of student-centred education by catering for individual needs in a mass higher education system that is expanding to accommodate an increasingly diverse student body. Flexible learning can provide students with real choices in when, where, how and what to study. Flexibility can be introduced in several ways. Flexibility in *time* allows students to study when it is most convenient to them, rather than being restricted to a set schedule of classes. Flexibility in *place* allows students to choose the location of study; learning materials can be accessed from different locations, either on-campus or off-campus at home, work or even the local library. Provision of a range of different learning resources and teaching methods allows students to choose *what* or *how* to study. Lastly, flexibility in *pace* allows students to progress through an individual course unit or a whole program of study at their own speed to match their own circumstances.

The vision for flexible learning at Macquarie University is to provide flexible learning options for all students. This paper highlights major issues underpinning the design, development and delivery of flexible learning and how these relate to the Macquarie University context. It introduces a three-stage IT-based developmental model which accommodates both curriculum redesign and the wider institutional changes that are required to ensure the delivery of high-quality flexible learning options.

2. Flexible Learning: The Macquarie University Context

Australian higher education has experienced major change since the early 1980s, with increasing student numbers, closer alignment to national political objectives, increasing government control, growing emphasis on 'quality' and 'value for money', organisational restructuring affecting all levels from system-wide to individual departments, and accelerating moves to recover costs from individual students. Policies introduced by the current Federal Government have encouraged competition between universities, with their growing differentiation an emerging outcome [Rich et al. 1997]. Among its responses to this increasingly challenging environment, Macquarie University has developed a Flexible Learning Plan, which is not only an attempt to respond to changing patterns of student demand but also reflects evolving conceptions of student learning.

Limited flexible learning opportunities have long been available to some students through a well-established distance education (external) program offered for some, but not all courses. This program runs in parallel with on-campus (internal) programs but is administratively distinct. Historically, students were required to enrol in one or the other; it was not possible to combine elements from the distance and internal programs. Students could not, for example, receive instructional resources available to distance students and also formally enrol in on-campus tutorials or laboratory groups designed for internal students. This limited flexibility of study patterns and restricted use of learning resource materials to those students who chose to enrol in the distance program. Demand for more flexible options now, however, goes beyond this group. Although the distance program was established to provide education for non-metropolitan students, it is increasingly used by local students who, for family, career and other reasons have difficulty in accommodating on-campus class schedules. Administrative and educational distinctions between the two groups have gradually been eroded. All students, not just the traditional distance education group, are now potential users of flexible learning programs.

Pedagogically the content of distance and on-campus programs is usually similar, but the learning experiences are varied. In some units of study, there is little distinction between learning resources and teaching methods, while in others they can be very different. On-campus students generally attend lectures, tutorials, seminars and laboratory sessions. Although traditionalists consider the skills of academic discourse are best learned through small-group discussions, Bates [1995] challenges the reality of this, claiming that small-group face-to-face interaction is quite rare in post-secondary education today. For both on-campus and distance students, by far the largest part of their study is done alone, interacting with books and other media. The difference is that for distance students this fact is acknowledged and learning resources are designed to provide opportunities for interaction.

Distance programs typically employ a resource-based approach to curriculum design [NBEET 1994] which uses teaching and learning strategies based on instructional resource materials designed so that study is largely independent of real-time contact with staff. Numerous technologies are available to deliver resources including printed matter, audio and videotape, computer-based learning applications, interactive video (disk and tape), audio- or videoconferencing, broadcast TV and radio, and computer-mediated communications. At Macquarie, however, instructional resources are still primarily delivered using the early technologies of print, audio and video. Little use has been made of newer multimedia, Internet and computer-mediated communications. Taking this into account, along with Bates' observations, we can surmise that upgrading instructional resources in the distance program and the use of such resources in internal programs can benefit all students.

Individual interaction with instructional materials, while crucial to the learning process, is only one element contributing to the complexity of learning and understanding. Cognitive development is strongly linked to input from others. Interaction among learners as well as between learners and teachers, whether through conversation or collaborative exercises, is an important strategy that should be embedded in any teaching program [Slavin 1997]. On-campus students have usually had more opportunities for communication between staff and students, both individually and in groups, than have distance students. However, modern communications technologies provide new ways for learners to interact at both a personal and instructional level that can partially equalise these opportunities. The selective and effective use of electronic collaborative learning exercises, virtual tutorials, bulletin boards and individual email conversations between staff and students has been shown to produce learning benefits [Katz & Lesgold 1993]. This provides, as never before, the opportunity to break down the barriers and isolation that many distance students experience. Likewise, in an environment of rising student:staff ratios and increasing class sizes, on-campus students could well benefit from these new avenues of communication.

The emerging reality is that it is now possible to provide similar learning experiences for on-campus and distance students by using instructional resources that exploit the interactive and communications capacity of modern technology. Incorporation of such resources into curriculum design not only facilitates the convergence of educational programs but, according to advocates, can produce other strategic and educational benefits. Well designed instructional materials can make students more active and independent learners; provide safety nets for students who are falling by the wayside in the more traditional mode of teaching; offer economies of scale where student numbers are large; reduce unproductive travelling time for part-time students; cater for student diversity; reduce pressure on teaching staff; and ease overcrowding of teaching space [NBEET 1994; Brown 1997].

The Macquarie University vision of flexible learning is to capitalise on these benefits to provide flexible learning options for all students, not just those enrolled in distance education programs. It aims to provide more choices by bridging the gap between on and off-campus students through the provision of similar curricula and learning experiences for both groups. In effect, this will result in a convergence of distance and internal programs which, for all intents and purposes, will mean academic staff will be teaching one program, not two. The benefits for students are threefold: on-campus students will have access to the comprehensive resources currently available to distance students; off-campus students will have greater opportunities to communicate and collaborate with staff and the entire student cohort; and most importantly all students will have the choice of studying either on or off-campus or a combination of both, according to their individual needs at a given time.

3. The Introduction of Flexible Options into Educational Programs

3.1 Design Issues

Underpinning the design of flexible learning options is the curriculum design concept of resource-based learning. The enabling factor making it possible to use different resources in flexible ways is IT and its capacity to access information, deliver content and facilitate communication. Consequently, IT in general and the World Wide Web in particular have a pivotal role in the design and development of curriculum materials as well as in the delivery and management of flexible programs. At its simplest, the Web can be used to coordinate, and manage the learning experience through the provision of course outlines, teaching schedules, news bulletins and communication facilities. At its most sophisticated, the Web can provide a virtual learning environment that: handles enrolments; disseminates administrative information such as course outlines and teaching schedules; records student progress; delivers content and supports interactivity; facilitates communication and collaborative learning; provides assessment and feedback to students; and administers student evaluations of teaching.

Within the foreseeable future, a unit of study with flexible learning options would have a range of learning options equally accessible from on and off-campus. A Web interface would manage learning by providing course information, suggested scheduling of the content to be covered and the learning resources and interactive opportunities available to students. Specific resources may be delivered through the Web or may be in print, CD-ROM or disk format. A mixture of on and off-campus activities could be available; for example, students could choose between a face-to-face seminar session or an electronic discussion group; live lectures may be available or alternatively videoconferencing or audiotapes could be accessed. Other resources could include electronic quizzes, computer-based learning packages, simulations, group learning exercise and textbooks. Communication between participants could be facilitated through the Web using email, bulletin boards, conferencing options or, for students on campus, consultation hours could be available. Assignments could be submitted, marked and returned on-line. The role of the teacher would change from that of an expert delivering information and knowledge to one of an expert coordinating and managing a range of learning opportunities. Students would no longer be classified as internal or distance with restrictions on study options but would select from a range of learning resources or events, whether on-campus, off-campus or a combination of both.

3.2 Developmental Issues

Developing flexible learning options, as well as enhancing existing offerings, will require time, resources and energy. For students and staff it will be a new experience and infrastructure and support facilities will need to be developed to accommodate the change. From an educational perspective, the change will require the dual development of a resource-based curriculum and IT capacity. The term IT capacity is used in this context as an all encompassing term including physical infrastructure such as networks, hardware and software, and the technical skills and knowledge required to design, develop, implement and manage IT-based teaching resources as well as the supporting technical systems.

Neither curriculum expertise nor IT capacity, especially the ability to integrate new technologies into teaching programs, is evenly distributed across Macquarie University. This is not unusual in the Australian higher education system as evidenced by a recent study of the expected adoption of computer-mediated communication in university teaching which revealed that "there was little evidence of a consistent move towards an informed use of new technologies for teaching, with most developments being related to individual enthusiasts or small groups with expertise" [Hesketh et al. 1996]. Consequently, any institution-wide move towards introducing flexible options must be coupled with the development and maintenance of the necessary human, physical and technical resources. A recent report on Quality in Resource Based Learning [NBEET 1997] identified these as including: the design and development of instructional resources, with more emphasis needing to be placed on instructional design to ensure there is a focus on active student-centred approaches and recognition of cultural and educational diversity; the development and maintenance of technical infrastructure; staff development to ensure confident and committed staff with new competencies; sustained and committed leadership; informed planning and management of resources; the provision of effective and efficient administration systems and services; support for learners; provision of adequate access for all clients; evaluation mechanisms to ensure continuous improvement; and new benchmarks for accrediting courses.

4. A Web-based Model for Introducing Flexibility

4.1 The Model

The Centre for Flexible Learning at Macquarie University has developed a three-stage model to facilitate the introduction of flexibility (Tab. 1). This Web-based model guides the development of on-line study programs within a framework that accommodates the institutional developments listed above. The model:

- recognises that flexible learning is underpinned by resource-based curriculum design;
- recognises that the Web is pivotal in coordinating and managing flexible learning programs;
- recognises that a variety of other media will also be used, depending on the particular teaching context;
- emphasises the active involvement of participants in the design, development, implementation, evaluation and maintenance of resources and programs;
- recognises and accommodates the need to develop institutional capacity to support flexible learning;
- recognises that institutional capacity requires coordination at all operational levels; and
- provides a practical context within which to develop, evaluate and refine products, supporting policies, strategies, and technical, administrative and managerial structures.

4.1 Stage 1: Developmental

Stage 1 is largely a developmental phase to orient staff and students to an on-line environment and to develop the structural mechanisms, skills, curriculum content and administrative procedures needed to deliver education through the Web. It commonly involves maintaining an existing curriculum structure and teaching resources but developing a homepage for the course unit or program involved, as a supplementary, not compulsory, resource. It might provide some or all of the following: administrative information, curriculum outlines, assessment requirements, lists of additional learning resources, a bulletin board or links to Internet sites, professional bodies or special interest groups. Initially, open (public) access to the homepage is recommended.

The Stage 1 homepage serves several purposes. It orients students to using the Web as a communication and information resource. For staff members and departments, homepage construction requires involvement in the development process and is an opportunity to gain an understanding of the scope and nature of the changes needed to accommodate Web-based teaching. Most importantly, this concrete experience is a basis for developing, evaluating and refining policies and strategies to deal with curriculum and management issues associated with resource development; technical, physical and human infrastructure support; access and equity issues in regard to computer ownership and Internet access; support and training for students; and staff development.

4.2 Stage 2: Partial Flexibility

In Stage 2 computer use becomes compulsory for at least one component of study, so that all access and equity arrangements, technical infrastructure, and student and staff support mechanisms must be operational. Typically, as knowledge and skills grow in Stage 1, new learning resources are developed using the Web environment's special features to cater for both on and off-campus students. Such resources may include compilations of relevant Internet links, quizzes, simulations, computer-based learning programs, practice exercises with hints and feedback, gateways into research or commercial databases, and communications facilities such as email, listservs and bulletin boards that can facilitate collaborative learning or individual communication. In Stage 2, the range of such resources often increases and they are fully integrated into the curriculum.

Only when the transition to compulsory computer use has been made can staff and students critically evaluate the initiatives. This stage can thus be seen as the trialing phase, which provides the opportunity to evaluate and refine resources, policies and procedures. At the same time there should be ongoing infrastructure, staff and resource development taking place. The internal and external curricula should be subject to continual review and restructuring with the aim of convergence to a common curriculum. It is often desirable to protect the increasingly valuable intellectual property embodied in the learning resources by a system of password protection, making them available only to enrolled students; as in Stage 1, organisational material and any content likely to promote the course unit or the University can be left available to the public.

4.3 Stage 3: Full Flexibility

Stage 3 is typically reached when there is sufficient confidence in the curriculum resources, access arrangements, technical capability and support structures to offer the program with full web-enhanced flexibility, although the transition from Stage 2 is not always clear-cut. Computer use is compulsory from either on or off-campus and again it may be desirable to password-protect key learning resources. The entire program of study is available flexibly to all students and is managed on-line. It is important to reiterate, however, that full flexibility does not imply that all components of teaching and learning are delivered through the Web. Rather, it is used to create a virtual learning environment which acts as a point of communication to coordinate and manage the learning experience which is provided through a range of resources in several different media.

	Stage 1: Developmental	**Stage 2: Selective Flexibility**	**Stage 3: Full Flexibility**
Usage	Development of supplementary learning resources. Optional use.	Partially on-line. Incorporates some Web components. Compulsory use of some components.	On-line delivery and management of the unit. Compulsory use for the entire unit.
Access	Open access.	Differential access. Open access for administrative information and restricted for learning materials.	Differential access. Open access for administrative information and restricted for learning materials.
Resources	Homepage as an additional source of information for the students and the community: • general information about the course unit • content outlines • links to Internet resources, professional bodies etc. • email links/request forms	Some components of the unit are on-line, eg: • Internet resources • quizzes • simulations • computer-based learning • practical exercises • group discussion • interfaces to databases	The entire unit is flexible. Stage 2 resources plus additional Web use; eg: • management of learning • content delivery • interaction with content • collaborative learning • assessment • evaluation
Strategic Issues	Development of policies, strategies and support mechanisms. Staff development.	Evaluation and refinement of policies, strategies and support mechanisms. On-going staff development.	All policies, procedures and systems in place and operational.

Table 1: An IT-based model for introducing flexible learning into the curriculum

5. Using the Model

Sequential progression through stages is particularly useful for programs with little or no expertise in the Web or in computer-based teaching. Most activity at Macquarie University is still at Stage 1 where expertise is being developed or Stage 2 with partial flexibility. While the University has flexible offerings in the form of traditional distance education programs, very few are operating at Stage 3 of the IT-based model with on-line management and coordination of students' learning. For Schools with existing learning resources, the conversion to full flexibility is often a process of integrating those resources and management systems within a Web-based environment: essentially a movement from Stage 2 to Stage 3.

The first programs to offer full Stage 3 Web-based flexibility followed this approach. Emerging from the School of Earth Sciences, the flagship was a first-year unit, GEOS114 *Global Environmental Crises* [Earth Sciences 1997; Rich et al. 1997] catering for 400-500 students. Before the emergence of the Web, a resource-based curriculum akin to Stage 2 was developed employing a computer-based multiple-choice quiz (available on-campus only), an interactive CD-ROM, a textbook and live or audiotaped lectures. The unit moved to Stage 3 and full flexibility with the development of a Web interface to guide study patterns, manage the use of learning resources and integrate communications facilities. New IT-based resources were developed, including an Internet Resources kit and two interactive learning programs. Alongside these, lectures and print materials are still used.

For existing distance education programs running parallel with internal programs one pathway to Stage 3 flexibility is to initially retain existing materials, but merge the programs by developing a Stage 1 Web presence to serve both, introduce computer-mediated communications and gradually develop new resources accessible on or off-campus. An example is a first-year law unit, LAW113 *Jurisprudence Law* [Law 1998]. A Website supports both on-campus and distance students; course unit content is identical for all students but different instructional options are available, for example a choice of lectures or audiotapes. A key feature is the ability to use structured and unstructured discussions via email and bulletin boards as an alternative to on-campus seminars. The program has currently reached Stage 2. While trialing and evaluation are taking place, a safety net for distance students without computer access is operating through the availability of traditional on-campus block teaching sessions. Once development and strategic issues identified in the model are resolved, Stage 3 flexibility can become a reality. At this stage, all students will be required to have computer access to enrol in the unit.

These are two of many examples of how the model is being applied, both representing initial units of degree courses. Both evolved from supportive foundations: strong IT capacity in one case and an existing distance program in the other. A major challenge lies in developing flexibility where neither of these foundations exists. In such a context, the three-stage model provides a framework to guide the sequential development of flexible learning, as an alternative to what can otherwise seem the insurmountable hurdle of achieving full flexibility.

6. Concluding Comments

The three-stage model is powerful because it actively involves staff in the development process; it accommodates different teaching contexts and levels of design and technical expertise; and it provides a framework for staff development, and for policies and strategies to develop IT infrastructure. Introduction of flexible learning into the curriculum will, for some, involve workplace changes as well as adjustments of personal philosophies of teaching and learning. The staged approach provides the time and space necessary to deal with such structural and developmental issues as well as the political and cultural factors that accompany any major change. Most importantly, the model can provide a means to move the University towards its goal of being an exemplary provider of modern education based on research, innovative teaching and flexible delivery.

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Web Screen Design Guidelines for Developers

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Abstract
Design is a series of choices that interact with each other and that reflect the theoretical underpinnings of a discipline. Techniques used to facilitate learner involvement with text fall within the domain of legibility. The following recommendations for basic typography are based on a number of studies both from print and electronic environments.

INTRODUCTION

Designers of computer screens for web-based applications make choices in manipulating several attributes which are common to both print and electronic media, among them, text, typography, layout, and graphics. Because screens are the direct means of communicating with the learner, design choices determine the success or failure of the web site. The wealth of research on printed texts gives us indications about making some of these choices. That extensive research base has been supplemented by studies of the legibility and readability of information presented electronically and by research into the cognitive processes involved in reading and learning. In addition, we can take into account information on user preferences that allows us to evaluate the probable appeal of our screens to our intended audiences.

INSTRUCTIONAL TEXT

The text and graphic elements of a web site combine to convey a specific message that will be translated into the reader's knowledge base. The goal of the designer is to arrange screen design elements (Tab. 1) in appropriate combinations that create visible and recognizable structures to facilitate perception, reading, and understanding. The developer's designs form the basis for an active interaction between page and reader.

Table 1: Screen Design Elements

Screen Design Elements		
type size	type style	leading
background color	type weight	kerning
foreground color	word spacing	boxes
tables	frames	letter color
rules	graphic resolution	shading flashing
progressive disclosure	animation	buttons
icons	fields	forms

LEGIBILITY

Techniques used to facilitate learner involvement with text fall within the domain of legibility. Legibility is the influence of the total format of the display on the ability of the learner to understand the text. Legibility is not just visible text, but also includes the factors of recognizability and readability. The designer must work, to some extent, with these three qualities to facilitate retention of information by encouraging deeper learner involvement.

Visibility refers to the perceptual detectability and discriminability of the printed character. Visibility includes characteristics related to the clarity of the image, crispness of type, and contrast between foreground and background. A visible display presents symbols clearly and accurately. Visibility variables interact with the eyesight of the reader, lighting, contrast, and size and shape of type. Letters that are too small may not be perceived for what they are. Visibility is a prerequisite for recognizability, for without adequate visibility the learner fails to recognize the meaning of individual symbols on the web page.

Recognizability refers to the ability of a page to convey the meaning of letters, words, and objects. Recognizability interacts with both text elements and reader characteristics — the background or prior knowledge of the reader. For example, a first grader may be able to recognize each of the letters on this page, but would have difficulty recognizing the meanings of all of the word symbols on this page, even though they are quite visible. Format variables that effect recognizability include type style, word spacing, leading (amount of space between lines), and kerning (amount of space between letters).

Finally, the third characteristic of a legible web page refers to how readable or understandable the message is. The reader must be able to comprehend the intent of the author and designer. Many of the factors that affect readability are within the domain of the author: syntax, vocabulary, sentence construction, and so on. However, the designer can facilitate readability by creating a micro and macro organizational structure appropriate to the message.

RECOMMENDATIONS FOR BASIC TYPOGRAPHY AND SPATIAL FACTORS

The following recommendations for basic typography are based on a number of studies both from print and electronic environments. Additional information can be found in style manuals including the *Yale C/AIM Web Style Guide* (http://info.med.yale.edu/caim/manual/).

1. Use only a few simple, familiar, and portable type styles.

Although most browsers limit the typestyles that you can use, graphics and PDF files expand these opportunities. Some type styles are intended only for display, or use as titles and headings. They often set a tone for the text that follows. For example, **Avant Garde**, is a modern type face useful for display purposes in screens that need to project a feeling of modernism and recency. Other fonts are more appropriate for masses of text and extended reading, including Helvetica, Times New Roman, and Bookman.

When determining your type style options, choose, at the most, two type styles. One font family may be chosen and used for both headings and text. Or, choose one family for headings and another for the text for visual interest. But, if you find yourself using three or more styles, analyze the reasons carefully. Too many type styles destroy unity and create busy, distracting screens.

2. Use type sizes appropriate for the audience and the amount of reading to be done. Be consistent in their use.

Type size is a matter of courtesy to the reader of the material. Frequently, a designer chooses on a type size on the basis of trying to fit as much material as possible on the screen. Remember that the reader is going to be between 18–inches and 24–inches from the screen. Any text presented on the screen must be large enough to be read by the average reader from the furthest distance. Usually a 12–point size is probably most appropriate for text, though 14 may be appropriate for younger audiences or people reading from more than two feet from the screen. Keep in mind that point sizes are not consistent and that some 12-point type sizes are larger than others (Tab. 2). The size also depends, to some extent, on how much reading is expected. The more reading that is necessary, the larger the type should be to prevent tired eyes. Consistency, as usual, is important here. Readers pick up cues from the size of the text used. Large sizes indicate headings. Smaller sizes indicate blocks of information. If the size changes from one screen to another, the reader may become confused as to the importance or the information or the meaning of the size change. Decide on the sizes used for each heading level and for text and maintain those sizes throughout the program.

Table 2: Comparison of 12-Point Type Style Sizes

Arial	reference
Bookman	reference
Courier	reference
Helvetica Narrow	reference
New Century	reference
Times	reference
Times New Roman	reference

3. Use both lower and upper case for text and extended reading.

While all UPPERCASE words may be appropriate for cueing an important word or phrase or heading, lowercase is easier to read words. Upper case letters provide fewer cues as to their uniqueness, interfering with recognizability. Now that most computers give you the options of italics and bold for emphasis, all upper case should be used sparingly. [Special Note on Italics: Depending on the font being used or the size of the type, italicized text can be difficult to read on a screen. Test it out before deciding on its use.]

4. Keep line lengths around 45 to 60 characters.

Readers prefer short lines, lines of about eight to ten words or 45 to 60 characters long. Although there is some flexibility in this recommendation, Grabinger (1984, 1987, 1993) found, in studies looking a viewer preferences, that readers prefer shorter rather than longer lines of text, especially when single-spaced. When lines are too long it becomes difficult to follow the lines of text completely across the screen. Another reason for keeping lines reasonably short is that it seems that lines around eight to ten words permit more line breaks based on syntax and idea units. This is particularly unique with browsers because the text often fills the width of the screen. Using line breaks, narrower frame, or tables are strategies for keeping line lengths to a reasonable length.

5. Generally, use single-spacing between lines of text.

The amount of space between lines of text, leading (rhymes with *heading*), is closely related with how long the lines are. Space between the lines helps the reader maintain vertical position in the text. Readers prefer shorter lines that are single spaced. This may be because it produces shorter blocks of text that appear to be manageable chunks of information. However, as lines get longer (more than 60 characters or 10 words), double spacing may be needed. The longer the line, the harder it is to maintain position on that line, therefore more leading is needed.

6. Left justification is adequate in most circumstances. Use full justification only when proportional spacing is available.

Which is easiest to read? Left justified text. Fully justified text is also common, but is slightly harder to read because of the artificiality of creating line breaks based on the end of a margin rather than the syntax. Fully justified text relies on hyphenation and breaks phrases and words. In text that uses a nonproportional font, an effort to fully justify often creates rivers of white space running down the screen or page. This sometimes occurs with proportional fonts as well. Generally, people use the fully justified style because of an inherent sense of neatness, thinking the page looks better if both right and left margins are equal. Although it may look neater, it is more difficult for the viewer to follow and read, so choose left justification as often as possible.

MACRO ORGANIZATIONAL GUIDELINES

Organization refers to screens that appear to have a coherent arrangement of all the major elements. Organized screens have both macro and micro characteristics. In the macro area, organized screens are divided into functional areas: text, graphics, title/status bar, and control panels. In the micro area, organized screens structured in a way that reflects the content of the subject matter. Structured screens use directive cues for emphasis, headings a organizers, and graphic devices to separate the information into chunks and to indicate important material.

7. Begin your page development by considering macro level organization.
Generally, the most useful way to operationalize this construct is to arrange the screen into functional areas. Designers should decide on where status and progress information navigation buttons, content displays, control buttons, and illustrations will be located, and use graphic devices such as shading, lines, and boxes to separate one area from another. This design techniques works best when consistency is also practiced. The functional areas should appear in the same locations, and the devices used to define them should be the same throughout a program and its parts.

The designer-defined areas of the screen represent the tasks the screen expects users to perform. Heines (1984) described the standard screen components as orientation information, directions, student responses, error messages, and student options. In hypermedia and multimedia applications, we can add areas for information presentation and illustrations. Not every screen needs a place for each of those tasks, it depends on the program.

8. Create separate areas to indicate important status and orientation information: location, page, topic, subtopic, objective, and so on.
Because computer programs show only one page at a time, users must be continually informed as to what they are seeing and where they are within the program. With books and magazines, a user can quickly thumb back and forth through the pages. The sense of feel, (e.g., mass, width, pages held between thumb and finger) of a book often indicates where readers are in the book. Unfortunately, it is simply not possible to transfer physical feelings in a computer program. A status area saying "page X of Y pages" is a helpful strategy.

9. Keep navigation controls in a separate area. Throughout the program, consistently use the same area of the screen for the controls.
On the web, left/right buttons are usually not necessary because they are part of the browser, however "home" and section buttons should be used liberally to help users get to their desired destination in two clicks or less. Options and control buttons should be located in the same functional area throughout the program. Use shading, boxes, and color to "unify" the buttons.

10. Use the bulk of the screen to present content. Separate this area from others.
The content portion of the page is still the most important part of the screen. It should be noticeably separate from control buttons or other indexes. Use tables, frames, lines, boxes, color, and so on to create this area.

11. Use frames with caution.
Frames create added development flexibility. People look at web pages on different sizes of monitors. Frames that specify specific pixel widths may not work on all monitors. Instead, specify the size of a frame by using the "percent of whole frame" option. Frames also create problems with links. Links that do not specify a specific frame target often end up in a new window covering the original window. However, with careful development, frames can create a clean and unified appearance.

MICRO LEVEL ORGANIZATIONAL GUIDELINES

Following this macro-level organization, designers should then consider how the screen can reflect the structure of the content to enhance readability. Generally, users prefer screens that use headings, directive cues, and spaced paragraphs to indicate the hierarchy of the content and to break the content into chunks of information.

12. Limit pages to discrete ideas or logical units.
Use the natural separation of screens to separate ideas into meaningful units. Large ideas may need to be separated into several pages, but make them discrete and separate units. There is no need to crowd pages with several ideas.

13. Use headings as organizers.
Headings of at least three levels are useful organizing points for users. Main headings providing orientation can be placed in the area of the screen that serves that task. Sub–headings referring directly to the information presentation should be placed within the text. Phrasing headings, such as questions, can direct users' attention and facilitate learning.

14. Put paragraphs into bite–sized bits of information by single spacing within the paragraph and using increased space rather than indents to separate paragraphs.
This gives readers manageable chunks of information because the information appears to be in bite–sized pieces. Unlike fiction, readers need built in pauses between each piece of information so they have a chance to reflect on what they have just read before continuing to the next unit of information.

15. Use indents to indicate hierarchically related subject material.
Subsume related material under their super organizing concepts. Traditional outline formats or lists with numbers, letters, and bullets should be listed under the super organizing concepts. In a hierarchical format, this suggests that one level of subheadings are an elaboration of the prior super heading.

16. Group closely related items within a box or a common background color or shading. Use the same graphic devices, as well as white space, to separate unrelated or contrasting ideas.
Graphic devices provide a visually interesting way to link common ideas or to separate unrelated ideas. If shading is used, make sure it does not reduce the visibility of the text it surrounds.

17. Use directive cues (i.e., bold, italic, underlining, inverse) to emphasize important terms or ideas.
Used sparingly, directive cues like color, size, bold, italic, shape, direction, brightness, underlining, uppercase, and inverse can facilitate learning by calling attention to (i.e., making more perceptible) important words or phrases. This technique should probably be limited to one to three items per screen. Flashing, which is another technique used to draw users' attention, should probably never be used. It can be extremely distracting to users.

18. Set up comparison/contrast situations in a side–by–side columnar arrangement.
Columnar arrangements are particularly useful for both comparisons and contrasts because it keeps in view all the items being compared.

VISUAL INTEREST GUIDELINES

Finally, designers should consider the visual interest of the screen. Viewers dislike screens that are plain or full of text without any headings, directive cues, lines, shading, buttons, titles, or illustrations (Grabinger, 1984; Grabinger, 1987; Grabinger & Amedeo, 1988; Grabinger, 1993). It seems that a variety of well-organized text elements enrich the environment and make it more interesting to explore. Excessive complexity results when too many elements or too much information is crammed on the screen.

19. Use accepted, general, aesthetic publication guidelines. Strive for balance, harmony, and simplicity.
Balance, harmony, and simplicity are general constructs often given to designers as the basic elements of design. All three constructs can probably be summed up in the word "moderation." Screens that display balance, harmony, and simplicity are not jammed with information, have elements distributed throughout the screen, and maintain a consistency in styles and locations from one screen to another. The following guidelines help operationalize these ideas.

20. To help create a sense of balance, maintain consistent internal margins and distribute the b ulk of the white (empty) space around the exterior margins of the screen.
The notion of balance is a complicated concept with both the weight of objects and the use of space used to create that sense of balance. Heavily weighted objects use think, dark lines or dark colors and shading. Lightly weighted objects use thin lines and light or no shading. *White space* is that space that contains no information, it is empty space on the screen (and could be another color depending on your background color selection). The first step in creating balance is to group the text elements together on the screen and to distribute the white space around the exterior margins. Maintain consistent internal margins among the elements on the screen.

21. To create a sense of harmony, be consistent and strive for simplicity.
Many times "consistency" has been mentioned in this paper. This refers to overall design, directive cures, type faces and sizes, button shapes, icons and so on. Designers often begin with a simple concept, but wind up adding "just one more button" or "one more field" to add that extra option or bit of information. Finally, by the time they are finished, the screen is cluttered with too many buttons, too much text, and too many design elements. Try for the "minimalist" look.

CONCLUSION

Good interface design requires close attention to student behavior and attitudes as well as system capabilities. The screen is the central point of the interaction between student and program, so much of interface design focuses on the screen. While a good looking screen requires both artistic talent and a good sense of organization, almost anyone can design attractive, functional screens by applying some common sense. A good place to start is with a design that looks useful to you. Alter it to meet the needs of your program.

While the concepts of organization and visual interest may seem to be common sense, common sense is not always followed by designers. In addition, knowledge of these concepts does not mean that designers will apply them in ways that create aesthetically pleasing and well-organized screens. However the studies by Grabinger and his colleagues suggest that these constructs are important to prospective viewers and may help gain attention and build confidence in using instructional material (Keller & Burkman, 1993).

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IDEALS MTS - A Modular Training System for the Future

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Abstract: With the increasing power of today's information- and communication technology new application areas have been opened in education and training. At the same time shrinking production and innovation cycles require ongoing lifelong learning and training.
With the increasing availability of the WWW, its usage for course distribution and delivery becomes more and more important. To meet the demand for flexible structures in learning and training to adapt to changing situation, the major goals are to increase overall efficiency in teaching and training and to improve learning efficiency. This includes support for self-driven learning, reduction of time and place restrictions as well as availability to wide audience.
Within the European projects DEDICATED and IDEALS, the Interactive Graphics System Group (GRIS) of the Darmstadt University of Technology developed concepts and technologies to achieve these goals. These concepts and their realisation within the IDEALS project will be discussed in this paper.

Concepts

Strict Modularization

For a learning system, capable to handle the requirements of the future, modularity of courseware is a crucial design issue. Looking at today's CBT-systems or the WWW, which to an increasing amount is used for education and training purposes, it becomes evident that these learning systems are conceptually based on fixed, monolithic courses.
Almost all of these traditional learning systems allow courses, that they can be split up into different parts, which can be stored separately (modules). Course flow information, layout and interaction description as well as the basic multimedia elements are combined into monolithic blocks of data, see [Fig. 2], whose size depends more on technical issues as disk size than on content-related issues. This and the strong interrelation among the blocks prevents the exchange and reuse of single course components.
Applying the idea of modularization to the area of courseware will change the notion of course. Instead of fixed arrangements of modules there will be a pool of independent modules, from which optimal modules will be selected and combined to a course on demand.
For modular courseware, each module must be complete and self-contained. Modules can make use of other modules, but they are not allowed to contain modules. Instead they only refer to other modules. So, parts of a course can be reused without the need to remove unnecessary parts of a former course. The real advantages of modularization shows, if module references can be specified in a content-driven way rather than solemnly based on identifiers. An author specifies a course, just as with traditional systems, by defining and arranging a set of modules. However, modules can be specified entirely on a goal-oriented level and the decision which module to actually use is done individually whenever the course is run. Thus, modularization allows courses to automatically adapt to a student, so that a student will always get an optimal course.
Automatic, goal-oriented selection and updating of modules can only succeed, if all modules are technically exchangeable. Therefore, referring module must not rely on individual features or assumptions on the internals

of the used module and vice versa. Instead there must be an abstract interface for modules, which all modules must comply to (black box concept).

Up to now it has been shown, that consequent modularization enables exchange, re- and multiple use of courseware and is therefore the basis for efficient production and usage of digital courseware. The second major aspect, which has to be considered in conjunction with modularity, is a subdivision into three *courseware layers*, which reflect the different layers of abstraction in the production of courseware.

- On the *content layer*, it is to be decided, which topics are part of the course and how to arrange them. Therefore the author will subdivide each topic into separate learning goals and organise them appropriately. This requires expertise on the topic, which is to be imparted, as well as didactical qualities.
- On the *learning layer*, a single learning goal specified on the contents layer is broken down into concrete learning steps. This includes layout and interaction definition. Here expertise is needed in the area of layout and design as well as in pedagogics.
- On the *material layer* the creation of the elementary course material takes place. Here it is asked for (technical) know-how and skills to create the elementary learning content.

Each of these different courseware layers corresponds to specific view on the courseware and to a different set of tasks for the author. For a complete course all three levels must be specified. Although this can be done by a single author, in real-life course production it will be more typical that several authors with different expertise co-operate. In this case, having besides a horizontal modularization, where a course is split in several parts, also a vertical modularization, which reflects the different courseware layers, will be enormously beneficial, since so each author can focus on the level most appropriate to him.

Self-description and Dynamic Referencing

In order to realise a modular and flexible structured courseware on all levels mentioned above, courseware should make use of courseware modules through links or references. The following section describes a concept for referencing modules through a characteristic attribute description.

Besides the internal representation of the module contents, each module has a *self-description* for characterisation. Such a self-description is a certain set of attributes, representing different properties of a module. It contains the usual set of technical or administrative attributes like name, creation date, type, author, etc., but moreover a self-description contains attributes, describing criteria characterising the contents or didactical/pedagogical issues, either.

In a way, the structure of a self-description can be interpreted as a (restricted) knowledge or information model. The self-description is a substantial part of each module. Hence, a module on the one hand encapsulates its knowledge in an internal format (the content format), on the other hand the self-description is a characteristic, describing the content in a certain format, so that the module can provide information about itself. The use of the self-description, besides the self-characterisation feature, is the possibility to enable searching for modules, which match specific characteristics, comparable to the classical way of indexing. Concerning the use of self-descriptions for searching, it is essential to avoid different interpretations of self-descriptions. Therefor it is important to restrict and control the set of attributes and valid attribute entries, e.g. by the means of standardised dictionaries.

Having a self-description available for the modules, the referencing of specific modules can be done using either their unique names, or by giving a set of attributes, which a modules self-description has to match. This second possibility can be extended to a more general mechanism, the *Virtual Reference*. Basically, a Virtual Reference does not address a specific module, but a set of 'similar' modules. It is an abstract description of constraints a desired module should match and is resolved during runtime. The possibility of dynamic resolving of reference enables new forms of adaptability of courseware, e.g. using constrains, that take into account the actual learning state, certain preferences, learning strategies, etc.

The issue of adaptability is another important aspect for efficient learning and training. In general, adaptation of courseware requires information about the current learning status of the student. By monitoring the actions of a learner, the modules presented to him and the results of tests information about the a student during his learning session can be gathered in a *user profile*. The information collected in such a user profile can be used further on to get knowledge about the current learning status of the student, which can be utilised to control the further course flow by influencing the selection of new or additional courseware or within the process of resolving a

Virtual Reference. Again, the information about the modules gained using their self-descriptions can be used here.

Realisation in IDEALS

The ideas presented in the previous sections are the basis for the EU projects DEDICATED [DEDICATED 95] and IDEALS [Borgmeier 96]. Similar ideas and concepts, can be found in COBRA [Beyer 96], OLA [Oracle 96], ARISTO [Llamas 96] and ARIADNE [Forte 96]. The following section will describe the realisation of IDEALS' Modular Training System (MTS).
As already mentioned, the modular courseware concept and a dynamic referencing mechanism are main features of the IDEALS MTS. IDEALS MTS does not only support courses based on dynamic referencing, but fixed arrangements of courseware too, since this type of course is especially well suited for delivering identical courses to homogenous groups of students. In this case, modular courseware will lead to an reduction of overall effort in course production, due to reuse and multiple use of modules. In contrast, dynamic courses are especially well suited for self-driven learning (learning on demand). However, authors of such dynamic courseware have to specify the course flow without knowing the details of, how the referenced modules carry out their tasks. The paradigm of course changes from a fixed arrangement of courseware into a well-structured set of reusable courseware modules.
Even though it seems quite easy and obvious to realise, our experience shows, that the creation of such modular courses requires a significant change in the way of structuring information and knowledge.

WWW Based System Architecture

Different than DEDICATED, which was based on proprietary client-server technology, MTS uses a client-server architecture based on the open standards HTTP and HTML for transmission and presentation of courseware. Besides being able to benefit from the ongoing development in the area of WWW and telecommunication, using a standard HTML browser on the client side makes MTS courses directly accessible to the entire Internet community. Moreover, this approach ensures that future extensions of HTTP and HTML can directly be used in IDEALS MTS. Therefore the IDEALS software has been implemented as a extension of a WWW Server, see [Fig. 1]. While a standard browser is used on the client side, the server side consists of three components, a standard WWW Server, a Database Server and the MTS Server itself, which communicates and co-ordinates these servers. The WWW Server only delivers the courseware to the student, while the Database Server provides the courseware modules. The MTS Server controls the course flow and the access to the courseware.

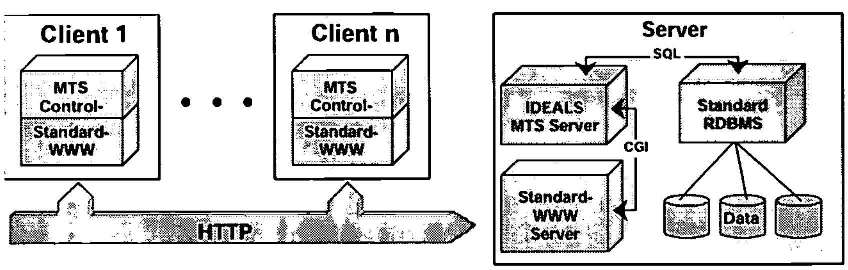

Figure 1: MTS System Architecture

MTS Modules

IDEALS MTS supports the three different courseware layer introduced above by providing three different module types. Each module type corresponds to one courseware layer and supports its specific view and style of working. So, in IDEALS, every author can work in a natural and therefore intuitive way on the abstraction level most appropriate. The use of specific authoring tools further increases the efficiency. [Fig.2] shows the different layers and their corresponding module types, which are described in more detail in the following section, in comparison to the usual structure of monolithic courseware.

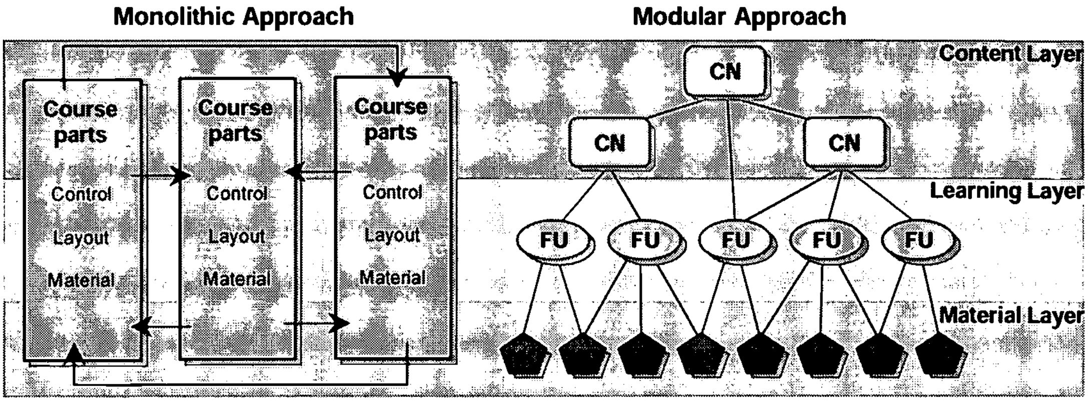

Figure 2: Horizontal modularization versus modular approach

Material Objects (MO) are the atomic, multimedia building blocks for courses. Basically they are the carriers of the learning content. This includes all standard multimedia formats (as GIF and TIFF for bitmaps and WAV and AU for audio, etc.). But MOs can also be complex program fragments or entire applications, e.g. simulators and microworlds implemented either as Java-applets or as JavaScript fragments, depending on their complexity. The other type of MOs consists of the interaction elements provided by the system for the realisation of an user interface. In the area of MOs, it is IDEALS policy not to invent own formats but use those available for the WWW.

Almost all browser provide build-in support for the formats GIF, JPEG, WAV, AU, JavaScript and Java. Other formats as e.g. video or VRML require helper applications or plugins. Using a plugin allows to seamlessly integrate the presentation with the other elements in the browser window, while a helper-application will always use a separate window to present the data. Common disadvantage to both solution is, the browser must be configured appropriately and a plugin or helper application must be available. An additional problem is, that in this area the development is still ongoing and therefore all the quasi-standards are more or less moving targets. Support for vector drawings and formulas would be most beneficial.

Besides those more technological issues there is also a more conceptual one.

IDEALS MTS requires MOs to be self-contained. Because of this HTML or plain text and JavaScript fragments, which realise learning content must be encapsulated into separate MOs. MOs must also be complete. Therefore if several HTML fragments, e.g. a picture and some accompanying textual explanation, belong to the same learning content they must be encapsulated into the same MO (Compound MO). Such Compound MOs can be realised as HTML fragments. Therefore, IDEALS MTS supports special MOs, which can contain plain or HTML formatted text, JavaScript blocks or any arbitrary HTML fragment.

A *Function Unit* (FU) defines for a specific subject the arrangement (layout) and the overall behaviour (interaction among each other and with the student) of the used MOs, which realises the desired learning step (function in the overall learning process). Such steps are presentation, exploration and test.

The FUs are specified and stored as HTML-I. HTML-I is an IDEALS specific extension of HTML. To realise the IDEALS specific kind of references a special tag is used which allows referencing of material registered in the database. This specific tag must be used instead of the HREF attribute. Since the student's browser is capable of plain HTML only, the MTS server contains a converter component which replaces the specific tag with appropriate HTML code.

According to the concept, the code to co-ordinate the interaction between different MOs must be part of the FU description. However, with plain HTML one can only create passive documents with, i.e. no interaction between the elements. Therefore JavaScript, which is an extension to HTML introduced by Netscape, allowing to add dynamic functionality to HTML, is used. MTS system functionality, e.g. to update the user profile or call for the next FU, can be accessed from the system using JavaScript.

A *Course Node* (CN) arranges the sequence of FUs based on a didactical concept or a certain learning strategy for the sub-domain. Within a CN an author is not restricted to certain teaching/learning paradigms, but is free

to choose an appropriate one. Since HTML provides only very limited means to structure documents and cannot capsulate contents from structure, MTS uses an own *Course Description Language* named CDL for the specification of course structure. To create CDL, an author uses the integrated authoring tool. This tool represents a CN as a kind of flow diagram and enables the author to visually create and edit CNs. This is an important issue, since typical authors of CNs are experts concerning the topic but do normally not have programming skills. For this kind of authors such an intuitive user-interface is an essential issue.
Beside the graphical authoring tool, the extended search engine supports authors in retrieving courseware by specifying semantic constraints. Here, the additional characterisation of courseware is a great advantage over the WWW as the material can easily be found by its characterisation. [Fig. 3] shows a screen shot of an authoring session.

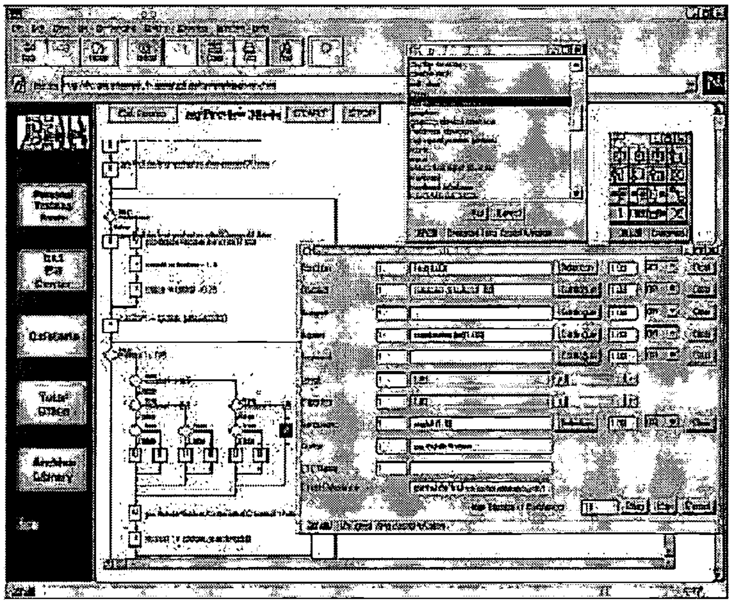

Figure 3: MTS Authoring Environment

Course Navigation

The modularity of courseware has impact on the realisation of the user interface for course navigation. Since an author does not know the situation, in which his module will be used, he is unable to create an appropriate user interface for course navigation. In order to preserve the modular courseware structure, exchangeability and reusability, the user interface for course navigation is provided as a system component. This has the following advantages:

- Since all MTS courses use this system component, there is a unique look and feel, so that a student will become familiar with the system quickly.
- Since MTS provides a system component for course navigation, an author does not need to implement the user-interface for the standard MTS course navigation by himself, and can concentrate on the internals of his FU, which reduces the production effort.
- In MTS FUs never communicate directly with other FUs. Communication with the parent CN is always done via the interface provided by the system. The existence of such an standardised interface is an crucial issue, since this guarantees the exchangeability of courseware.

Details of MTS' Self-Description and Virtual References

The basis for the concept of dynamic referencing is the self-description. In IDEALS the self-description contains four content related attributes, *context*; *aspect, keyword* and *subject*. These four attributes are structured in a hierarchical way. The most general term for describing the content is the attribute context, identifying a specific topic like computer graphics, software engineering, etc. The attributes subject and keyword depend on attribute context. I.e., for every value of attribute context there is a distinct set of valid entries for the attributes subject and keyword. This hierarchy is necessary to distinguish between different meanings concerning the general topic, in which it is used. As a specific term for subject or keyword may appear more than once, it usually has different meanings dependent on the context, it is used for. E.g. the term 'projection' is interpreted differently, whether it is used in the context of 'algebra' or of 'computer graphics'. Besides this hierarchical order, the attribute aspect has the same hierarchical level as context. This attribute describes a specific view on the courseware, e.g. 'introduction of' or 'motivation for', etc.

It can be foreseen at this point, that the set of classification attributes must be extended to a more global classification scheme in order to match a wider range of knowledge as well as didactical and pedagogical parameters. To ensure exchangeability within IDEALS, the catalogues for the different attributes have been standardised between the IDEALS partners, so that the self-description match a common interpretation and meaning, which is needed for sufficient dynamic referencing.

Within the IDEALS' implementation of the MTS, courseware modules can refer to other modules using the referencing mechanism of MTS. As mentioned above, the concept of dynamic referencing is used in form of *Virtual References*, which address specific modules using an abstract description instead based on the self-descriptions. The Virtual References enable an author to specify either technical constraints as well as - and more important – constraints based on the attribute sets of the self-descriptions. To enable extensive flexibility, an author can assign weights to each attribute of a Virtual Reference and also to each single attribute value. These weights determine to which degree an attribute is taken into consideration in the process of resolving a Virtual Reference. The author is not limited to give only one single value per attribute, but can combine more complex constraints making use of several valid values from the scope of the attribute using the logical operators 'NOT', 'AND' and 'OR'. In this way, the author can define complementary or alternative constraints or can weaken or strengthen single constraints respectively.

The process of resolving Virtual References (the so-called Mapping) is of great importance. The mapping is an iterative feedback process. During the first step of Mapping all modules are determined, that match the maximal set of constraints. If the set of resulting modules is sufficient, it is determined, which of the modules does fit best in order to match the constraints best. Depending on the structure of the Virtual Reference, during mapping a generalisation or deduction with respect to the given weights takes place, until the set of matching modules becomes sufficient. Finally an optimal module will be found and used.

Although the IDEALS MTS collects data about a students learning sessions, his learning results and therefore about this knowledge status at a certain stage, this information currently is not used during the mapping process for resolving Virtual References. Instead, the information can be used directly within the level of CNs. At this level, an author can specify constraints regarding a students knowledge and learning results and explicitly control the flow of presented learning information.

Demonstration of MTS in the University Pilot

In 1996 the main activities, in IDEALS, have been the design and implementation of the MTS. Besides development of the software this included also the set-up of the technical and organisational infrastructure (so-called Local Training Centre - LTC). After the verification of the system succeeded in first half of 1997, the project has entered demonstration phase. Here the department of Graphical Interactive Systems (Germany) together with the Faculdade de Ciencias e Technologia da Universidade de Coimbra (Portugal) and the Raahe Laboratory at the University of Oulu, (Finland) jointly developed courseware on "Fundamentals of Computer Graphics". Each of the three institutions used and is still using the courseware, adapted to its individually needs, in its ongoing teaching activities. During this demonstration the experiences of all users (authors, administrators, and students) are monitored and evaluated. The results of this will provide information on:

- Efficiency of the MTS for course production and delivery.
- Learning success of the students and overall learning efficiency of MTS.
- Acceptance of the system from the side of authors and learners.

A showcase with selected courseware from this pilot can be accessed from the WWW via the URL *http://ltc.gris.informatik.th-darmstadt.de*.

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[W2] Examples for the commercial use of WWW based training: http://www.gglearning.com/, http://www.internet-academy.de/, http://skylab.us.oracle.com/education/

[W3] IDEALS Home-Page and showcase: http://ideals.zgdv.de, http://ltc.gris.informatik.th-darmstadt.de

Design of a Project-based Study Environment on the World Wide Web

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Abstract:
Curricula at the higher and university education level will become more and more flexible and interactive of nature. Problem-based or project-based education will become keywords in such curricula. In this paper we present the design of a project-based study environment on the web. The basis for this design is the e-study concept, studying by means of the Internet. We describe central design guidelines and present ComMedia as an example of such an environment.

Introduction

Curricula at the higher and university education level will become more and more flexible and interactive of nature. Future education will become embedded into the rapidly forthcoming global information society. Information and communication technologies (ICT) enable the students all over Europe to put individual curricula together based on available international flexible and interactive courses. Teachers will be able to guide students in a flexible and interactive way. In the project FLINT (de Vries, 1997) we focussed on the design of study environments in order to enable students and teachers to work and study in a flexible and interactive way. We coined the concept e-study (de Vries, 1998), this concept stands for studying by means of Internet technologies. In this paper we describe some of the results of the project FLINT. The question we want to answer here is how to design project-based study environments on the web. Firstly, we outline the concept e-study. Secondly, we describe key design guidelines for such environments. Thirdly, we describe ComMedia as an example of a project-based study environment.

The E-study Concept

'E-study' concept stands for studying by means of the Internet. On the Internet, teachers are expected to prepare study tasks. While learners perform these tasks the teachers guide the study processes, after which teachers are expected to evaluate the study processes and results. Software tools are needed for preparing study tasks, performing study tasks, guiding the study process and evaluating study results and processes.

Educational Institutions will be able to disseminate certificated courses. Certificated means that these courses are rated against European educational standards. In addition to these courses, a variety of organisations can offer (online) Study Services. For instance, publishers can provide for instructional multimedia information objects (IMIO's). Such objects are expected to become the electronic counterparts of for instance chapters from study books. Figure 1 illustrates the E-study concept.

We use the concepts Interactive Study Environments, Interactive Study Systems and online Study Services to describe the E-study concept (Vries, 1997, Vries & Vogel, 1997). Basically, we see an Interactive Study System (ISS) as a software system consisting of study task forms (electronic forms that provide learners with information and/or tools necessary in order to attain the study goals), study tools (software tools that are particularly designed to enhance individual or group-based study processes), information resources (the multimedia information content matter), and if needed additional materials (information and/or tools that support study processes but which are not offered in an electronic way). The main goal of an ISS is to enable an interactive study process between a user of the system and other users and/or between the user(s) and educational resources. It is important that an ISS can be very small and simple. An example of a simple ISS is an individual study task, a webpage providing learners with information about a specific task, relevant links to information resources, and enabling e-mail contact with the teacher. However, an ISS can also refer to a complete two-month course involving 100 learners, in which course specifically designed study tools and multimedia information content are applied.

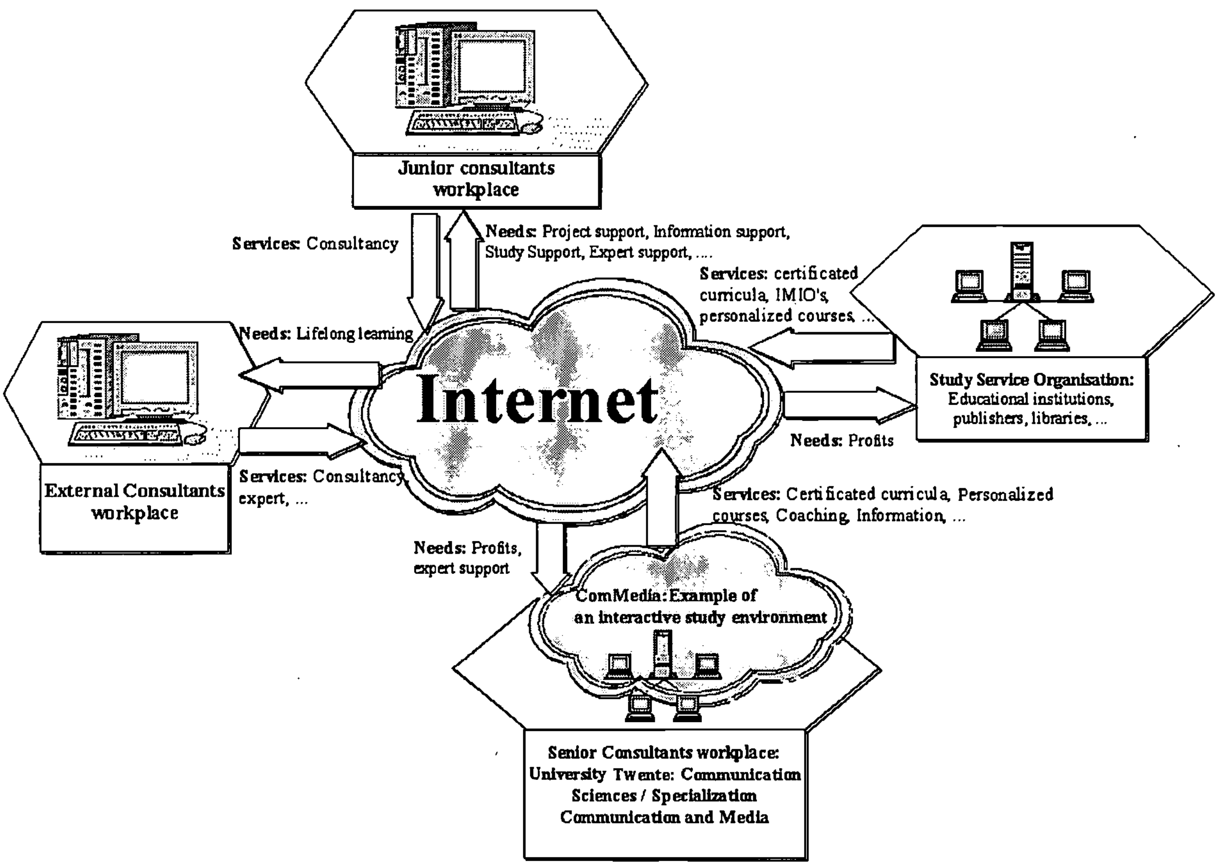

Figure 1: The E-study Concept

To give the needed support to teachers, there is a need for Interactive Study Environments (ISE's). An ISE is a software system for the preparation, application, and evaluation of ISS's. Such an environment consists of the following basic components: preparation, application, and evaluation tools and Interactive Study System Components. An electronic library and an electronic café can for instance extend it. Preparation tools are for instance information editors, 'learners' prior knowledge analysis tools, and ISS-assembling tools. Application

tools are for instance learner guiding tools and schedule tools. Evaluation tools are for instance study process/results evaluation tools and Interactive Study System evaluation tools.
The main goal of an ISE is to improve the effectiveness, efficiency and attractiveness of the (re-) design, use and evaluation of ISS's. An environment in which the tools and methods are linked to the design and use processes should help teachers in the assembly process of ISS. We investigate if such an environment supporting a lifecycle of Interactive Study Systems (ISS) can be developed based on insights from the field of method engineering (Brinkkemper, 1996), more specifically situational method engineering (Harmsen, Brinkkemper, & Oei, 1994). In the E-study concept teachers and learners will be supported by means of a wide range of communication and information services, summarised in the concept online Study Services. For instance, educational publishers as 'content owners' may act as a Study Service Provider. They provide teachers and learners, who apply study books of the involved Educational Publisher with services linked to the study books. Examples of such linked services are for instance: the so-called Instructional Multimedia Information Object's, examples of study tasks, updated instructional multimedia information content, updated links to relevant websites, new study tools, and shared magazines filled with results of various but related study projects. In the E-study concept ISS's, ISE's and study services are interrelated.
In this paper we look at project-based study environments is a specific type of an ISE. Study projects can be seen as a type of an ISS. We took a task-oriented approach in order to distinct guidelines for this type, because project education stands out for doing project tasks.

Design-Guidelines for a Project-based Study Environment on the Web

In Project-based education the tasks of the instructor and students are different from those in a regular school environment. The instructor is no longer the source of knowledge, but he facilitates and monitors learning. Learners face problems that they have to solve by working together in groups. An online project-based study environment has to facilitate such education. Project-based education can be described in three phases; prepare, guide and evaluate education (Dolné, 1977). The instructor will complete these three phases. In the 'guide phase' of the instructor the students complete three subphases: prepare, perform and evaluate the project.

The design-guidelines we mention here are based on the tasks of the users. We first make a distinction between generic and phase specific guidelines. Generic guidelines are related to all three phases, while phase specific guidelines only refer to one phase.
We distinguish four generic guidelines. These refer to information exchange, communication, performance support, and administration. Both instructor and learners need information from each other. Learners need for instance the content matter that the instructor has prepared and the instructor has to give feedback on the reports that the learners have sent in. *The users have to be able to up- and download information, for instance documents, to and from the ISE*. An instructor has to give feedback to his learners, he has to motivate them and has to take care that they perform their tasks. A learner has to meet and discuss with groupmembers and asks the instructor questions. *The users have to be to communicate with each other in an ISE*. The project members are not experienced in carrying out projects and the specific project assignments. They therefore need additional support in carrying out their tasks. *The users do need appropriate performance support by means of the ISE.* An important task of the instructor is to do his administration. During the whole project he performs activities to keep his administration up to date (e.g. enter learners for the project, make groups, write down marks etc.). *The instructor has to be able to perform his administration.*

The users have specific tasks in each phase, these are project preparation, project performing, and project evaluation.
In the phase 'Prepare Project-based education' the instructor prepares the project which he will offer in the second phase when the students begin with the project. In this first phase he has to make or collect all the documents the students need for the project and make them all accessible at the Environment on the Web. It is therefore very important that the instructor can upload documents to the Environment. This first task is very time consuming. It is therefore important to start a considerable time before phase two starts. Furthermore he organises the project in this first phase. He makes a schedule with due-dates for the assignments. In this way

he can stay in charge of the project. *The instructor has to be able to prepare the necessary project information and make this information accesible for students.*

In the second phase, where the instructor guides the study processes of the learners, he has to communicate quite a lot with the learners. In this phase he has to monitor his learners and give them feedback on their performance. Also he has to motivate them to execute their tasks and to discuss and meet with their group-members. Communication is the most important thing in project-based education. The instructor needs some means to communicate. During this phase he also has to do administrative work; enter learners- and group-information. When all is done the instructor marks the products of the learners. In this phase the instructor has to monitor for progress. Process control is an important task of the instructor in the second phase (Van der Veen, 1997). *The instructor has to be able to guide the study project processes.*

The learners begin with their project in the instructors second phase. The learners complete three phases: prepare, perform and evaluate the project. In the first (sub) phase the learners have to get acquainted with the project. The learner first has to make a group with other learners and then choose a subject. In project-based education a problem is the starting point of a project. Then they gather the information they need for the project (projectmanual, articles, schedule etc.). The students need to download these documents from the Environment. In Project-based education every student has a specific role in the group. And with every role there are some tasks the student has to fulfil. The last, but very important, task of this first phase is to make a workplan, where the group write preconditions and basic assumptions, a specification of the problem, method of approach, planning, division of tasks etc. In the second sub-phase the learners perform the project. They do research at the problem by searching (on the web) for literature on the subject, by interviewing experts and discuss with groupmembers. Communication is very important and takes place between groupmembers, between groups and between instructor and learners. The students need means to communicate with others. The final product is mostly a report about the problem. They have to be able to upload the report the Environment, so others (instructor or other groups) can evaluate it in the last phase. In the third sub-phase the learners have to evaluate. The learners evaluate their own product (self-evaluation) on content, structure, style used, and they reflect on their own process (what went wrong, why and how would they do it the next time). Furthermore they have to evaluate the products of other groups (peer-evaluation) and give their comments. The last task for learners is to fill in an evaluationform. The learners give their opinion about the project: what they think of the planning, the content, the assignment, the quality, tasks etc. *In a word, students have to be able to prepare, perform and to evaluate the study project.*

In the last phase of Project-based education the instructor has to execute his evaluation plan. In this plan he evaluates the planning, the process and the results of the project. Furthermore he analyses the evaluation forms that the learners have to fill in after they have finished the project, in order to further improve the quality of the courses. *The instructor has to be able to execute his evaluation plan.*

The guidelines mentioned are rather general of nature. Given a specific context of use, they have to be further specified. Grooters (1998) gives a more comprehensive overview of design-guidelines for an ISE for Project-based Education. In the next paragraph we describe ComMedia, a project-based Study environment, in which we meet the stated requirements.

ComMedia: A Project-based Study Environment on the Web

As stated, ComMedia is an example of an Interactive Study Environment. We took the metaphor of a company as the point of departure for designing ComMedia. Students are junior and teachers senior members. As a company, ComMedia has the following mission (de Vries, 1998):

- to offer consultation and design services to (non-) profit-companies facing corporate communication-media problems or interested in communication opportunities made possible by information and communication technology developments;
- to offer a usable information and communication platform to students and teachers to set up, look after, pass through, and evaluate study projects.

ComMedia is designed as a virtual learning 'Knowledge Company'. It is a knowledge company in the meaning of a business and a company, which primary tasks concern knowledge about the design and use of interactive media for corporate communication purposes. The company is a virtual one. It is an imaginary profit company and it exists online only. Last but not least, it is a typical learning company. Its major task is to enable 'junior consultants' to become 'senior consultants'. We identify four major roles: administrator, senior consultants (teachers), junior consultants (students), external consultants (former students) and visitors. Tasks are carried out in (study-) projects. Each project team has a lot of freedom in completing the project, as long as they meet standard preconditions, set by teachers.

ComMedia is designed with a front and a back office. The front office is the reception for visitors. Intended visitors are mainly (non-) profit companies who have an interest in our work, but visitors can also be students who have an interest in the specialisation. Companies have the opportunity to ask for information, to use the 'online knowledge base' called the Cabinet, and to submit assignments, which students can carry out. Possible students have the opportunity to ask for information, and to use the Cabinet.

The back office is accessible for administrators, and senior, junior, and external consultants, so not for visitors. The back office 'functionality' for employees is dependent on their roles. The back office consists of four departments, the administration department, the education department, the research department, and the Cabinet. The administration department offers the functionality for managing the company and setting up courses and projects. The user role divides up the access to functionalities. A junior consultant, for instance, has only access to his or her own data. The education department offers the functionality for setting up, looking after, passing through, and evaluating projects. The research department is not active yet. The goal is to develop research facilities for research projects, for instance, computer-supported co-operative work tools for designing flow charts for websites, coaching facilities, etceteras. The Cabinet is the ComMedia repository in the sense of a mine of information. It is an online archive consisting of a wide variety of information genres, for instance, student reports, scientific articles, concept descriptions, methods descriptions, links to interesting information sources on the web (see Figure 3).

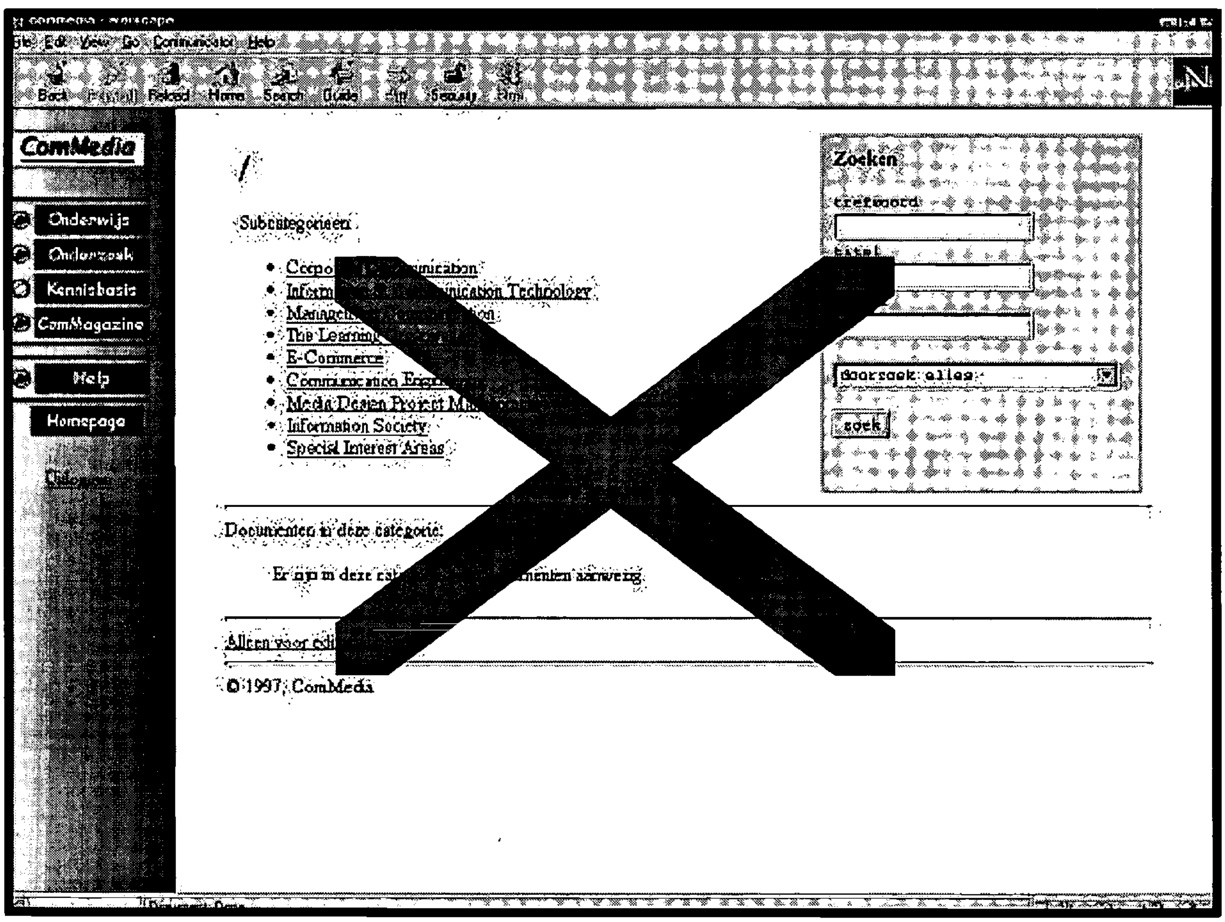

Figure 3: The Cabinet in ComMedia

The content concerns the domain knowledge of the specialisation Communication and Media, the design and use of interactive media for Corporate Communication. The Cabinet is being extended and updated continually. For that, we make use of an editorial board. The intention is that all study content materials developed by teachers and students are going to be stored in the Cabinet.
We consider ComMedia as an example of a project-based study environment. It offers teachers the opportunity to prepare, apply and evaluate study projects. Students have the opportunity to pass through these projects. In our courses, we still make use of lectures, practicals, assignments, and etceteras. We consider a study project in ComMedia as a type of an interactive study system. In such a project, students work together in an online project room. There are project information documents available, and they have applicable functionalities at their disposal, like a bulletin board, discussion platforms, and a logbook. They can also make use of an information resource, namely the Cabinet. In general, students can make use of offline information, like lecture materials.

Discussion

We think that our design approach, and as an example of this ComMedia embedded in the specialisation Communication and Media, offers opportunities for lifelong learners to acquire knowledge and/or skills in a flexible way.
ComMedia is going to be used in the second trimester of this year in a course of the study Communication sciences at the University of Twente. In the beginning it will be used in combination with classical lectures. An advantage of that is that the students who work with the environment can give their comments right away. These comments will be used as a formative evaluation, after which improvements will be made.
In theory the participants are able to perform all their tasks of project-based education in ComMedia. How it will be in practice is still a question. Because it is not implemented yet, there is no data about the possibilities of the users to perform their tasks. But the expectations for the future are high. No more classical lectures, students and instructors can do their work at home, even if home is at the other side of the world

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The Effects of Two Modes of Interactive Televised Video

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Abstract: The purpose of this study was to compare ITV student satisfaction in performance and its predictors for two settings - one with two sites connected, each seeing the other simultaneously, and one with three to five sites connected, each seeing only one of the other sites at a time. A difference in satisfaction in performance in these two settings was not found but there was a difference found in its predictors.

1. Introduction

With rising educational costs and decreasing resources available to meet them, many students are delaying college until after they have gotten jobs and started having their families. This has contributed to a growing need for alternatives to the traditional mode of classroom instruction. These must be designed to meet the needs of these students who have restricted travel schedules.

Historically, colleges and universities offered correspondence courses to serve such students. These courses, however, offered little personal interaction between student and teacher and no interaction between students. Today, technology can meet the student need for conserving travel time and still offer some of the interaction experienced in the traditional classroom through two-way interactive televised video (ITV). However, using it is very expensive. One way to enhance its cost-effectiveness is to increase student enrollments. This can be done by increasing the number of sites. In doing so, it is imperative that ITV continues to offer learners the satisfaction necessary to perpetuate interest.

Little research has been done to investigate student satisfaction in voice-activated ITV with only one of several connected sites visible at a time. This mode of instruction may minimize potential for interactivity since class size is usually increased and since the teacher does not see all students at all sites at all times. However, preparing teachers for its use may enable them to overcome the barriers of this mode of instruction, producing as much interactivity in this setting as in the simultaneously-viewed point-to-point setting where students and teacher at one site and students at the other site can see each other continuously.

A determination of student satisfaction in voice-activated multipoint distance education can reduce the institutional risk of spending money on a mode of instruction that may not be efficient. Additionally, the determination of predictors of student satisfaction can be helpful to those institutions that have already invested in this mode of instruction since identification of these factors can be utilized to improve ITV programs.

2. Related Literature

Pinpointing predictors of satisfaction in ITV is a challenge; many factors are considered influential. These include the class size (Scheck and Others, 1994); the functioning of the technology to provide clarity of picture and sound (Hackman and Walker, 1990, and Johnson and Silvernail, 1994); course availability (Wakamatsu and Obi, 1990, and Jurasek, 1992); learner autonomy (Moore, 1977); learning style (Atman, 1991, Ehrman, 1991, Gibson, 1991, and Billings, 1991); teaching style and strategies (Moore and Thompson, 1990, Hyatt, 1992, Price and Others, 1994, Comeaux, 1995, and McHenry and Bozik, 1995); interaction with teacher and other students (Holmberg, 1981, Barker, 1989, Catchpole, 1988, Kitchen and Kitchen, 1988, Nelson, 1985, Cvancara and Peters, 1989, Pirrong and Lathen, 1990, and U.S. Congress, 1989); teacher experience and perception of ITV (Baker and Hansford, 1990); and amount of information received (Walker and Hackman, 1991).

3. Research Technique

3.1 Design

A quasi-experimental two-group posttest was used to find differences in satisfaction in performance. It was developed by the researcher. Student ratings were recorded on a continuous scale.

Likert scale questionnaires were used to measure predictors of satisfaction. These included the Demographic Survey and Motivated Strategies for Learning Questionnaire, developed by the National Center for Research to Improve Postsecondary Teaching and Learning (NCRIPTAL); University of Michigan Problem Solving Survey, developed by Berger; Closure/Flexibility Concealed Figures Assessment, developed by Thurstone and Jeffrey; Student Survey of Instruction with instructor Verbal Immediacy and Nonverbal Immediacy Scales developed by Gorham, Richmond and McCroskey; Grand Valley State University Interactive Television Student Survey, developed by Major; and Student Survey of Distance Learning and Distance Survey of Instruction, developed by the researcher. The predictors included:

1) student motivation and learning strategies
2) student field dependence
3) student problem solving types
4) student grade expectancy
5) student intrinsic and extrinsic motivation
6) student ITV orientation and experience
7) student perception of the technology in ITV course
8) student demographic characteristics including gender, program of study, and age
9) student feelings toward students at other sites
10) student feeling part of class
11) student use of the fax, microphones, videotaped class sessions, and their ability to get materials from the library
12) student ability to hear and see the teacher
13) student ability to hear and see other students
14) teacher ability to hear and see students
15) teacher nonverbal and verbal immediacy
16) teacher visits to sites
17) teacher instructional style
18) teacher ITV orientation and experience
19) teacher ITV pay compensation
20) teacher use of zoom
21) teacher use of zoom
22) teacher perception of ITV importance

Other variables assessed were number of sites, numbers of students in the ITV courses, student distance from main campus, and the requirement of the ITV course.

3.2 Treatment and Setting

This study was conducted at Grand Valley State University (GVSU) in Grand Rapids, Michigan. This institution has North Central Accreditation and an enrollment of more than 13,000 students in graduate and undergraduate degree programs.

GVSU has replaced the use of satellite for serving students in surrounding areas with ITV instruction offered in two settings, point-to-point with 2 sites connected and multipoint with 3 to 5 sites connected.

In these settings, the classroom configuration allows each site to act as the host site with other sites acting as remote sites. Two monitors are in the front of each room. The one on the left always indicates what is being transmitted from that room (a graphic, the instructor, or student/s). The one on the right in the point-to-point setting displays what is being received from the other site and in the multipoint setting displays what is being sent from the site activating the broadcast.

3.3 Sample Population

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3.3 Sample Population

The subjects in this study were volunteer college students enrolled at Grand Valley State University in Grand Rapids, Michigan. There were 237 students who participated in 10 point-to-point courses and 120 students who participated in 4 multipoint courses. These courses represented a wide range of disciplines.

Comparability of the groups was explored. It was found that the groups had no significant differences in year of high school graduation, ethnicity, or gradepoint but the point-to-point group did have a significantly higher proportion of males.

4. RESULTS AND CONCLUSIONS

4.1 Research Question Results

The research methodology was designed to answer the following questions:

1) Is there a difference in the satisfaction in performance of students participating in point-to-point with two sites connected) and multipoint courses with three or more sites connected)?
2) Is there a difference in the predictors of satisfaction of students participating in point-to-point and multipoint courses?

Research hypotheses expressed below were tested using regression analyses. The Null Hypotheses 1 was accepted and the Null Hypothesis 2 was rejected. The Alternative Hypothesis 1 was rejected and the Alternative Hypothesis 2 was accepted (Tables 1 and 2).

Null Hypotheses (Ho):

1) There is no significant difference in satisfaction in performance for students participating in point-to-point and multipoint courses.
2) There is no significant difference in the predictors of student satisfaction of performance for students participating in point-to-point and multipoint courses.

Alternative Hypotheses (Ha):

1) There is a significant difference in student satisfaction of performance for students participating in point-to-point and multipoint courses.
2) There is a significant difference in the predictors of course satisfaction in performance for students participating in point-to-point and multipoint courses.

Table 1--Significant Difference in Satisfaction in Performance of Students in Point-to-Point and Multipoint ITV n=346

Research Question	Result
Is there a difference in the course satisfaction in performance of students participating in point-to point and multipoint distance education? Research Hypotheses: Ho: There is no significant difference in course satisfaction in performance of students participating in point-to-point and multipoint distance education. Ha: There is a difference in course satisfaction of students participating in point-to-point and multipoint distance education.	Regression Analysis: Point-to-Point/Multipoint F-ratio = 0.418 Not Significant t-ratio Probability Constant .... 0.0001 Point/Multipoint .... R-squared = .001 Adjusted R-squared =.002 Findings: At alpha = .05, it can be concluded that there was no significant difference in the course satisfaction in performance in the two groups. Conclusion: Fail to reject Ho.

Table 2--Significant Difference in Predictors of Satisfaction in Performance of Students Participating in Point-to-Point and Multipoint ITV

Research Question	Result
Is there a difference in satisfaction of point-to-point and multipoint ITV courses? Research Hypotheses: Ho: If ITV courses are offered in point-to-point and multipoint settings, there is no difference in predictors of course satisfaction in performance. Ha: If ITV courses are offered in point-to-point and multipoint settings, there is a difference in predictors of course satisfaction in performance.	Regression Analysis Point-to-Point n=87 F-ratio = 12.5 Significant t-ratio Probability Constant .... Grade Expectancy 3.57............ 0.0006 Nonverbal Immediacy 2.41............... .... Feelings Toward Students 2.22 .... 0.0295 Feeling Part of Class 2.77............ 0.0068 R-squared = 3.78 Adjusted R-squared = 3.48 Multipoint n=237 F-ratio = 13.7 Significant t-ratio Probability Constant 7.27 0.0001 Grade Expectancy 2.69............ 0.0103 Self-Efficacy 2.76............ 0.0084 College Requirement .... R-squared = .440 Adjusted R-squared = .412 Findings: At alpha = .05, it can be concluded that there is a difference in predictor variables of Satisfaction of Performance. Conclusion: Reject Ho; accept Ha.

5. Conclusions

There was no significant difference found in Satisfaction in Performance of students (Table 1). There were differences found, however, in the predictors (Table 2). Only grade expectancy was found to be a common significant predictor in both point-to-point and multipoint groups. With additional analyses, it was found to be a significant predictor at host and remote sites for both groups (Table 3).

Nonverbal communication of teachers, feeling part of the class and having positive feelings toward students at other sites were significant in the point-to-point group but not in the multipoint group (Table 4). With additional analyses, the researcher found that nonverbal communication of teachers was a significant predictor at both host and remote sites while feelings toward students at other sites and feeling part of the class were only significant at the remote site (Table 3).

For multipoint students, taking the class as a college requirement was a predictor of lower satisfaction in performance. This was true, however, only at the host site. Self-efficacy was also a significant predictor and was significant at both host and remote sites (Tables 2 and 3).

Table 3--Significant Predictors of Student Satisfaction in Performance at Host and Remote Sites

Research Question	Results
Is there a difference in Satisfaction in Performance for students participating in point-to-point and multipoint ITV courses at host and remote sites? Research Hypotheses: Ho: If ITV courses are offered in point-to-point and multipoint settings, there is no difference in predictors of Satisfaction in Performance. Ha: There is a difference in predictors of Satisfaction in Performance at host and remote sites.	Regression Analysis Host Site n= 201 F-ratio t-ratio Probability Grade Expectancy .... College Requirement 7.94 ....-2.82 0.0054* Self-Efficacy 17.9 4.23 .... Feeling Part of Class .... Feelings Toward Students 2.47 1.75 0.1189 Nonverbal Immediacy 6.04 5.66 0.0153* Remote Site n=148 F-ratio t-ratio Probability Grade Expectancy .... College Requirement .... Self-Efficacy 8.23 5.92 0.0049* Feeling Part of Class .... Feelings Toward Students 5.59 3.36 0.0202* Nonverbal Immediacy 6.54 2.56 0.0001* Findings: At alpha = .05, it can be concluded that there is a difference in predictor variables of Satisfaction in Performance at host and remote sites. Conclusion: Reject Ho; accept Ha.

5.1 Generalizability of Sample

Since this was a university study, its results may not be generalizable to students younger than adults.

5.2 Important Findings

The researcher conducted an exhaustive review of literature and found no previous studies that compared satisfaction and predictors of satisfaction in performance of students in point-to-point settings to those in multipoint settings. This study explored these to answer important questions related to distance education in the context of increasing alternatives available through ITV technology.

While Scheck and others indicate that large class size has been found to negatively affect student performance, the results of this study indicated that there was no difference in the satisfaction of performance of students in the point-to-point settings and in the multipoint settings. The researcher recommends that educational institutions advance administrative incentive to transmit to more sites from one classroom, thereby, enhancing numbers of students receiving educational services.

Additionally, the results of this study indicated that there was a difference in predictors of course satisfaction in these two groups. The significant predictors, self-efficacy and taking the course as a program requirement, found in the multipoint group are personal characteristics and not related to classroom dynamics. This is not true, however, for the point-to-point group for whom the significant predictors were interpersonal characteristics - nonverbal immediacy of instructor, feelings toward students at other sites, and feeling a part of the class.

These findings indicate that instructors in the point-to-point setting need to be especially cognizant of their nonverbal behavior directed to both host and remote sites. These include teacher's use of gestures, use of monotone voice, practice of looking at the class, practice of smiling at the class, display of tense body position, practice of moving about the room, habit of looking at the board or notes while talking to the class, practice of smiling at individual students in the class and use of a variety of vocal expressions when talking to the class. Findings also indicate that instructors in this setting need to be sensitive to student feelings toward others and feeling part of the class. These predictors were consistent with the assertions made by Holmberg, Barker, Catchpole, Kitchen and Kitchen, Nelson, Cvancara and Peters, and Gorham and McCroskey who emphasize the importance of student interaction and teacher immediacy. Additionally, they challenge the results of research done by Walker and Hackman who suggest that students in these are willing to trade off their socio-emotional needs for contact with the instructors and rapport with classmates for the currency of telecourse information.

The influence of these predictors were "washed out" when multiple sites participated in this mode of instruction and were replaced by self-efficacy and the requirement of the ITV class. In this setting, the sense of isolation at the remote sites may be reduced by the sharing of remote site frustrations at one site with students at the other sites. The old adage "misery loves company" may be manifested here.

College requirement in the multipoint group negatively influenced course satisfaction at the host site but not at the remote site. One reason for this may be that students at the remote site desire to take as many courses as possible using this mode of instruction to experience the benefit of reduced travel. These students may be willing to deal with the challenges of ITV. In fact, Walker and Hackman indicate that amount of information transferred is the primary determinant of learning and satisfaction in telecourses. Students at the host site, however, may be less satisfied with their performance in this context because they are required to face the related difficulties without any benefit to them. The frustrations of ITV may be further enhanced for these students when the ITV course is important in their program and the need to comprehend course concepts and to obtain a good grade is optimal.

Choice may be a very important factor in overall course satisfaction. To provide it for all students, it may be appropriate to: (a) have instructors teach from empty classrooms on campus to students at distant sites desiring the ITV course, and (b) provide the instructor the training needed to enhance nonverbal immediacy of instructor and the interactivity needed for students at the remote sites to feel a part of the class and to have a positive feeling toward students at the host site.

Additionally, it was found that Self-efficacy was a predictor at both host and remote sites in the multipoint setting but was not a predictor in point-of-point settings. The researcher emphasizes that academic performance may be a great concern for students in the multipoint setting since classroom dynamics is very complex. This environment, which has much camera switching, may be overwhelming to some. Those, in this setting, who have a better sense of ability to do well, consequently, are more satisfied with the course. Students who struggle with mastering course content should not be encouraged to learn in this setting without given much support.

5.4 Suggestions for Future Research

To verify the findings of this study and to explore other ITV areas of interest, the researcher suggests the following:

1) Replicate this study using more point-to-point and multipoint classes, instructors, and courses.
2) Investigate reasons that feelings toward students at other sites, feeling part of class, and nonverbal teacher behavior are predictors of student satisfaction in performance in point-to- point ITV distance education and not in multipoint ITV distance education.
3) Investigate reasons that self-efficacy is a predictor of student satisfaction in performance in multipoint ITV distance education and not in point-to-point ITV.
4) Investigate the variables for student motivation and learning strategies, student problem solving types, and intrinsic motivation. These variables had moderately strong relationships to Satisfaction in Performance for the multipoint setting but were not included in the regression model as predictors. The omission of these variables may be due to interaction with Grade Expectancy. Further investigation of these is recommended in future study of ITV.

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Student Constructed Software to Teach High-School Mathematics

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Abstract: This paper describes the experience at Texas A&M - Corpus Christi in assisting Minority Students to develop software to teach high school mathematics. The first section describes our initial situation: the goals of the projects, students involved, and the domain chosen. The objectives not only consisted in developing useful software but also maximizing the students' learning. The second section describes the development life cycle, which serves as a guide for constructing other educational software prototypes. The third section describes the two prototypes that were developed to learn linear inequalities and difference equations. The fourth and last section describes the goals that were accomplished, it was an example of learning by constructing [Harel & Papert 1990], where students increased their knowledge of mathematics, software design (navigational charts and storyboards), implementation (HyperCard), and pedagogy in a short period of time. It also described how minor modifications in the programs, making them more open-ended, resulted in significant gains.

1. Introduction

The main goal of this project was to supply a group of minority students with a real world research problem as opposed to an artificial or directed experience, thus giving them confidence in their skills and abilities, and enhancing the likelihood of pursuing scientific careers. A second goal was to produce educational software capable of enhancing the teaching of high school mathematics. These objectives are dependent, because the students can only gain skill and confidence in their work by producing educational software of good quality.

The second goal had a sub-goal of producing a prototype that could be presented to teachers and students of the Corpus Christi School District participating in a Summer Camp at Texas A&M University - CC. The development time was a little less than one semester and the group initially consisted of nine undergraduate students from different majors (computer science, math, and biology). Their work time was limited to 10 hours a week, which was sponsored by the alliance for minority participation program of the National Science Foundation. Furthermore, most students had limited experience in computer science and five students left the project due to other commitments. They were replaced by three new students.

2. The Development Process

All undergraduate students were given research material in the domain (mathematics), design and implementation tools (storyboards and HyperCard) and educational software (articles on the web such as those found in the engines of education at http://www.ils.nwu.edu/~e_for_e/). HyperCard was chosen because it is easy to learn, it is licensed by the University, it is a language that doesn't demand a lot of programming time (permitting more time to be spent with the domain problem), it is supported by numerous HyperCard reference books [Goodman 1993, Turner & Land 1994] and there are HyperCard-like development environments that run on other computer platforms (example: SuperCard on Macintosh and MS-Windows, Toolbook on MS-Windows).
After two weeks of researching the material, a bottom-up strategy was adopted. The students were given two prototypes to implement, as opposed to a top-down design strategy, where the student's task would be to design the whole system before any implementation. In the top-down approach, there would be a detailed study of the research material and educational software available prior to design.

Besides meeting external demands, this approach prepared the student in a constructivist way. For a top-down approach to be successful, the students would have to be followers. With the bottom-up approach, the students took control of their projects, thus requiring very little intervention by the professors.

Two projects were chosen: linear programming and interacting growth models based on difference equations. The programmers that developed the difference equations were assigned to test the linear programming and vice-versa. Once the prototypes were finished, they were presented to the Corpus Christi School District teachers who were participating in a summer camp at Texas A&M University. Next, the prototypes were presented to the Corpus Christi School District students. However, our test was quite limited because it was not tested in a real classroom environment. Neither students nor teachers of the Corpus Christi School District had commitments to what the school district students learned during the summer and both were working under university professors, therefore the testing lacked criticism. Furthermore, due to other commitments, the software developers were not present to observe the students using it.

Having developed a prototype, the students had the necessary experience to design the software with a much broader view, being able to adopt a top-down approach. The seven students were divided into four groups to research:

the educational software existing in the market;
the design of software to teach mathematics;
new interface options using HyperCard;
educational software developing environments.

The natural priority would be to research existing educational software in the market, for the other three tasks were dependent on this one. However, that would have consisted of research in schools and due to the difficulties in obtaining any information during the summer period, the above research tasks were a better option as opposed to everyone researching the educational software on the market.

At the end of the summer, each group presented their results, and all students became more aware of the need to: further research educational software, create an open-ended constructivist software and separate the content from the tool.

3. The Prototypes

Both prototypes attempt to teach mathematics through real world situations, as opposed to abstract formulas that are meaningless to students. With one of them, the problem was to use linear programming to solve the real world problem of trying to optimally feed a cat named Fedora. With the other one, learners were to master difference equations through predator-prey models, where foxes were the predators and rabbits were the prey.

A characteristic of both programs is direct manipulation: as users input data, they see the corresponding algebraic formula and graph immediately. Another characteristic of both applications is that the students' answers are stored in an external text file that permits instructors to critique students' activities. However, both prototypes lacked flexibility, because the examples were hard-coded into the programs. Therefore a second version of both prototypes were constructed to be used in a classroom environment and compared against the first version. In the second version, the software was designed to be a cognitive tool, as opposed to substituting the instructor's lesson. The first version attempted to diagnose the student, giving them precise feedback, while the second version left this part up to the instructor and concentrated in supplying more options to use the software.
Figure 1 shows the problem of feeding Fedora. In the example, cats need fifteen units of proteins, five units of carbohydrates and ten units of fat. One bag of Extra contains three units of protein, twelve of carbohydrates and one of fat. One bag of CFS contains one unit of protein, one unit of carbohydrate and two of fat. Students set up the linear equations A, B, and C on the top right of the screen by entering this information properly. When they click the buttons A, B, and C, the respective lines are drawn on the graph. The objective function shows that one unit of Extra occupies one cubic foot, while one unit of CFS occupies 1.5 cubic feet. In the second version of the prototype, a linear calculator was constructed. Figure 2 shows how the Fedora problem was inserted by the instructors as an example of the Linear Calculator. Fedora was no longer an instrinsic part of the program.

Figure 3, 4 and 5 show illustrate the predator-prey program (second version of prototype). As with linear programming, students constructed a prototype with the example (rabbits and foxes), built into the software. In the second version of the prototype, this characteristic was removed. Students fill in the blanks for initial population, birth rates and death rates of both predators and prey (Figure 3). When they click the *create equations* button, the change in predator population (delta predator/delta-t) and change in prey population (delta prey/delta-t) equations are generated respectively. They then inform the number of time intervals (run-time=50 in the example) and click the *create table* button. Finally, they click a button to see one of the graphs: predator population versus prey population, predator population versus time or prey population versus time. The graph shown is predator population versus prey population. In a real world application, the students will not be given a formula, but raw data. In Figure 4 illustrates another characteristic that was added to the prototype. The students try to discover a formula (right side of the screen), based on raw data that is typed in or read from an input file (left side) of screen).

4. Evaluation

When the first version of the prototypes were presented to teachers and students of the Corpus Christi School District, there was great enthusiasm. However, the enthusiasm soon ended when the examples were mastered.

When the second version of the prototypes were presented, the initial enthusiasm wasn't as much as with the first versions. Initially, students and instructors wanted the software to perform the calculations for them. However, when they learned that the software was just a tool, and they were going to do the thinking, they began to appreciate more the programs. Although, no formal evaluation took place, instructors were much more satisfied at the end with the results of the second version, because it didn't limit the students creativity. Students even used the programs to create examples that were not thought of by designers and the instructors, such as the one illustrated in Figure 5, where Republicans are the predators and Democrats are the prey.

The project's main goal has been accomplished. Even though students specialized more in the domain within which they had greater background and skills, in a short period of time all students improved in some way their knowledge of: mathematics, software design (navigational charts and storyboards), implementation (HyperCard), and pedagogy. Perhaps more important than the specific knowledge acquired, were the general skills that were developed: team work, organizational planning and research. Confirming other experiences [Harel & Papert 1990], this was an example of learning by constructing, which is more effective than if the students had sat in a classroom and took notes on how to develop educational software or participated in the project by only implementing the design done by the professors. Students learned the importance of developing open-ended (constructivist) software in a hands on experience.

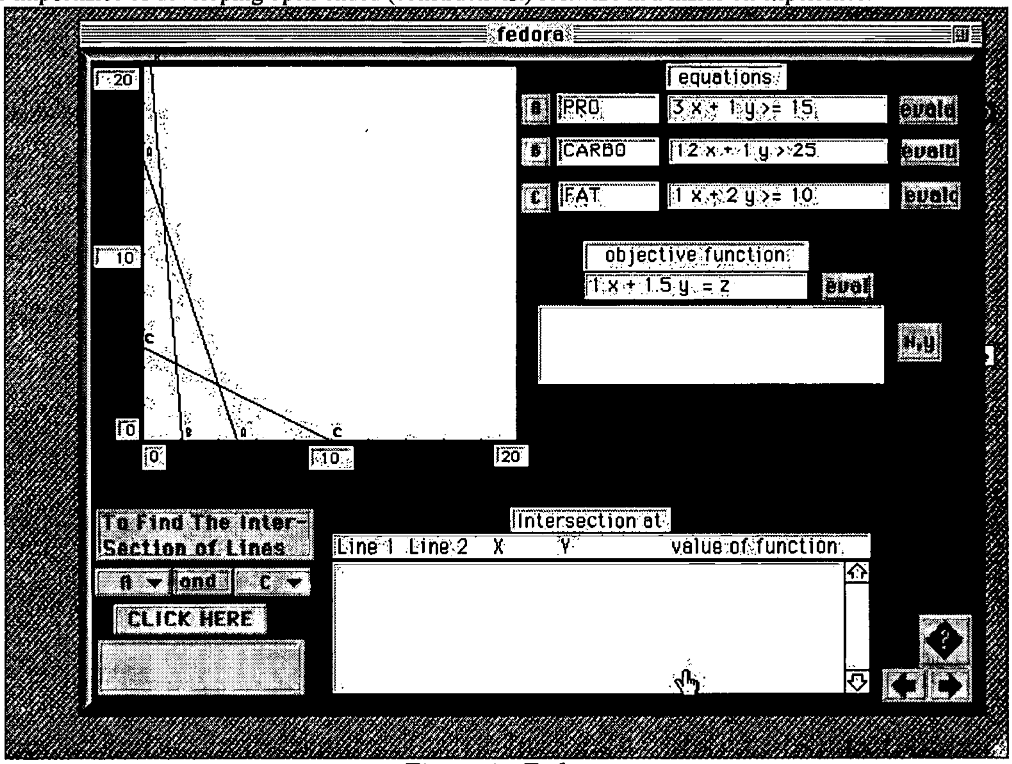

Figure 1 - Fedora

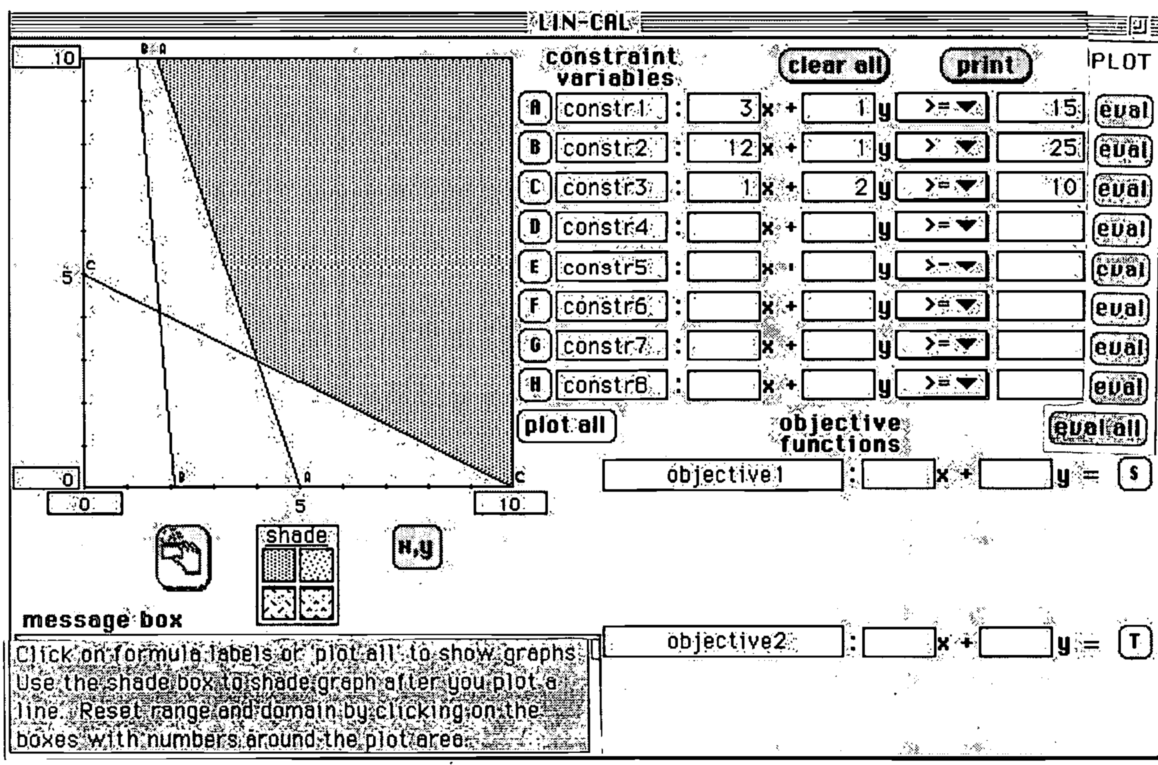

Figure 2 - Linear Calculator

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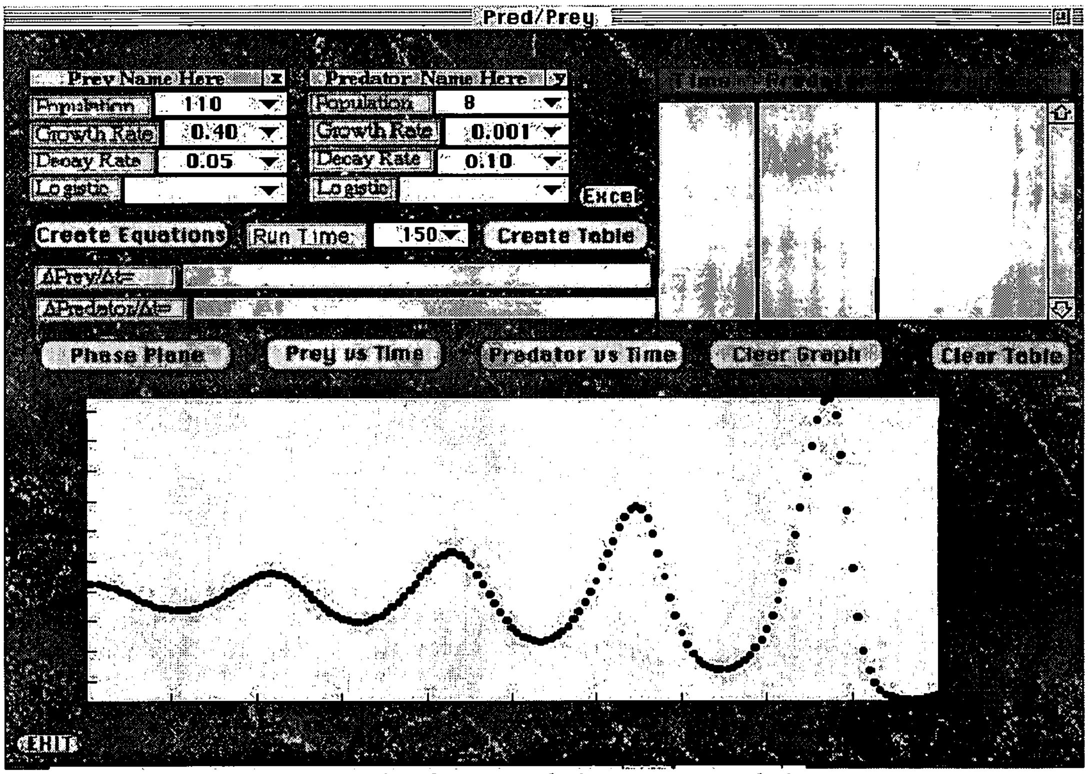

Figure 3 - Predator population x prey population

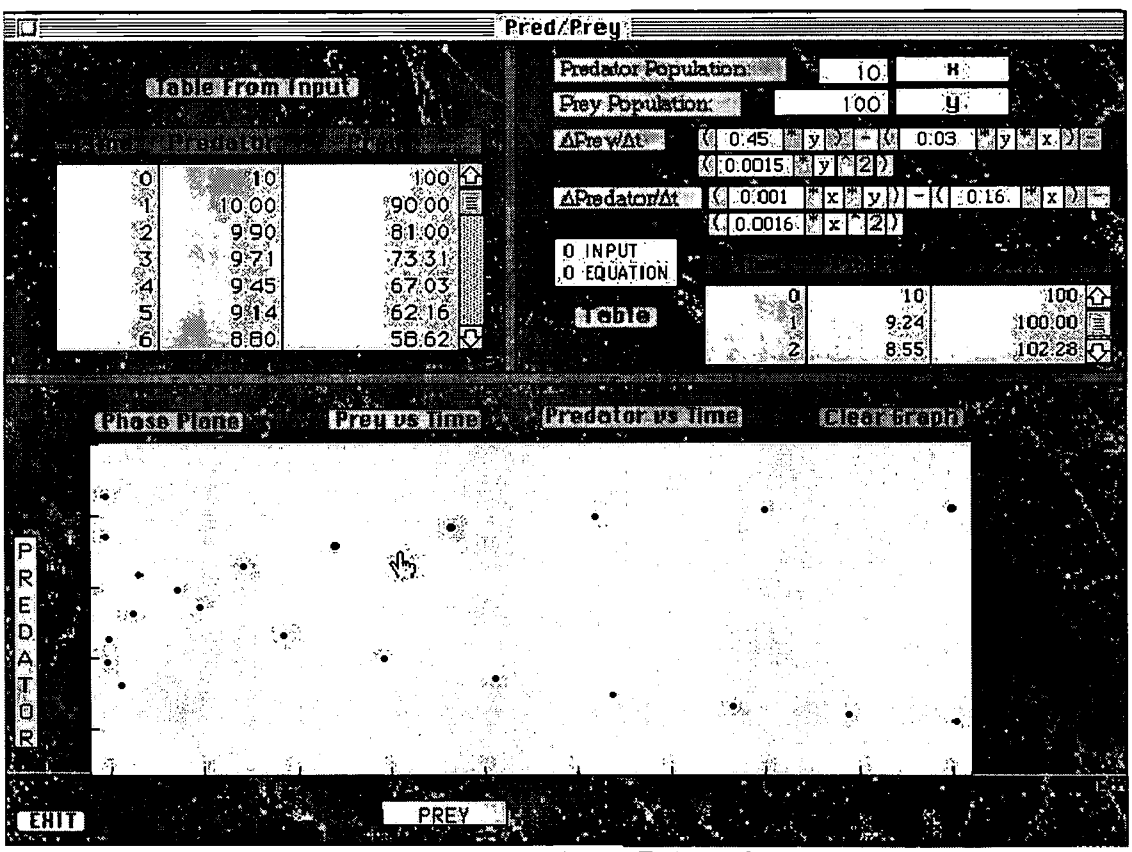

Figure 4 - Raw Data x Estimated

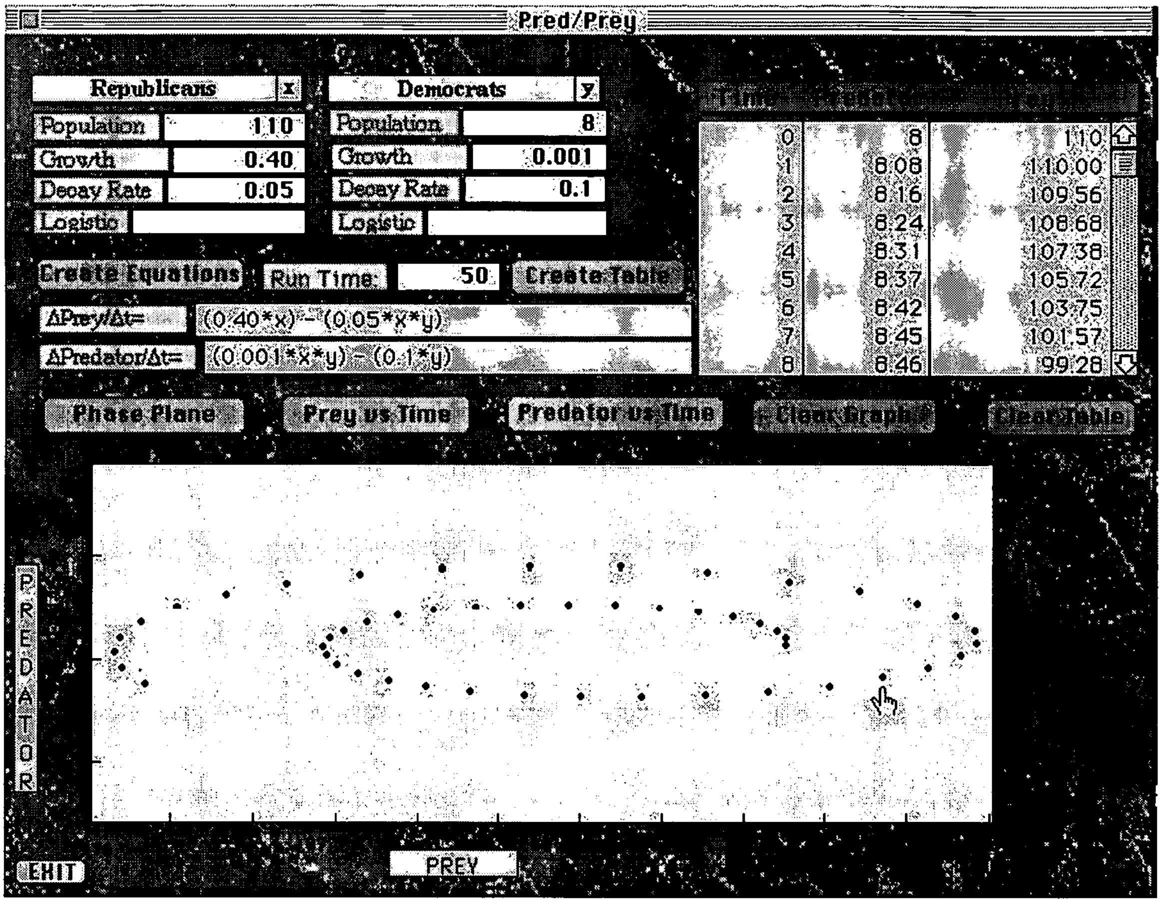

Figure 5 - Predator x Prey (example)

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6. Acknowledgements

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mechANIma-
New Didactic Concepts, Visualisations and Arrangements For The Teaching Of Mechanics

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Abstract: The term *mechANIma* tries to establish a connection between "mechanics" and "animation"*MechANIma* is not simply a computer program or a collection of materials for the mechanics course, but stands for a philosophy of new methods for the teaching and a better understanding of mechanics. With the help of the research group of Prof. Reinhard Keil-Slawik, Paderborn, we try to develop new methods and didactic concepts of teaching mechanics in many different courses taught at the University of Paderborn. The evaluation of new teaching environments and didactic arrangements for the daily use of new media in lectures, tutorials and student assignments is a particularly important part of our research. Animation systems developed by ourselves offer many advantages for the integration in our didactic concepts: All of our animation systems visualize the effects and parameters of the covering lectures and tutorials. Hence by modifying these parameters in animation systems, students get a much better idea of the underlying physical and mathematical aspects. Modern electronic learning environments offer possibilities to focus on a student-centered approach for learning. Therefore the *mechANIma* knowledge-base and information system develops new forms of teaching and learning methods.

Philosophy

To obtain better results in learning it is necessary to develop and to establish new media for education in university as well as in schools. It is widely known that individual learning is a rather complex process which cannot lead to good results without considering all forms of human learning. Human learning is a form of social activity. Human learning must be defined as a process of remembering, recollection and reminiscence. Physical artifacts like pens, paper, books, and also the new electronic media function as an "external memory" [Keil90]. Therefore students take facts form lectures, courses, or tutorials, and combine them to arrive at a new understanding of the presented material. Consequently, individual learning can be considered to be a self-organizing process.

The problem of conventional learning, as with the help of black boards, flip charts and overhead slides, is the nonintegrated use of these media. A student who attends a lecture with many other students, e.g., twice a week is not able to transfer the presented materials to tutorials, or even to access literature referenced in the courses at home. Hence no continuous access to necessary educational material is guaranteed. A student who does his / her homework must get the same materials as in group working in the university or at the lectures. In the classic form of learning, this continuity was realized in a primitive form by use of pen and paper. Students prepare lessons by reading and browsing through books and papers and make annotations on copies or there own summaries. In tutorials and lectures they have to write down what is written on the blackboard and compare their notes with reference books and papers. In the time of collaborative learning it becomes more and more difficult for the students to lively participate in discussion groups and to write down necessary facts for the upcoming examination at the same time. Additional successful and effective forms of learning need student-centered structures of teaching. Student-centered forms of learning are defined as presenting different views on the subject to allow students to develop a personal and individual understanding. This may be achieved by the use of electronic media called multimedia and hypermedia with the help of new educational didactic concepts and infrastructure requirements.

Modern electronic learning environments offer possibilities to enhance a student-centered approach for learning. In this concept the student himself is responsible for his personal learning progress. Socially embedded learning processes are the necessary condition for effectiveness of teaching. To achieve better success in the understanding of the presented material and in order to let students develop their own insights in the topics, it is necessary to offer a wide range of high quality information. The student has to extract the core information from a multitude of imported facts. In conventional forms of learning the students get the information step by step (portions of the presented subjects) and are required to take an examination later. The students do not feel responsible for the selection of the information. Modern forms of learning require the willingness to accept responsibility for the selection and for the filtering of fundamental knowledge. The process of extracting the real essence may be defined as the real achievement of learning. The goal of the *mechANIma* project is to reduce the break-down in the use of electronic media and to create an interactive learning environment that can be actively worked upon by the students.

Such an integrated approach cannot be accomplished by a single research group that creates a high tech island within the department of the university. The term "Alltagspraxis" (every-day-life practice) [BrRKS95] has been used to indicate the goal of setting up a learning suggestive infrastructure that can be used under the typical constraints of the day-to-day teaching constraints imposed at a university.

mechANIma, hypermedia and mechanics

The term *mechANIma* tries to establish a connection between "mechanics" and "animation." However, m*echANIma* is not only a computer program or a collection of different materials for a mechanics course, but rather a philosophy of new methods for the training and understanding of mechanics. With the help of the research group of Prof. Reinhard Keil-Slawik, Paderborn, we try to develop new methods and didactic concepts of teaching mechanics in many different courses to students at the university of Paderborn. Especially the evaluation of new teaching environments and didactic arrangements for the daily use of new media in lectures, tutorials and student assignments is an important part of our research work.

mechANIma^{teach} - workflow...

One goal of the *mechANIma*^{teach} project is the achievement of a continuous flow of information between the students and the lectures. Electronic mail and the concept of workgroup computing are widely spread in of our modern society. Large companies use intranet solutions and groupware products to achieve a faster and less complicating flow of information. At non-computer science institutions of our university the concepts are not always consistently implemented. Therefore we try to put a new "communication layer" and structure on top of our traditional organizations and forms of communication with our students. Students can communicate by electronic mail among each other and, of course, send emails to the staff. A few years ago we developed the idea of a direct access for students to all teaching material available at our institute, the Laboratory for Technical Mechanics (LTM).

The mechANIma system, accessed through the internet

When the World Wide Web entered the internet, we tried to develop hypertext with the rudimentary Microsoft help system which was not very useful for our texts that contained many mathematical formulas and other complex graphics. Later we discovered the hypermedia system HyperG, now Hyperwave, developed by Herrman Maurer [AKM95], which allows a more structured design of web publishing and active working with the materials.

Hyperwave, history

In the last years Hyperwave developed from a specialist's system to a widely used modern Web information server, which may be accessed by common internet WWW clients, such as the Microsoft Internet Explorer, Mosaic, Netscape etc. Hyperwave implements a fully object oriented hypermedia database which allows to integrate all known digital media like, hypertext, movies, sounds and animation. Especially the Hyperwave feature for the protection of documents with special access rights, Unix-like group and user structures are necessary pre conditions to organize a course based on electronic media. The possibility of the limited access to documents is particularly necessary for documents which underlie copyright constraints and may only be read by the registered participants of the course. Consequently, access rights and a user/ group structure are absolutely essential for the use of WWW information server teaching environments. Hyperwave offers an easy way to use user interfaces including a set of special tools which allow in a very simple interactive way to insert hypertexts and all forms of hypermedia documents into the server. Additionally the Hyperwave information server offers special forms of structuring the material with the help of "collections" and "clusters," a concept equivalent to classical file systems. Besides the features mentioned above, Hyperwave allows for a full text search over the whole database which involves rather complex search terms, e.g., regular expressions, make a work with a large number of hypermedia documents possible.

Hyperwave guarantees that students have continuous access to the latest release of electronic documents. Mistakes which are found in lectures or tutorials can easily be corrected and published on the information server. Printed versions require much longer turn-around times. It is even possible for students to put their homework on the server and discuss it in later tutorials. This concept called learning-supporting "infrastructure" was introduced by [BreKe95] for collaborative learning with the help of integrated teaching and learning environment and satisfies many requirements to achieve more flexible forms of combining individual and social learning processes.

However, in the field of the technical mechanics additional requirements arise besides these concepts. Students have to deal with complex mathematical and physical problems. Therefore, special animation, simulation and visualization software was designed within the *mechANIma*^{animation} project in order to visualize the complex mathematical and physical relations of technical mechanics and to overcome the classical way of how to present mechanics, namely with the help of a blackboard and chalk.

Animation, Simulation, Visualization

The requirement to visualize complex mechanical effects was the initial spark for the *mechANIma* project. A few year before the term "multimedia" was created we had tried to develop small simulation software, e.g., to visualize caustic ([Man64], [FeHe96], [Rad70]) effects, which are difficult to show in real experiments. One important aspect of our concept of *mechANIma* is to use the most popular programming environments like Microsoft "Visual Basic" or Borland "Delphi" which can be handled by "normal" students without special knowledge in computer science. Therefore we are still testing a great range of visual development environments and computer languages. However, the best results were achieved by using the Visual Basic development kits. Our experiences show, that "normal" students of mechanics need only need 4-5 weeks to adjust and to produce nice results with a good for cost-to-effort ratio. High end programming environments such as the family of Microsoft Windows C development solutions offer much greater opportunities, but require a much longer time for non-experts produce results. Especially for students who simply want to visualize an effect which is needed for further research the motivation to use easy and visual programming environments is much better. At the actual stage of the *mechANIma* project we evaluate newer programming environments of the JAVA language in order to find alternatives for the Visual Basic language, which runs only on PC platforms. The screenshot below shows first results.

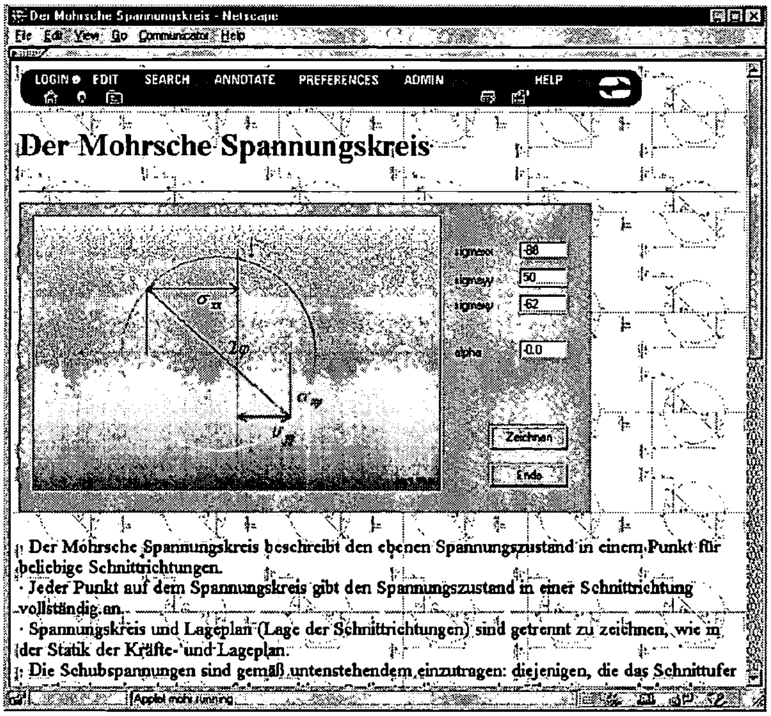


Figure 1: Prototype of a visualization system as a JAVA applet

Animation systems developed by ourselves offer a number of important advantages for the integration in our didactic concepts. The most important aspect is that all our animation systems visualize exactly the effects and parameters addressed in the lectures and tutorials. Hence, by modifying these parameters in animation systems, students get a much better idea of the underlying physical and mathematical effects.

The visualization of a "compressive edge load on a half plane" which is shown in Figure 2, allows to manipulate all necessary mathematical and optical parameters in a very intuitive and interactive way. It is even possible to use the whole system on a touchscreen terminal without connection to a keyboard (all numerical input fields are accessible through a small calculator-like input control). In our laboratory one of these touchscreen terminals is available to the public 24 hours a day. Besides the animation systems students can access the whole *mechANIma* collection of electronic teaching materials like manuscripts, homework exercises, exams, etc. Also the latest news about lectures or additional events are accessible through these information systems which are connected to the university-intranet. The installation of such terminals was a very important milestone to accomplish a continuous access to media as mentioned in the first section.

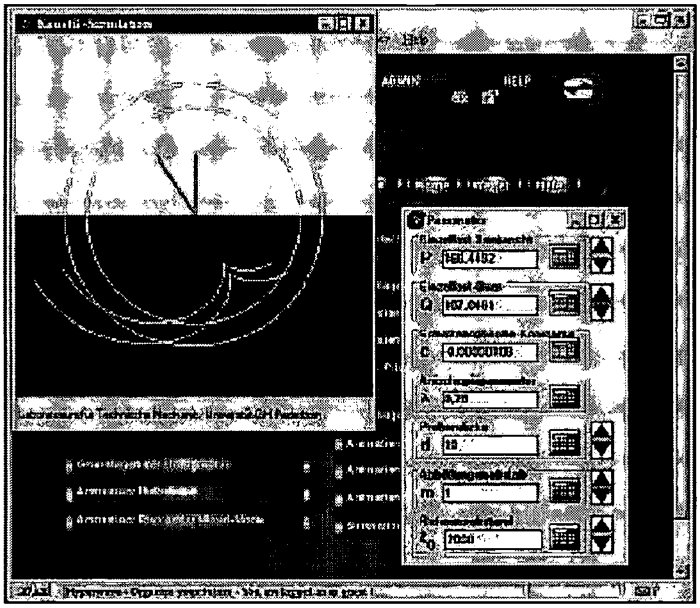


Figure 2: Special animation systems for the caustic effect developed in the mechANIma project.

Computer Algebra systems

Another important component of *mechANIma* is the integration of computer algebra worksheets into the Hyperwave information system. Rather complex mathematical derivations are much easier to understand if it is possible to automatically plot functions and equations, modify parameters, or simply by changing a number. A few example screenshots of the mathematical aspects of the "compressive edge load on a half plane" visualization are added in Appendix A.

Course materials containing computer algebra worksheets offer a great flexibility in the possibility of direct interaction. Therefore the concepts of characterizing individual learning as a self-organizing process is achieved by enhancing the possibilities for the student interacting with the hypermedia system.

Virtual Laboratory

As an additional way to illustrate complex mathematical derivations it is planned to prepare virtual views of the experiments. Appendix C shows one of the examples of using Apple Quicktime Virtual Reality to give students an idea of the real experiment. Our experiences show that students can understand the caustic effect much better, if it is shown in a conspicuous manner. The Quicktime VR format allows in a relative simple way to create three-dimensional panoramic views by taking pictures of the real surrounding and the experiments.

As a conclusion, *mechANIma* is still under construction and will never enter a stage of being complete. The field of technical mechanics is much too complex to say that a hypermedia system and information systems holds all information and visualizations for the whole sector of mechanics. Additional animation and simulation systems are still necessary. New technologies will lead to exciting opportunities for the future. And: social embedding of hypermedia into learning processes will always be a great challenge.

Appendix A: The caustic method

Today the method of "shadow patterns" which also is known as "shadow spot method" or "method of caustics" represents a powerful optical method to measure stress intensity factors in static and dynamic problems of experimental fracture mechanics. The method of shadow patterns was introduced in 1964 by Manogg [Man 64] who performed a shadow optical analysis for a stationary crack under mode-I-loading. Later the method was further developed and its field of application was extended by Theocaris and by Kalthoff and their co-workers. The physical principle underlying the method of shadow patterns is illustrated in the following illustration.

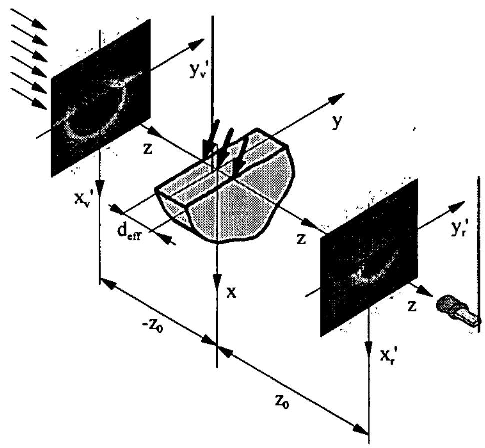
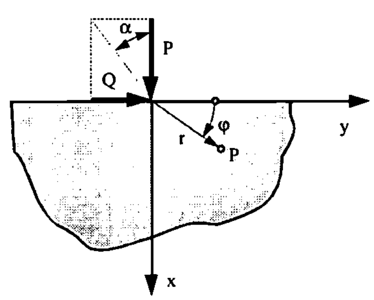


Figure 3: Schematic diagram of the caustic effect

A specimen with a crack is loaded by a tensile stress and illuminated with light generated by a point light source. In this case a specimen of a transparent material is considered. The stress intensification in the region surrounding the crack tip leads to a reduction of both the thickness of the specimen and the refractive index of the material. As a consequence, in the transmission case, the light passing through the specimen is deflected outwards. Therefore, on an image plane at any distance z_0 behind the specimen a dark shadow spot is formed. The spot is bounded by a bright light concentration, the caustic. Because the magnitude of the light deflections is correlated with the magnitude of the stress intensification at the crack tip, the shadow pattern contains information about the stress-strain conditions in the vicinity of the crack tip and, in particular, about the stress intensity factor.



Compressive edge load on a half plane

$$-\frac{\pi}{2} \leq \varphi \leq \frac{\pi}{2}$$

The caustic curve is defined by the following mapping equations:

$$\mathbf{w}_{1,2} = m\mathbf{r} + z_0 d_{eff} c[\nabla(\sigma_1 + \sigma_2) \pm \lambda \nabla(\sigma_1 - \sigma_2)]$$

The complete family of the deflected light rays form the shadow space behind the object plane. Its surface is an envelope to the light rays and is called the caustic surface. The following equations form the basis for the simulation of the caustic effect (e.g., for the simulation systems shown in Figure 2):

$$x'_{a,i} = mr\cos\varphi + \frac{2\left(P^2 + Q^2\right)^{\frac{1}{2}}}{\pi} z_0 c(1 \pm \lambda)\, d_{eff} r^{-2} \cos(2\varphi + \alpha)$$

$$y'_{a,i} = mr\sin\varphi + \frac{2\left(P^2 + Q^2\right)^{\frac{1}{2}}}{\pi} z_0 c(1 \pm \lambda)\, d_{eff} r^{-2} \sin(2\varphi + \alpha)$$

Appendix B: Visualization with the help of computer algebra systems

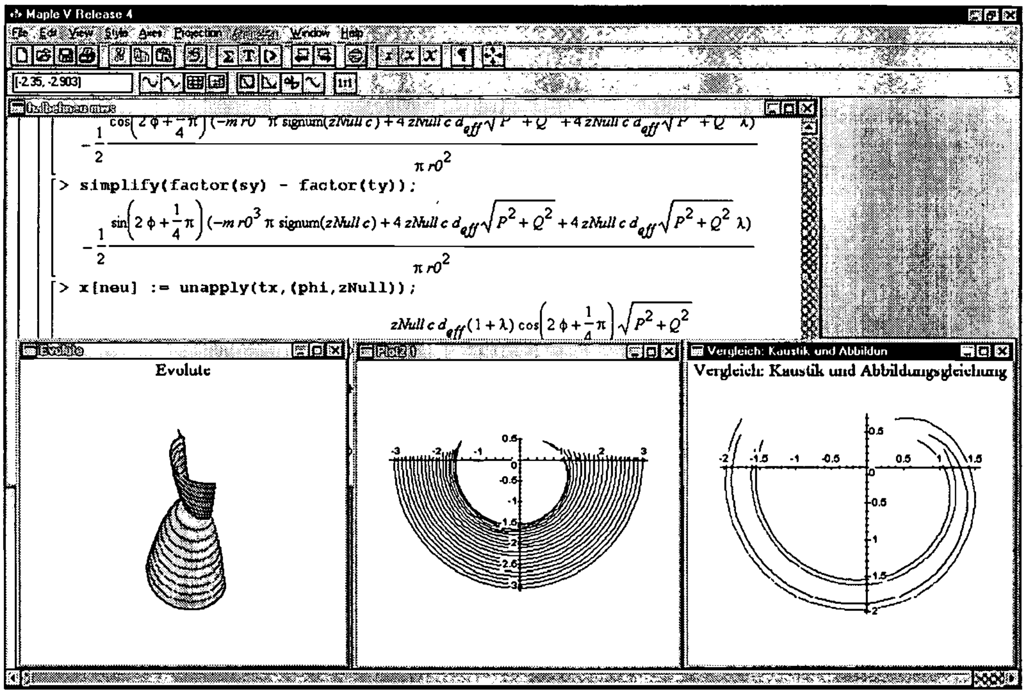


Figure 3: Visualisation of the mathematical background of the caustic effect

Appendix C: Physical experiments as virtual reality models

Figure 4 Physical experiments as virtual reality model (e.g. the caustic effect)

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Navigating The Virtual Building Site: Quicktime VR In Civil Engineering

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Abstract: Quicktime VR (virtual reality) is a cross-platform media format made possible through Apple's Quicktime 3.0 software. This paper examines some its applications in Civil and Structural Engineering education, both for exploration ("The Virtual Site Visit") and as a means of ordering visual information (a "virtual menu"). The author speculates on the possibility of further educational applications with the addition of Quicktime Layer formats.

CIVCAL

Civil and Structural Engineering is literally one of the biggest businesses in Hong Kong and, hectare for hectare, there are probably more skyscrapers, bridges, reclamations, tunnels and airports under construction in this tiny region than anywhere in the world. For those of us who live in Hong Kong it sometimes seems as though the whole city is a building site.

Yet for engineering students it is difficult to gain practical experience of practical site work and most students will have spent only a short, often frustrating time on a civil construction site before they graduate. There are two main reasons for this:

1. The construction process is slow, so in a one day site visit or even a one month work experience it is difficult to perceive any progress; and
2. Building sites are by nature chaotic with many and varied jobs taking place at the same time — it is often difficult to comprehend what is going on.

It is not surprising then, that for many young graduates the first practical experience of working on site can come as an unpleasant shock.

CIVCAL (CIVil engineering Computer Aided Learning) is an attempt to address these problems by providing a series of "virtual site visits" to significant civil engineering projects in Hong Kong. CIVCAL is based at the University of Hong Kong, but straddles four Engineering Faculties at the City University, Polytechnic University and the Hong Kong University of Science and Technology. It has been funded under the Teaching Development Grants program of the Universities Grants Committee. It commenced in September 1997 and is funded for two years.

When it is complete, CIVCAL will be an easily-accessible data base of photographic, graphic, organizational, financial and structural information on significant current construction sites in Hong Kong such as:

- Chek Lap Kok airport
- Tsing Ma suspension bridge
- Strategic sewage disposal scheme
- Aberdeen landslide, 1996
- HKU Biological Sciences Building construction
- Kam Tin water management system - Rubber dams (see Figure 1), etc.

Each project is the responsibility of a team of engineers and research assistants from one of the participating universities and the coordination, structure and funding of the overall project is overseen by a steering committee.

The material is being developed in the first instance as a WWW site, using HTML as the presentation and hyperlinking technology. Although in the future we anticipate that the project may be reorganized into a series of CD-ROMs to enable faster access and searching, particularly of video, animation, VR material, simulations and mathematical models.

- Click a TAB to select a project
- Click on the PICTURE to visit the project
- Click on a THEME to visit the projects which include it.
- Click the SITE OFFICE to return to this menu.

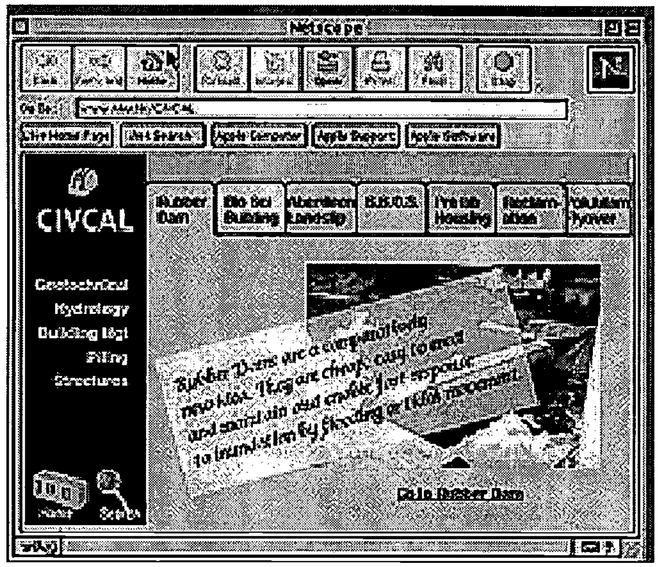

Figure 1: Menu screen showing projects (tabs) and themes (menu L)

The initial structure of CIVCAL divides the material in two ways: by Project and by Theme. In Figure 1 Projects are selected using the Tabs at the top of the page and Themes using the marginal menu. So the Aberdeen Landslip project is primarily Geotechnical; the Rubber Dam project is primarily Hydrology; and the Airport will include all the themes.

This paper looks at two aspects of this large project: the use of QTVR as a means of exploring space; and also as a means of structuring the material in space and in time.

Menus

The standard means of finding your way around a multimedia data base is by menu and index. Both are useful: alphabetical indexing is a widely understood means of tracking down information, provided you know what it is called (and provided you use an alphabet...); a hierarchical menu is a convenient means of moving from the general to the specific, providing the information is logically structured, but index trees are a labour-intensive way of searching and difficult to browse. Image banks (including video stock-shot libraries) are traditionally classified and searched according to content: location, topic, date, people, etc. Once again an alphabetical or hierarchical classification which depends upon an imposed structured that needs to be learned by the user.

This is not problematic if the Engineering curriculum is a top-down process of instruction, but in a constructivist environment students are encouraged to explore and to find things out for themselves. Building sites are littered with strange equipment and people on them are engaged in arcane processes which seem to have little to do with the job in hand. On a real building site the students could ask questions, refer to plans, or come back next week when the Clerk of Works can talk to them. But in a virtual visit, the only research tool available is the navigation device.

"The Virtual Site Visit" employs two less conventional forms of navigation: VR menus, enabling navigation through space; and 3D menus, which facilitate navigation in time.

Virtual menus

VR menus take advantage of Apple Quicktime VR technology to enable exploration and discovery. QTVR comes in two forms: panoramic movies and object movies, both of which are useful discovery tools. They rely on Apple's Quicktime Media Layer software, which in its Version 3.0 incarnation runs equally well on both Mac OS and Windows (3.5, 95 and NT) under both Netscape and Internet Explorer. Unlike 3D software such as VRML, which must be generated from a CAD program, QTVR is a two-dimensional medium generated photographically. The viewer remains in a static position able only to rotate his viewpoint around the inside of a cylinder or to manipulate a small object, although he can move from "node" to "node" using hyperlinks. But it is simple to produce, requires few resources and the files are comparatively small.

Panoramic movies

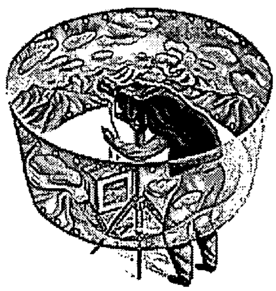

Figure 2: Apple's QTVR Authoring Studio

QTVR panoramas are 360° navigable images which run on any computer which has Quicktime installed. The viewer uses the mouse to pan around and up and down the inside of a cylindrical panorama, zooming in and out using control keys. Individual panoramas (or "nodes") may be linked together into a QTVR "scene" which allow the viewer to travel through a space, exploring as s/he goes. Additionally, panoramas may contain "hot spots" which are hyperlinks to other types of information (text, images, movies, etc.) as well as to URLs when used within a WWW page. With the Quicktime 3.0 "fast start" extensions installed, the viewer can began examining the panorama almost as soon as it begins loading.

QTVR panoramas are produced by taking a 360° series of overlapping still images from a tripod. If they were to be assembled manually they would form a sequence as in Figure 3. QTVR software such as Apple's QTVRAS or Roundabout Logic's Nodester applies a warp to the image (dependent upon the lens employed) and "stitches" them together (Figure 4). The detail available depends upon the quality of the original image: photographic negatives scanned at 1,200 dpi produce high quality panoramas in which the viewer can zoom in on small details, but may take several megabytes to store; panoramas produced using video or digital cameras make small files, but lack detail. One useful technology for WWW distribution is QTVR's dual-resolution capability where the end-user can choose between a fast download and image detail. Codecs such as Cinepak, Movie JPEG and Sorenson enable satisfactory compression to 20% or lower. At present, a 320 x 240 QTVR averages 240K and it is expected that future advances in image compression technology will be able to produce even smaller files. Java is also being employed as a replay format by some WWW producers.

Figure 3: 360° series of still pictures (courtesy Apple Computer)

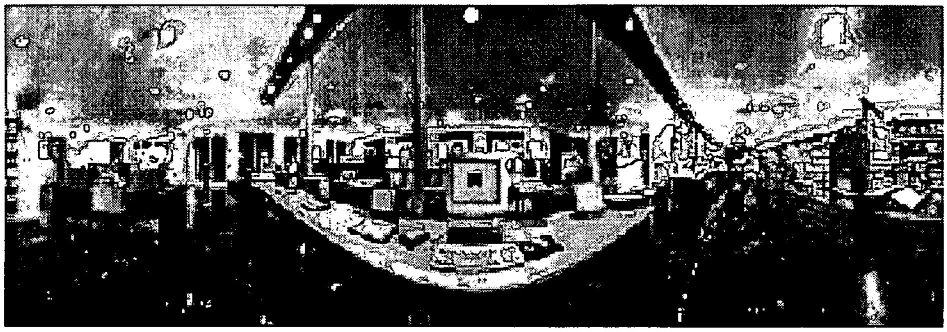

Figure 4 "Stitched" panorama (courtesy Apple Computer)

QTVR as a navigation device

In "The Virtual Site Visit" the QTVR panoramas function as navigation devices, or entry points into the data. For example, on the vast Chek Lap Kok Airport site there are literally hundreds of separate but interlocking contracts simultaneously underway: land reclamation, runway construction, airport terminal, roads and railways, communication infrastructure, housing, water and sewage, etc. How to distinguish between them?

The example below illustrates a more modest project, a QTVR coverage of a building site on the University grounds. Figure 5 illustrates:

- A site map with four QTVR locations or nodes. Clicking on any of them will take you to the appropriate panorama.
- From within each panorama the viewer can use the navigation tools to zoom in and our and to move between nodes.
- Clicking on "hot spots" brings up information about particular equipment or processes.

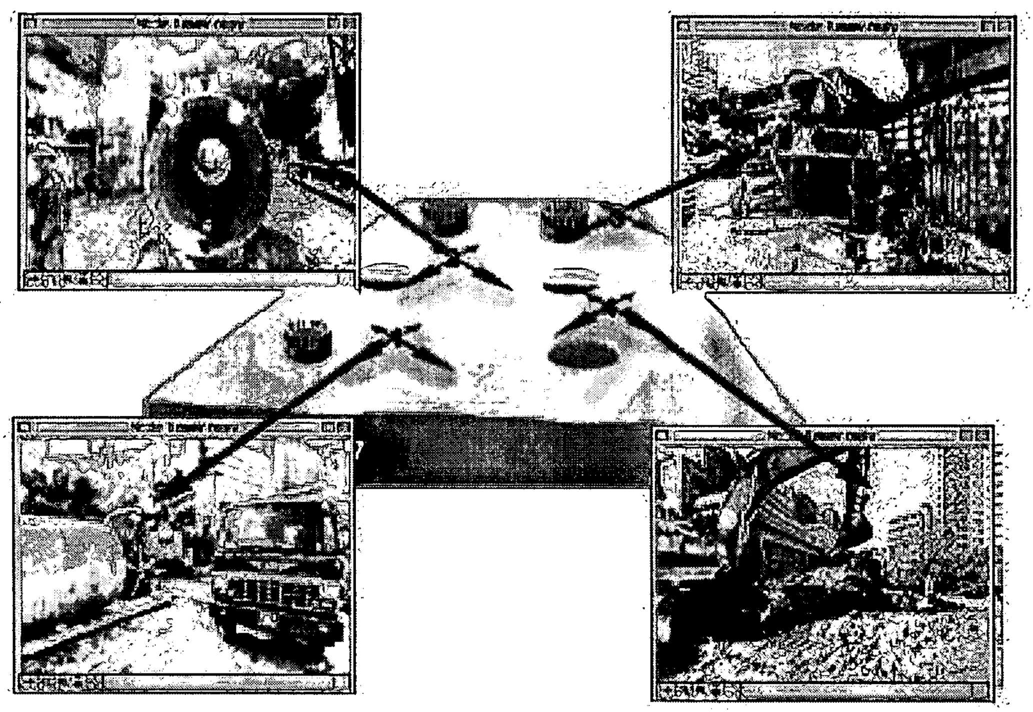

Figure 5: Site map and links to panoramas

Object movies

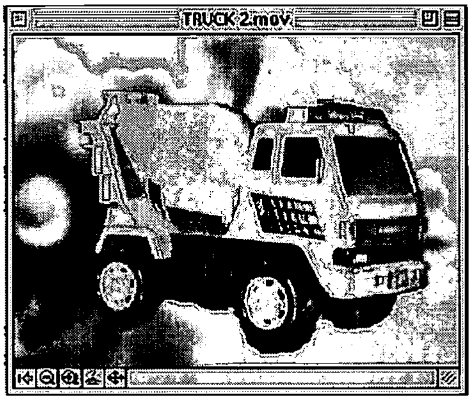

Figure 6: "Objet-trouvé" from site

QTVR object movies are a little like panoramas in reverse. Rather than turn himself around in virtual space, the viewer uses the mouse to rotate a 3D object in any direction and control keys to zoom in and out. It is an excellent way of presenting small, expensive or obscure components.

Object movies are produced using a camera rig which enables a controlled series of rotations. The resulting images are assembled into a matrix which the software then presents in an order according to mouse movement.

In "The Virtual Site Visit" hot spots lead the viewer to QTVR objects which can be manipulated and inspected. Unfortunately the practical maximum size of objects is 8-10 ins tall and on building sites the most relevant objects are rather larger than this. (See Figure 6)

3D menus

A factor important in construction, but difficult to manage in navigation, is time. Most of the processes in civil engineering are as much dependent upon sequence and timing as they are upon equipment and technology. The sequence of events involved in reclaiming land from the sea and the time needed for dredging, settlement, etc. are as important as the materials used in the fill. Other factors such a building regulations, safety, comparative cost factors etc. add dimensions to a process which make it difficult to represent conventionally.

One solution is to use three-dimensional menus. Figure 7 illustrates a 3D site map with spatial links (horizontal) and time links (vertical). [Note: This sequence was not completed at the time of submitting the paper, but will be demonstrated in the conference presentation.] Another possibility is to employ animated "sprites", a feature of Quicktime 3.0 which enables multiple layers (video, audio, text, animation). In this case the time factor could be built into the QTVR panorama itself with an additional "time" cursor enabling navigation to various time periods of the construction (See Figure 8). This possibility is currently under investigation.

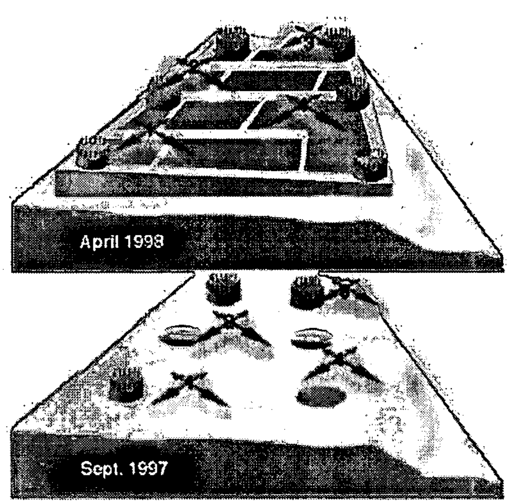

Figure 7: 3D Site Map with time as a vertical axis

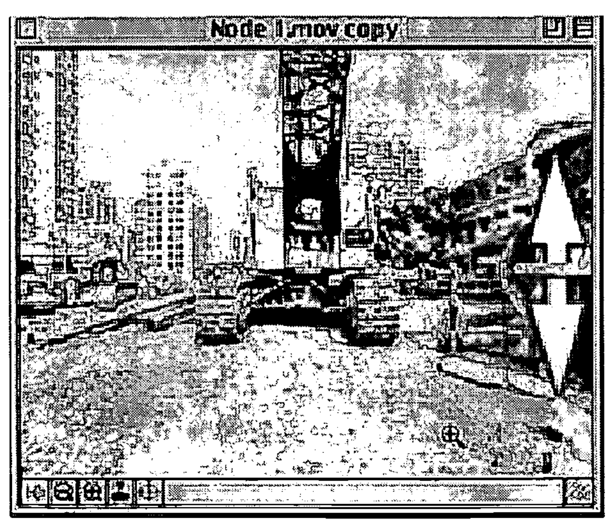

Figure 8: Temporal navigation sprite - cursor

Conclusion

Quicktime VR, combined with the flexibility of the Quicktime 3.0 layers is proving to be an invaluable tool for educational multimedia. It can serve as both a medium for exploration of an environment and a tool for navigating through it. This presentation has illustrated its application to Civil Engineering, but at the University of Hong Kong it is currently being applied to a much wider range of disciplines, among them Architecture, Medicine, Art History, and Ecology.

This written paper has been an attempt to explain the essence of QTVR, but it is a dynamic and visual medium which requires a multimedia format in order to appreciate it fully. Interested readers are referred to the following URLs as a starting point for exploration:

http://www.apple.com/quicktime/qtvr/index.html — the "mother" site
http://www.roundaboutlogic.com/ — information on panorama and object software, plus gallery
http://www.netfront.net/~ian/ — the author's QTVR-enhanced site

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Using the Internet to Provide Communication Benefits to a Low Tech Community

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Abstract: This paper presents a web site which can foster community building and technology skill building in a technologically inexperienced community. A plan is presented for a project, using this web site, that can overcome the Internet access obstacles of cost of computer equipment and lack of computer training. Two pilot locations have been identified for testing the hypothesis of this research. The user groups and technology equipment in these locations are described.

1. Introduction

This paper describes a plan for bringing the Internet into inner-city communities in America in a way that can address the special needs that exist there. This plan shows how, through the use of the Internet, new communication can foster community building and skills development which could help to break the cycle of poverty that is so prevalent among urban families. The plan includes building a customized web site through a participatory project with the particular group who uses it. The prototype web site, called "Town Square," functions as a communications hub and as a technology learning center. The process requires providing the initial expertise for knowledge transfer and technology support to users who will ultimately be their own information architects and teachers using the equipment.

The central idea of the project is that instances of this prototype will be developed as a collaborative effort with a resident group in a particular location. Through the process of confronting the technology closely, by making choices for personal material and hyperlinks to other sites of interest, the user group is learning about the Internet. They are also learning the techniques that can be used to contribute to the material available in this public forum. A school community, a neighborhood or other group, collectively creates the site that will be personally useful to all of its members. Therefore, the project is not only useful for acquiring technology skills and for creating a useful communication tool but also for building community within the user group.

2. Background

People talk about the positive value of the Internet to society. There is now much evidence that it has power to bring people together, and to help them communicate like no technology which has come before it. There is empowerment that comes from sharing in Internet communities and from the support and knowledge that can be obtained through collaborating with others [Rheingold 1993]. Through telecommunications systems, which include electronic mail, newsgroups, on-line chat rooms, and web publishing, there is much to be gained for undereducated people.

That there are people in America who have no opportunity [Kozol 1991] to utilize the resources available on the Internet is an issue which is being addressed through the initiatives of President Clinton and others. And indeed, all over America wires are being dropped and computers installed in public libraries, public schools and other public spaces. Concurrent with the populating of the Internet, and its increasing accessibility, is the development of technologies which will allow the merging of the Internet with television. Set-top boxes, as they are presently called, such as the one that WebTV Network provides, are a vision of the near future where entertainment, education, and research capabilities coexist and are delivered via television.

The value of the set-top box Internet technology to the low income user is that the web interface can be personally utilized without great cost and without the learning curve required for a fully functional personal computer. This technology is a valuable addition to the work described in this paper.

Everyone who uses a personal computer knows of the considerable knowledge, expense and time required to become a user. There are many people in America who are living at the poverty level, who have limited formal education, and who have family responsibilities. In order to provide this valuable Internet access to everyone, provision must be made to insure that the needs of the underserved community are met.

The Town Square project doesn't remove the time constraint, but its design process adds other benefits that make the time spent even more worthwhile. Work on the prototype design for Town Square began in 1996 in the School of Literature, Communication and Culture at Georgia Tech in Atlanta. The prototype was designed with a particular community as its focus, as information about this group was readily available from many sources and has been widely publicized. That community is the New Community at East Lake (formerly East Lake Meadows), a Federally subsidized housing project in Atlanta. There are images and information within the prototype site which reflect this focus.

3. Pilot Sites

There are presently two sites in the Atlanta area in which the thesis of this research is being demonstrated, one is a public elementary school and the other is a Federally subsidized housing project. The process that is being followed for both sites is the development of a site design group with the Town Square prototype as its focus.

3.1 Benteen Elementary School

Benteen Elementary School, which serves students in grades K-5, is a school with great potential for a very high tech learning environment. Desktop computing and network equipment is either in place or will be in the next year or two throughout the school. In addition, with the help of Sprint and the Harris Media Group, 25 WebTV units were purchased in the '96-'97 school year and unlimited access to the Internet provided through individual accounts attached to each of these units. The idea is that a student can check out a WebTV unit from a "library" and use it at home in the evenings. The school also has Internet access for several of their desktop units and the expectation is that Internet access will be available school-wide possibly as early as the Fall of '98. However, as yet there is no formal curriculum with which to structure or direct the learning of the students with respect to this new technology.

Benteen is a multicultural, urban school, a part of the Atlanta Public School system, which is receiving support from various civic volunteer groups, but with little participation from the families of its students. That the families are 45% African-American, 45% Spanish speaking, 8% Vietnamese and 2% Caucasian, creates some difficulties in developing connections between school and home. There are other factors to be sure, such as the lack of time and a lack of understanding as to how parents should be involved with a school, due to the parents' own childhood experiences and diverse cultural backgrounds. Technology may be able to help bridge this gap.

Since early January 1998, two groups have been meeting weekly in order to participate in a Town Square project at Benteen — a faculty group and a student group. It is envisioned that families will become a part of the participatory project in the near future by attending training classes on Saturday mornings at the school.

The Town Square @ Benteen project faculty group consists of seven faculty members along with the Benteen Technology Coordinator. Lessons are planned for the faculty several weeks in advance, with a formal syllabus and weekly agendas for meetings which are held on one afternoon each week. They are also given assignments for work between sessions. The faculty is encouraged to work together and help each other to accomplish the assignments.

The other group at Benteen is a student group — the "Computer Club," which meets as a part of an after-school program directed by Hands On Atlanta (HOA) AmeriCorps. HOA is an Atlanta organization committed to creating a vehicle for change, driven by volunteers. The AmeriCorps program is a national service initiative which provides education funds in exchange for community service work. There are 10 students in the club who meet together daily for 6 week periods. In the present group, there are 6 boys and 4 girls. At the end of the 6 weeks, the opportunity to participate in the Computer Club will be offered to a new group of 10 students who will meet for the next 6 weeks.

The focus of these early lessons is, in the case of the faculty, learning about the Internet and HTML coding, and for the students, computer literacy, including keyboarding and word processing, along with building skills to develop web pages. Each session lasts about an hour. The goals for the Town Square @ Benteen are as follows:

- To provide education for faculty and students and their families that will enable them to develop web documents suitable for viewing through their library of WebTV units.
- To provide a repository for information about Benteen Elementary School, its community, and its larger environment within the city of Atlanta and the state of Georgia
- To provide new methods of communication between the school, and the students, and their families.
- To provide a tutorial for computer technology/Internet education

3.2 DeKalb County Public Housing

Implementation of the Town Square @ Decatur, positioned in a public housing community center in Decatur, Georgia, is in the planning/startup stage. There are three housing projects served by this center, with 230 families in residence, nearly all African-American. As a part of its ongoing plan to improve services offered to residents, the Housing Authority has requested some $60,000. in Public Housing funding this year to purchase equipment and software for their Learning Center and to contract with four certified teachers and two part-time teaching assistants to staff the center. In addition to these funds, IBM and Goodwill Industries, a key service agency in many U.S. communities, have donated approximately $10,000. in computer equipment and classroom furniture.

There are many other support services in place for the Housing Authority tenants which complement the plan for the Town Square project. The goals for this project are much the same as those for the Benteen project. However, this project will offer the opportunity to structure the Town Square effort in a way different from that at Benteen due to the learning center location and its different mode of operation. In this case, the Learning Center will function as the hub for training sessions in a lab setting and the WebTV units will be in the homes of area residents. It is expected that the outcomes of community building and learning will be facilitated in the same way. This experience will give people skills to go to the marketplace and compete for more than minimum wage jobs. Skills in the computer-related technologies offer job potential in almost any industry in America. Can one be useful in a business office today without being able to function well with technology?

4. The Town Square Project

4.1 Product Definition

Purpose Statement: *To provide, for users in urban schools and low tech neighborhoods, a development strategy and design prototype which can enable a participatory web site design project. A visible product would be a useful, interactive digital repository for personalized communications links and computer technology tutorials on the World Wide Web.*

The Town Square Project was designed to help bridge a gap — between those who need access to income building resources but have few, and the Internet which has the potential for support, both emotionally and economically. The project has three major components: the development of prototype software, the use of the software as a base for collaborative further development with a target audience, and the analysis of the effort in terms of the proposed outcomes of community building and technology education.

Town Square's area of application is small communities. The intended tasks that the system will initially support are personal publishing, and linking to various WWW sites of interest. With the required Internet access for Town Square, the users will also be able to use e-mail and newsgroups. Ultimately, the site could include a link to a video-conference system within a community's daycare center.

Town Square is a prototype that provides the information components and design scheme for a full-fledged operating site. It can be used to give an initial understanding of the purpose and a plan for design to the participating group. The principal activity of the Town Square project is a participatory design project. Participatory design is on-site design. It involves the user not only as an experimental subject in the sense of evaluating the requirements, responses, desires, and needs of him/her, but also as a member of the design team. Users are active collaborators in the design process, rather than passive participants whose involvement is entirely governed by the designer. This collaboration is envisioned to take place in brainstorming sessions and workshops at a convenient central location for the group.

The Town Square prototype has been designed to the development specifications published by WebTV Network, so that the product is usable by employing either a personal computer with a web browser or by the WebTV and a television. There is also a keyboard available with the WebTV unit for an extra charge, which is essential for gaining skills which will transfer to computer use. In addition to the benefits provided by the style and connection design of the WebTV system, an advantage for home use of the system is that the initial investment is relatively low and the assumption is that most users will already own TVs.

4.2 Design

There are many specific issues with respect to culture, language, and image to consider in the design of this web site. It is a communications medium, with all the considerations for any computer-mediated communication system — literacy level, sharing space, individual presentation style, emotional interactions, and equipment limitations. The development process should also include ideas from users about this site's place with respect to local schools, other local institutions, or other sites outside the local community.

Town Square is organized as a home page leading to four main modules in order to provide for logical and effective maintenance of the documents by the user community. [see Fig. 1] The modules are accessed by links from the home page to: the neighborhood network, community activity information and links, Atlanta resources, and often-needed resources available from the State of Georgia. Links from within these modules can be to hypermedia resources or other information delivery systems. Within a module the user can choose to navigate back to the home document or to any of the other modules.

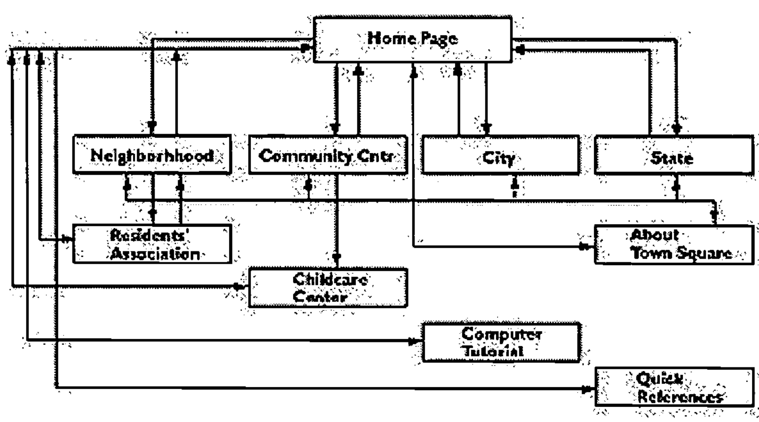

Figure 1: Structure of the Town Square prototype

The interface is designed to simulate the look and feel of a grid based conventional print resource. The students are expected to be somewhat new to the medium of web interaction, and therefore would easily assimilate interaction with the new tool if it is familiar in format. After using it for a time, the interface may logically begin to appear as a control device. The pages are all "color-coded," so that a user can see by the color of the page which module s/he is visiting. The design of the overall product includes an opening screen which is also the central navigation screen or "home page." [see Fig. 2]

The home page will allow new users to understand the purpose and scope of the product. With the headline graphic the user is positioned in the environment. Even though in this case the interface is designed for East Lake, the product can be easily used with a new user community by changing only the neighborhood or group name on the home page. The navigational buttons indicate their affordance quality through rollover text and images. The four photographs are familiar and identifiable as to their physical location in the user's environment, and thus aid the organization of the site. They are also easily customized to a new site by exchanging the four graphics. At the bottom of the page is a navigation bar to link to "quick reference" sites, such as a medical reference, the child care video camera, or the tutorial module.

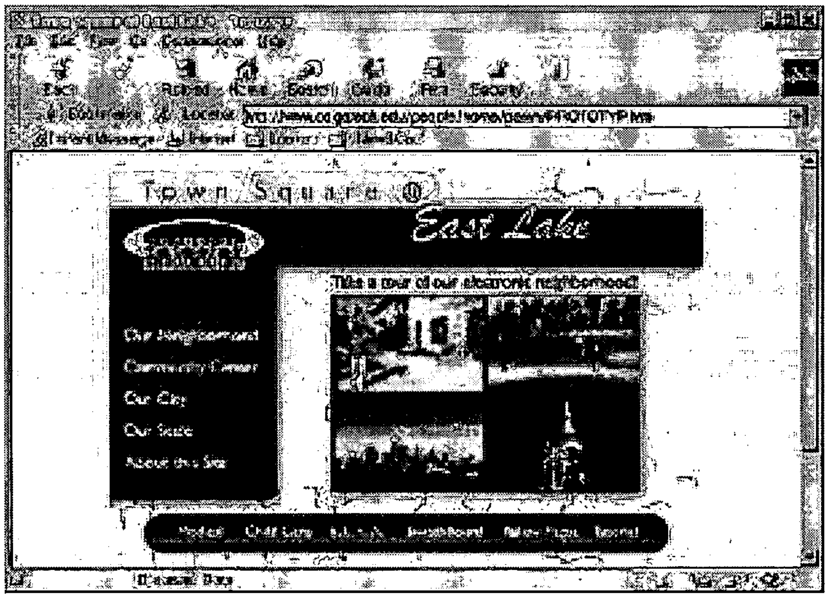

Figure 2: Town Square @ East Lake home page

The design of the four main module interfaces is consistent with the look of the home page and has the same navigational design. Each module has a different color to identify the different text content located there. For example, the "Neighborhood" page banner is colored orange to connect with the orange colored photograph and pop-up title flag on the home page.

The main goal for the module pages is that the information be very useful and presented in a simple, highly graphical format. The content of the modules is from various sources. There are other organizations [Center for Applied Special Technology 1996] that are also in the business of assisting with specialized technology education activity on the Internet. Therefore, the practices within the scope of this research is augmented by keeping track of the activities of other researchers. Information provided by the web sites of others is presented as hypertext links with a brief description of the information to be found there. In some cases important content from these outside links will be re-designed and organized on the Town Square linking page so that the user can more easily understand what information is to be found at the outside source and how to access it.

In the tutorial module, the current material is presented as an interactive video. It has been developed using Macromedia Director and compressed for the Web into a Shockwave movie. This material is planned for use both at home and in a classroom setting. When it is used in a class, an instructor will be available to help, if necessary, with the execution of the tutorial documents, as a well-designed resource can be enhanced by a human coach to aid its presentation. The instructor may wish to display this module on an enlarged presentation screen at the front of the class as a visual aid. New tutorial modules can be added as useful material is identified for reinforcement or home study.

5. Development Plans

In order to continue to improve the interface and the process of Town Square implementation, we will continue to examine the issues involved with designing for a multicultural environment, and the design of educational materials for the Web and the WebTV. We will encourage more Atlanta schools to participate in the project, so that the interface will become a useful tool to the school community at large and therefore have input and feedback from a wider user group. This wider usage could provide support for families who must relocate from one school to another, and therefore would enable the family to see a familiar space in otherwise new surroundings. A further development plan is to provide a more complete template for web site design by putting the prototype site documents into a total package which would enable easier site implementation, expansion and management. As more features become available for WebTV units, it is planned that the Town Square will incorporate these into the prototype design.

Organizations are invited to use the Town Square prototype documents freely and thus expand the familiar environment to the benefit of other communities. The designer will customize the graphics to reflect the new community free of charge. The documents may be downloaded from the Town Square website: (*http://www.lcc.gatech.edu/gallery/townsquare/*).

6. Conclusion

Low tech communities can become participants in the world of computer technology and the Internet by creating a web site which is a personalized communications center. The education that can result involves a community building from within, as users share the information with each other and as educational institutions collaborate with them. It can foster skill building, and be life changing. The technology skills that are likely to result are those of computer literacy, telecommunications, word processing, e-mail, web browsing, on-line researching, and web authoring.

This paper offers a model process and a prototype design for use by a community to build and empower itself with the help of computer technology. Even with the speed of the computer, this is not a quick fix [Gates 1996]. There are many years of sustained effort required for this project to be successful. It must be more than providing money (as in welfare), or equipment, or network access. There must be a provision of knowledge. To ensure that people not only have access to computer technology, but are given the best opportunities to use it for personal and collective benefit, human technology educators must be provided. The Town Square project is in its infancy, but offers a replicatable software design and process that holds the possibility to make a difference in low tech areas in America.

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Lifecycle Support for Hypermedia Based Learning

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Abstract: Despite considerable advancements in instructional theory, most hyper media-based learning systems found on the Web today are little more than slide shows. To foster more advanced learning systems on the Web, we propose a WWW-compliant approach for capturing instructional knowledge, emphasizing reusability: i) *WebStyles* for the representation of knowledge (e.g. instructional theories or authoring guidelines) and ii) *Ontologies* - expressed again as WebStyles - for capturing the phases of learning system lifecycles as well as various instructional models and strategies. WebStyles can be thought of as a typing concept for specifying "families" of WWW documents. Ontologies form the basis for WebStyle reuse and sharing. For the ease of understanding, most concepts will be introduced by way of examples.

1. Introduction

For years now, a sharp contrast persists between two camps of hypermedia-based learning systems (HBLS). Fairly advanced HBLS can be found in the "academic" world. On the other hand, there is an ever disillusioning state of the art of the large number of HBLS found on the Web: even behind the fancy curtains of 3D-VRML welcome screens offered by many so-called "virtual universities", little more than HTML-enabled slides can be found, sometime augmented by animations.

We consider the following to be the four key reasons for this discrepancy: 1. After several waves of enthusiasm and frustration about computer-aided learning, many practitioners do not want to "buy" any further promise. After the age of presentation-type CAI systems induced by behaviorism, the age of intelligent CAI induced by cognitivism, and other exaggerated hopes induced by prophets of one-fits-all theories, authors in the field believe that structuring and assessing the domain as good as possible (using hypermedia) is all they can do - no instructional strategy (disguised as "exploratory learning") is better than a bad, hindering one. 2. By and large, the experts camp has not yet succeeded in putting their expert knowledge into concrete, like for instance typography experts have (cf. desktop publishing tools). 3. The expert pertaining to the HBLS domain is fairly complex and, in particular, distributed over several phases of the authoring process. A single "word processor" kind of tool cannot hold this knowledge; rather, a domain author would have to have several means at hand, accommodating several phases of a HBLS lifecycle. 4. Wherever there has been an attempt to solve the problems described under points 2 and 3, the results were bound to rather proprietary systems and mostly to a particular instructional theory. Neither has there been a full integration with the Web as *the* underlying technology, nor has there been an easy way to extend such systems towards further theories, models, and methods.

The above analysis does not mean that there were no advancements. Many steps forward have been made, and the time seems to be ripe for cutting the nod. As to instructional theory, the one-fits-all attitude is close to be overcome. For instance, pragmatic constructivism [Good, Wandersee et al. 93] is even based on the observation that each individual has a distinct learning process; nevertheless - or better: just because of this - this theory brings forth concepts and rules that are widely applicable and useful. Even very ambitious approaches like Csikszentmihalyi's flow theory [Csikszentmihalyi 91] are accompanied by very handsome, broadly applicable design rules. Recent discussions between edutainment protagonists - focussing on success factors for instruc tion like fun, challenge, and engagement like [Quinn 96] - and defenders of "serious" learning systems - focussing on success factors like relevance, cf. [Kent 97] - were marked by the search for the respective pros and cons and not by the search for a single solution or "winner". In summary, instructional theory *has* to offer useful concepts, but there is a broad variety of "bits and pieces". Thus, *openness* for all these pieces is a central requirement for advanced HBLS development support. This openness must be generalized from instructional strategies to all facets and phases of HBLS development, such as instructional analysis, domain analysis, user modeling, etc.

Since this article focuses on *hypermedia*-based learning systems, the residual state of the art discussion will be restricted to hypermedia. Independent from the focus on learning, authoring support for hypermedia has long been recognized as a requirement. However, the WWW is by far the most wide-spread hypermedia system, but by far *not* the most advanced system. This observation holds for hypermedia authoring/design support: many advancements have been made in integrating design support, typing concepts, and database schema approaches with hypertext. For further details of these advancements the reader may refer to [DeVise] or [Grønbæk et al. 94] for DeVise, a hypermedia system of university of Aarhus, to [Furuta, Stotts 89] and [Scotts, Furuta 89] for an overview over Trellis, to [Richartz 96] for PreScripts, and to [Schwabe, Rossi 95] for an overview and [Schwabe, Rossi, Barbosa 96] for more details of the object-oriented hypermedia design method (OOHDM). In summary, there have been considerable achievements in the attempt to provide design support for hypertext; the more promising ones (like Trellis and PreScripts) are based on type concepts of entire hypertext documents i.e. "graphs" of nodes and links (HTML pages and URLs in WWW terms). However, most such developments relate to hypertext systems *other* than WWW. Even worse, the considerable achievements made are contrasted by a rather moderate state of commercially available authoring tools for WWW. These tools provide templates almost solely on the level of individual HTML pages (nodes in proper hypertext terminology), and focus on features comparable to those of source code management tools for programmers. It is rather in the context of WWW query systems such as WebSQL [Mendelzon, Milo 97] that more advanced typing concepts for entire hypertext documents (sets of HTML pages) have been developed. Despite the varying focus, these examples show that design support for entire hypertext documents is feasible and desirable. We will retain this observation as another requirement for HBLS support systems.

2. The GUTS Approach

Summarizing the analysis from above, we state the following requirements for HBLS authoring support systems: 1. *Lifecycle coverage*, since HBLS development is a complex, multi-phase process. 2. *Openness* with respect to a broad variety of instructional theories and strategies, analysis and design methods, lifecycle models, domain analysis and user models, and other constituents and results of the HBLS development process. 3. Incorporation of *type concepts* for hypermedia as a promising approach to capturing expert knowledge for hypermedia authoring. 4. *WWW conformance* as a tribute to its role as a de-facto standard and its global deployment.

The GUTS approach (generic unified typing system) leverages off multi-year research at our hypermedia learning group. It is based on two principle approaches which realize the above-mentioned four requirements:

Requirements 3 and 4 are met by the *WebStyle* approach to hypertext typing concepts in the WWW context. It is implemented in Java and features full HTML conformance. *Openness* in the above sense is the key prerequisite for meeting requirement 1. It is achieved by introducing ontologies for all parts that have to be open. E.g., if the system should be open with respect to instructional theories, there has to be an ontology-WebStyle which explicitly specifies a vocabulary (conceptualization) for expressing specific instructional theories.

The reader may not yet grasp how the introduction of an ontology might lead to support for a certain lifecycle phase or an instructional concept, nor how WebStyle typing actually works. To this end, the authors decided to introduce details of their concept by way of example, rather than by describing abstract architectures or models.

3. WebStyles and Ontologies

The key to understanding GUTS is its way of representing knowledge. In the teaching context, *knowledge* means i) *content* of courses, ii) *context*, i.e. the entities involved in the teaching-learning situation (e.g. learners), and iii) *meta-information*, i.e. information about i and ii (e.g. a particular structuring of content). All three kinds of knowledge are represented as WebStyles. This is why GUTS is *generic* and *unified*. Below we first explain how knowledge is structured and represented in GUTS. Then we briefly introduce WebStyles and examine the GUTS lifecycle based on a toy example course about the astronomer Johannes Kepler.

aspect	**formalized sentence (HT structure)**	**meaning (learning system content)**
static	Node A has exactly one link to node B.	Kepler has exactly one mother.
dynamic	Link L is only visible if B contains R (user-model variable B represents the learner's background, content information R states required knowledge).	The thermodynamic implications of Kepler's second law are only shown if the learner has 'enough' background in physics; other learners are not bothered with this link to minimize the cognitive load.

Knowledge Representation: WebStyles, Semantic Networks, Graph Grammars. The principal mechanisms for knowledge representation and inference in GUTS are rooted in the fields *semantic networks* and *graph grammars* (see for example [Sowa 91] and [Rozenberg 97], respectively): The basic underlying data structure is the *Graph*. Our extended notion of Graphs, called *WebStyles*, comprise a grammar for expressing both *static* (syntactic, structural) and *dynamic* (semantic, navigational) aspects. The table above gives just one example for each of these aspects, relating to both hypertext structure and content.

Structuring the Knowledge Space: Ontologies, Types. Knowledge representation involves *classifying* the 'things' to be represented, e.g. «Mars» is a «planet», «next» is an «order relation», «is a» is a «genus-species relation». Ideally the *classes* (concepts, types) are explicitly written down and put in relation with each other. This is called a theory, conceptualization, or an *ontology*. (More technically one would call it a *type system*. Ontology as a part of philosophy is the study of being, or, the basic categories of existence. With the indefinite article, the term "an ontology" is often used as a synonym for a taxonomy that classifies the categories or concept types in a knowledge base. [Sowa 91])

There are ontologies for 'everything'. For instance, in instructional design, if one wants to use Gagné's events of instruction [Gagne et al. 92], he could define an ontology containing «gain attention», «indicate goal», «recall prior knowledge», «present material», «provide learning guidance», etc. Or, to be able to talk in terms of Reigeluth's elaboration theory [Reigeluth 87], one needs «fact», «concept», «principle», and «procedure».

In these examples we did not consider any relations and formalization of semantics. If one tries to work out these aspects, it soon will be evident that something crucial is missing: *How* can such an ontology be defined? In which language? The answer in our context is: using a particular, built-in ontology. The GUTS *representation ontology* is rich enough to capture the computational content of new, user defined ontologies.

Ontology-WebStyles (WebStyles representing ontologies) are more than plain vocabulary for objects and relations since rules and procedures as offered add meaning (semantics) to the vocabulary. Hence an ontology-WebStyle specifies values and operations on these values; i.e. it is a type. This is why GUTS is a typing system.

4. WebStyles and Lifecycle by Example

4.1 Introduction

WebStyles are based on work about "genericity and dynamics in hypertexts" [Richartz 96]. They consist of three parts: generic nets, procedures, and rules. Generic nets are in essence graph grammars (cf. [Rozenberg 97]) represented as graphs. An overview of the symbols used with WebStyles is shown in [Fig. 1].

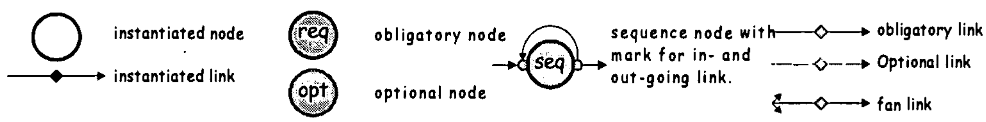
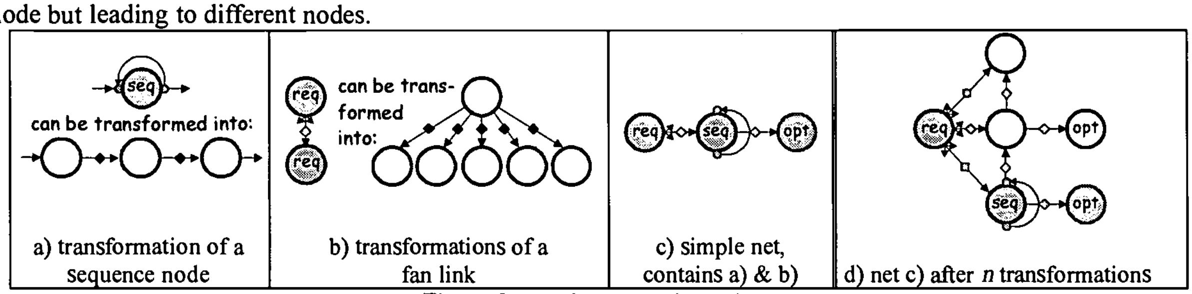


Figure 1: WebStyle symbols

Transformations: Two kinds of transformations have to be discussed in more detail for WebStyle nets: the instantiation of "sequence nodes" and "fan links". Intuitively spoken, i) a sequence node expands into a "chain" of nodes and links of arbitrary length; ii) a fan link expands into a "bunch" of links originating from the same node but leading to different nodes.



a) transformation of a sequence node | b) transformations of a fan link | c) simple net, contains a) & b) | d) net c) after *n* transformations

Figure 2: WebStyle transformations

In [Fig. 2 a)] some transformations have been applied to a sequence node. In [Fig. 2 b)] a possible transformation of a fan link is shown. In [Fig. 2 c)] a net consisting of three types of nodes (required, sequence, optional) and two types of links (fan, required) is presented. By applying the transformations introduced in [Fig. 2 a)] and [Fig. 2 b)] to this net and mapping some generic nodes to instantiated nodes, the net shown in [Fig. 2 d)] can be constructed. As to the semantics of generic nets, note that all instances derived from the sequence node might lead to the same "opt" node - details like these can be controlled, e.g., via reserved attributes.

To find out which nodes and links are affected by a transformation, the so-called chain-algorithm is used. This algorithm defines which nodes and links belong to a chain and, in a first step, marks them. In a second step all the marked objects are instantiated and connected to the original net.

Attributes and Advanced Concepts: Each WebStyle object has attributes like a name, a lower bound and an upper bound. The bounds for example are used by the transformations and define how many nodes or links can be instantiated. Besides default procedures (like *isTraversible* which tells if an object may be traversed) user defined procedures and rules may be attached to nodes and links. These procedures and rules may influence the construction of and the navigation in such a net. Two more types of objects are supported: *alternatives* and *meta-nodes*. Using alternatives, the author of a WebStyle can choose from different possibilities during construction; meta-nodes help to model hierarchies. For a more detailed description see [Richartz 96].

4.2 The GUTS Lifecycle

We will now examine the GUTS lifecycle, developing a toy course about the astronomer Johannes Kepler. (We concentrate on the process and not on the underlying WebStyle.) Usually lifecycles start with a *requirement analysis* and end with *evaluation* and *modification*. We omit these phases in this presentation: *requirement analysis* is skipped because it is less formal (e.g. for the Kepler course: "A small example course that demonstrates some of GUTS properties, possibly with some relation to the university of Linz."), and *evaluation* and *modification* are left out for the sake of space.

It is important to mention that the different phases are potentially carried out by different people: domain experts, instructional designers, didactic experts, teachers, learners, media experts, and programmers. Substantial progress can be achieved if course authors can (re-)use expert knowledge, i.e. didactic knowledge that was written down by didactic experts, or pedagogical patterns identified by instructional designers, or content processed by domain experts.

Instructional Analysis — The Learning Situation's "what?". We start with instructional analysis in order to familiarize the reader with the goals. The context used is an astronomical introduction to our solar system. [Fig. 3] shows artifacts of the instructional analysis in a well-known hierarchical style (expanded and collapsed entries are shown, indentation expresses substructure). The ontology for the goal structure is quite simple, we have just one object, *goal*, and one genus-species relation, *subgoal*. [Fig. 4] shows a WebStyle notation for this example.

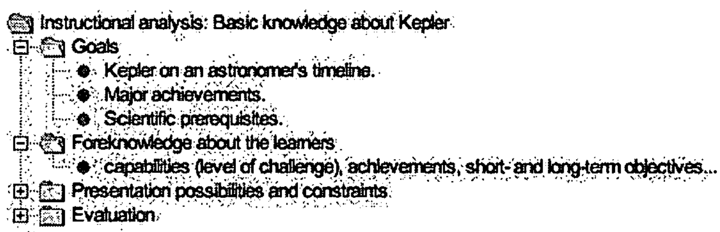


Figure 3: Instructional analysis for the Kepler course.

Figure 4: WebStyle: Goal structure.

Domain Analysis — Collecting Content. This phase deals with the task of providing content and content meta-information (information about the content) for a specific domain model. Such a model should be *objective*, in contrast to the outcome of other lifecycle phases (e.g. goals of a course) to maximize possibilities for *reuse*.
For a actual learning material, knowledge from several domains can be used. Each domain has its own ontology. E.g. learning material on our solar system may use the domains astronomy, space aviation, physics, geography, history, etc. In [Fig. 5] we show a fragment of the corresponding domain analysis.

Learner Modeling — Individualizing Courses. As mentioned in the introduction, the pragmatic constructivist approach to instructional theory recognizes that each individual has a distinct learning process. The "failure" of ICAI showed that it is virtually unfeasible to *automatically* individualize learning material in order to match *each* learner's cognitive model.
On the other hand there is the need of adapting courses to match the information needs of the learner. The learner model captures parameters that may be used to individualize courses, and the author may provide explicit information about how to make use of them. To cope with the rising authoring effort, GUTS provides means for reusing didactic knowledge represented as WebStyles. A simple example for such a parameter is the «learning

history», a list of courses (or parts of courses) the learner has worked through. For other parameters see the 'foreknowledge about learners' in the example for the instructional analysis.

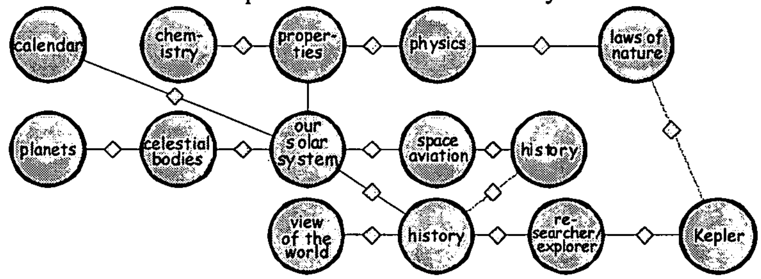


Figure 5: Domain analysis for the solar system

Instructional Design — The Learning Situation's "how?" (conceptually). The structure (WebStyle) created during the instructional analysis must be augmented with operational goals, instructional strategies, pedagogical patterns, and presentation strategies. The augmenting process can be guided by strategies formulated as WebStyles (see [Fig. 6]). Depending on meta-information, some automatic generation is possible.

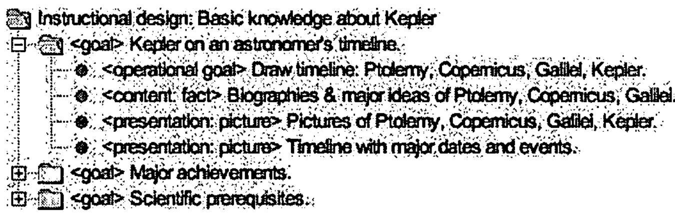


Figure 6: Hierarchical view of the instructional design for the Kepler course.

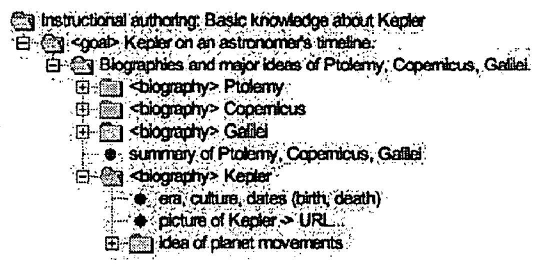


Figure 7: View of the instructional authoring of the Kepler course.

Some ontology information is included in French quotes.

Instructional Authoring — Linking to Content (how realize the "how?"). The structure (WebStyle) from the instructional design must be linked to content, and instructional transactions and presentation details are specified. As in the design phase, WebStyles may guide the task. [Fig. 7] shows an example. The entries for which content exists are augmented with a link to that content, e.g. the entry 'picture of Kepler' can be linked to URL http://www.idv.uni-linz.ac.at/kepler/kepler_bild.gif.

User Annotations. All users (learners, teachers, instructional designers, etc.) can add annotations to the learning material which they are browsing through. They can share the annotations with others or set up *rules* that modify the material depending on annotations. As an example we could imagine a rule expressing that all things which Bob has annotated as being «important» are emphasized (displayed in red color, or played louder if it is an audio stream; in this example, the appearance changes but not the structure).

Temporal Order of the Lifecycle Phases. Domain analysis and learner modeling can proceed in parallel with the other phases. The remaining phases are more or less sequential: requirements, instructional analysis, instructional design, instructional authoring, user annotations, evaluation, and modification. Transformations can be applied in and between all phases, and iterations and validation phases may be added "everywhere".

5. WebStyles Implementation

A first prototype was implemented using JavaScript 1.1. It was capable of dealing with nodes and links, it even implemented the chain-algorithm on a very basic level. The most serious drawback of the prototype was the lack of a proper user interface, so a lot of activities had to be done by hand. Java was chosen as language for the second prototype. The Java prototype features graphical editing of WebStyle nets (this includes manipulation of the graph structure and the objects) and implements the complete chain-algorithm. The prototype is loosely based on the Dexter hypertext reference model [Halasz, Schwartz 94] and is divided into two main parts: the user interface, residing in the class WebStyleEditor, and the WebStyle engine. The engine manages the hypermedia objects and defines a well formed interface, which is only listed partially in the UML diagram. The Prolog interpreter in the diagram is used to evaluate the Prolog rules.

Prototype. In order to demonstrate the prototype, a small part of the domain as introduced above is modeled with the editor. In [Fig. 8 a)] one can see a generic net which models the main characteristics of a biography; it consists of an overview node *Biography*, a node for the birth and an optional node for the death of a person. In addition, a biography contains some major sections (modeled as a sequence node) which can for instance be mapped to major periods in the life of a person. Each section may have *n* dates. Furthermore a person may write publications which have *n* dates of their own.

[Fig. 8 b)] shows the net after some transformations: some nodes and one fan link have been instantiated.

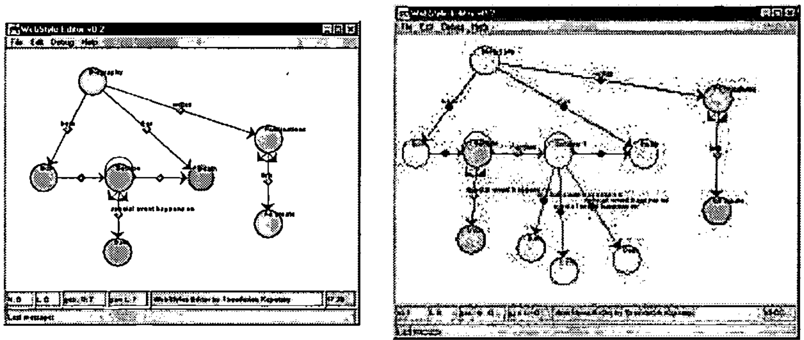


Figure 8: Screenshots of the prototype, a) the starting net; b) after some transformations

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Group Learning Environment
Linking Synchronous and Asynchronous Learning

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Abstract: The style of computer based educational systems has been changed from individual learning to group learning, cooperative learning, collaborative learning and so on. In the viewpoint of architecture of the computer based educational systems, network typed educational systems have been developed using network and multimedia technologies. We are currently developing an educational system called LEA: Learning Environment with Agent which has the features of both synchronous and asynchronous group learning environments. This paper describes the design and features of LEA.

1. Introduction

Recently, the learning style which computer based educational systems deal with has been changed from individual learning to group learning, cooperative learning, collaborative learning and so on. In the viewpoint of architecture of the computer based educational systems, network typed educational systems have been developed using network and multimedia technologies. Watanabe et al., whose work is called the Global Classroom Project [Watanabe et al 1995], introduced Internet applications into classes at junior high schools in Japan. Nakabayashi et al. developed an educational system using WWW (World Wide Web) [Nakabayashi et al 1995, Soga et al 1995]. Ayala and Yano developed a CSCL system called GRACILE which supports communications by software agents[Ayala & Yano 1994].

The purpose of these works is to develop computer based educational systems which offer group learning environments. Since discussion among students is the most substantial part in all group learning processes, it is very important for the educational systems to have functions for supporting communication. These functions are classified into two categories: one offers the means of communication and the other supports smooth discussion. CU-SeeMe is an example of the former. The discussion supporting system called iDCLE developed by Inaba *et al.* [Inaba & Okamoto 1995] is one of the latter examples.

In general, communications are classified as synchronous and or asynchronous. The former type is realized by using synchronous communication tools, and the latter type is realized using asynchronous communication tools such as electric mail, electric bulletin boards, and so on. The aim of most existing communication tools is to support only the synchronous type. Group learning environment are classified in the same way as communications. Students can learn more effectively in a synchronous group learning environment than in an asynchronous group learning environment, because they can exchange their opinions, ideas, and so on through real time, interactive communications. However, synchronous group learning environments have a serious problem with schedule management. While students in an asynchronous group learning environment do not need to manage their schedules. So this is a point where asynchronous group learning is superior to synchronous group learning. Students may learn in both types of group learning environment according to their needs. Therefore educational systems for group learning environments should support both synchronous and asynchronous types.

Group learning progresses through discussions among the students. So the quality of discussions among students significantly influences the effectiveness of group learning. Since the discussions are more effective if each student can grasp their understanding level, we propose a new student model called Public Student Model (PSM) which makes students aware of it. A student model of ITS (Intelligent Tutoring System) does not make students aware of their understanding level. With respect to this, PSM is different from student models of ITS that do not provide this information to students.

We are currently developing an educational system called LEA: Learning Environment with Agent which has the features of both synchronous and asynchronous group learning environments. This paper describes the design and features of LEA.

2. Group Learning Environment

This section describes the features of group learning environment. From the viewpoint of a student who is participating in learning environment, some other students exist in the group learning system and do not in the individual learning system. A student has educational interactions with other students in order to promote learning. Therefore, communication among students is important in a group learning environment.

2.1 Differences between individual learning and group learning

In a group learning environment, students can use the knowledge of other students as a human educational resource that does not exist in an individual learning environment. Therefore, to get the knowledge of other students, discussions among students are essential, and through the discussions, they can learn the subjects at hand more effectively.

Group learning environment progresses via interactions among students. Other students could act as a human educational resource according to their understanding level. In this point, they are different from the traditional resources such as textbooks, dictionaries, and so on. In order to get the understanding level of other students and to behave educationally, a student must present their own opinions and points that s/he does not understand. Therefore, the discussion among students are very important in a group learning environment. The quality of communications among students influences the quality of group learning, because the main difference between an individual learning and a group learning environment is the existence of other students. This feature is the basis of the advantages of the group learning environment.

2.2 The classification of group learning according to the style of communications

In a group learning environment, communications are important. As described above, communications are classified into two types: synchronous type such as a video conference system, a chat application, and so on, and asynchronous type such as electric mail, electric bulletin boards, and so on. Group learning environments are classified according to the type of communications used as synchronous group learning environments, or asynchronous group learning environments, because the discussion among students is most significant feature in a group learning environment. Table 1 shows the features of each group learning environment.(GLE means Group Learning Environment in the table) .

Table 1: Features of synchronous and asynchronous group learning environments

	Synchronous GLE	Asynchronous GLE
Learning style	tends to *Collaborative Learning*	tends to *Individual Learning*
Schedule management	necessary	not necessary
Response time	short	long
Quality of communication	good	bad

Synchronous group learning environments tend to have the style of collaborative learning in which members of the group collaborate with each other solve problems by means of real-time, interactive communication. On the other hand, in asynchronous group learning environment, a quick response from each student cannot be obtained. Therefore a student learns asynchronously with others, when they need others' helps. it is also difficult for students to communicate well in asynchronous group learning environment, because few cases hold common contexts of students' utterance each other, response time is long and so on. However, students do not need to manage their schedules in an asynchronous group learning environment. On the other hand, students in synchronous group learning environment must manage their schedules, and this management becomes more difficult as the group size grows.

3. Public Student Model

In general, the more deeply each student can grasp the understanding level of other students in the same learning group, the more efficient the group learning becomes. Focusing on this point, we propose a new student model called PSM: Public Student Model which allows students to grasp their understanding level.

3.1 Grasping other student

A student can learn effectively in a group learning environment, if s/he can have many opportunities to interact with other students. In this case, other students behave as a human educational resource for the student. However, this human resource is not the same as the traditional representative resource such as textbooks, dictionaries, and so on, because the former resource can behave educationally by grasping their own understanding level and that of other students. In other words, other students are a flexible and adaptive resource. We especially believe that it is important to grasp the understanding level of other students in order to behave as good human resource in group learning environment. Recently, many CSCL systems have been proposed and developed, but there are few CSCL systems that emphasize on this point.

Focusing on the point described above, we propose to open each student model that represents the understanding level of a student in a group learning environment to other students. General student models in ITS and so on can only be referred to by the educational system to identify and infer the understanding level of student[5]. Our approach provides students rich information necessary to grasp the understanding level of other students. PSM has the database which stores the information, and all students in a group learning environment can access this database.

3.2 Information about student in PSM

PSM consists of the following modules that store the student information and are accessed from other students in a group learning environment: (1) an understanding model, (2) a learning history, and (3) a question database. The understanding model presents the understanding level of student. Other students can access this model freely so that they can easily grasp what understanding level the student has already achieved. In addition, a student can also access their own understanding model. This suggests a possibility for the student to use it for her/his reflection and then amend his/her own knowledge by her/himself, although our current system does not help students with this task.

The learning history holds the sequence of the student's actions. Tracing the learning history, other students and also the system can identify the cause of errors and misunderstandings by the student.

The question database is also open to other students. A student can put her/his questions in their own question database. Other students can access this database and put answers into it. In this way, the question database can be used as a temporary memory for asynchronous question and answer.

4. LEA: Learning Environment with Agent

As described in Section **2**, learning environments are classified as either synchronous or asynchronous. We conjecture that learning environments should have the features of both types in order to compensate the defects of each type. Group learning environments that have both synchronous and asynchronous properties allow students to be absent temporarily from the system. To allow the absent student to learn from the results that were obtained during her/his absence, we introduce an agent that plays the role of absent students. In section **3**, we proposed the PSM in order to aid in effective group learning. To satisfy the requirement, we are developing the new learning environment called LEA: Learning Environment with Agent. In the following, we outline LEA and describe its goals.

4.1 System configuration

Figure 1 shows the configuration of LEA system. LEA offers a virtual space and an agent for each student. Every student manipulates their agent to learn in the virtual space. Next, we describe the functions of main modules in the LEA system in the followings.

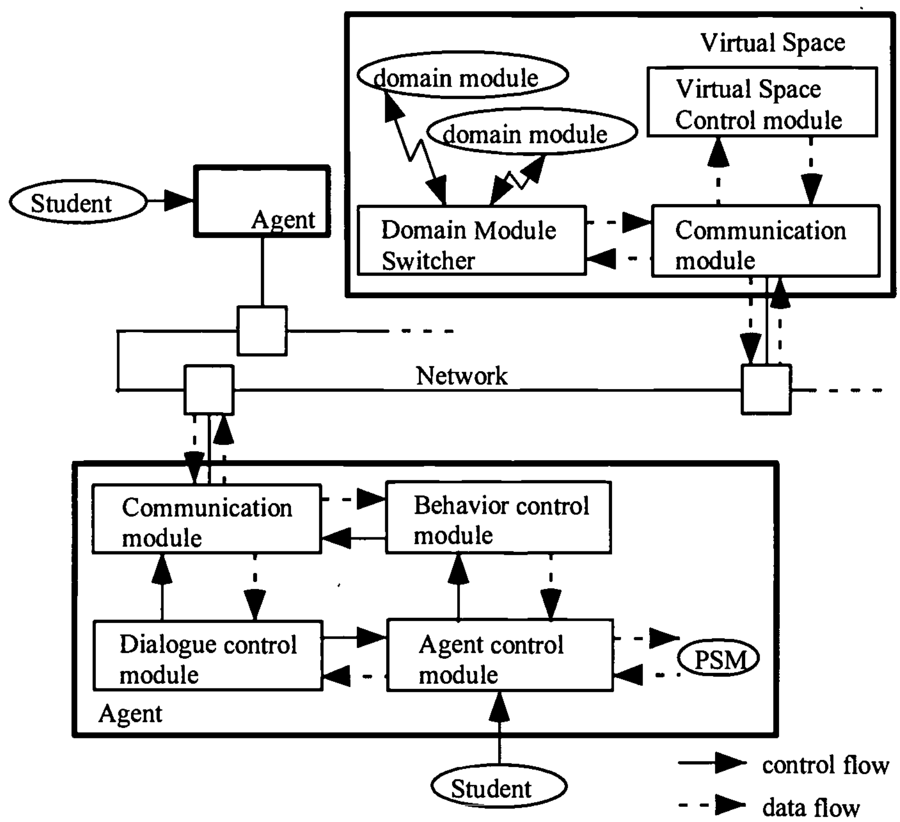

Figure 1: System configuration of LEA

4.1.1 Virtual Space

In the virtual space (LEA group learning environment), every student learns her/him subject(s). There are domain modules in the virtual space. The domain module provides educational tools for specific domain. For example, the domain module for mathematics offers virtual ruler, compass and so on.

4.1.2 Agent

Each agent may be in either marionette or normal mode. In marionette mode, a student can completely manipulates the agent to learn in the virtual space. On the other hand, in normal mode, the agent simulates educational activities an absent student without her/his manipulations. An agent can report the performances taken during the normal mode to the client student, when the student uses LEA again.

4.1.3 Agent Control Module

This module controls the activity of an agent and decides an agent behavior based on commands which the student set in advance. Then, the agent executes educational action of the absent student in the normal mode.

4.2 Learning in virtual space

LEA system contains a shared virtual space and students' agents. Each student has one own agent. Students behave as virtual people in the virtual space. The students gather potential members, make a learning group, and learn their common subject(s) in a classroom of the virtual space. The virtual space provides classrooms for each domain. Each classroom is separated into small rooms based on fields, groups and so on. In this way, the virtual space is structured as a hierarchy of fields, groups and so on. This structure makes it easy for students to look for members and groups interested, because LEA is not a domain dependent system and group learning about some domain is feasible in the virtual space offered by LEA. In addition, LEA has a function to show the members of each group and the theme to be discussed. Figure 2 shows an example LEA virtual space.

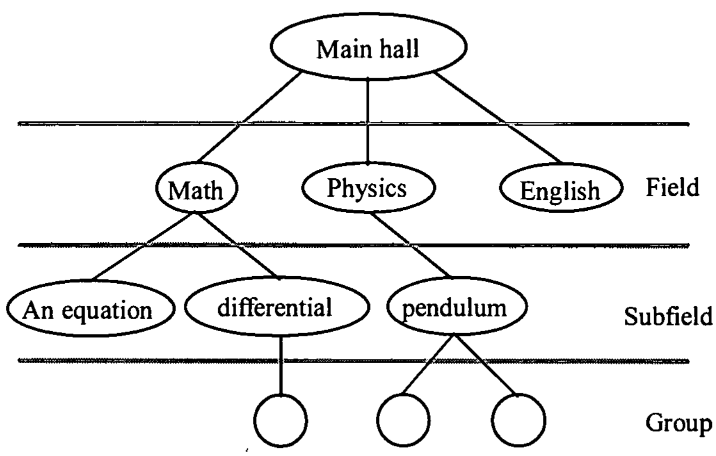

Figure 2: LEA virtual space

4.3 Learning through agent

An agent has two modes: marionette and normal mode. Students can use these modes according to their needs. In the marionette mode, manipulating an agent, students gather potential members, form a learning group, and learn subject(s). In this mode, they learn synchronously. On the other hand, in the normal mode, an agent supports students who cannot participate synchronously. In this mode, an agent asks questions and participates in the group learning which is selected by the absent student. The agent reports the contents of thhe learning sessions perform during the normal mode to the client student, when they return to the LEA. In this mode, students learn asynchronously.

In the LEA, students behave as virtual people and the system does not show the personal information of students. Hiding the information makes students evaluate other students properly through their actions in the virtual space only.

We adopt PSM model as a student model for group learning. So, students can use the knowledge of other students by accessing the other students' PSM as an educational resource. Students who participate asynchronously can learn more deeply, since their knowledge is reflected to the group learning.

5. Conclusions

This paper described LEA that supports both of synchronous and asynchronous group learning. In LEA, students can learn in the virtual space. LEA makes possible to bridge between synchronous and asynchronous group learning, since students can learn synchronously and asynchronously by using agent in two modes. We have proposed PSM which is a student model for group learning, and adopted it in LEA. Students can discuss effectively, since PSM makes their level of understanding available to other students. However, we have some problems with PSM and LEA that remain to be solved are described.

PSM inherits the same problems which traditional student model has, such as how dose the system generate excellent model, how does problems to solve the model. Besides, there are problems with to get the necessary information to make PSM from discussions among students and how to model students, how to represent the understanding model so that other students can grasp the understanding level of a student. Developing LEA has two big issues. The first problem is how to realize behavior of an agent in the normal mode. It is desirable to have the behavior of an agent in the normal mode be the same as behavior in the marionette mode. Although, it is hard to make such an agent completely by employing state-of-art AI technologies, we are currently considering the alternative method using current technology. The other problem considers LEA group learning environments where students participate synchronously or asynchronously, simultaneously. In such situations, the existence of students who participate asynchronously in Synchronous Group Learning may confuse other students who participate synchronously. We will consider this problem through experiments with a prototype of LEA. In this way, as our future works, we will solve those problems of PSM and LEA, and consider the learning style bridging synchronous and asynchronous group learning.

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Supporting Ill-structured Problem Solving in Interactive Multimedia Learning Environments

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Abstract: The convergence of technologies that allow the representation of ideas in many different media formats (data, text, graphic, sound and video) and the growth of constructivist approaches to learning has created new challenges for learning software development. The applications increasingly incorporate more production–focussed learning strategies. Typically instructional designers have accessed models that were devised within a behavioural approach to the learning task. Many of the popular instructional design models do not reflect this change in philosophical orientation and suggest anything more than a process. This paper describes how an award–winning interactive learning product, developed within a constructivist paradigm incorporating problem solving challenges for learners (including both task/deductive and data/inductive driven scenarios), is used in classrooms.

Introduction

The convergence of technologies and the growth of constructivist approaches to learning have created new challenges for learning software development. Typically instructional designers have accessed models that were devised within a behavioural approach to the learning task. Many of the popular instructional design models do not reflect this change in philosophical orientation and do not suggest anything more than a process. Recent proposals [Jonassen and Tessmer, 1996-7] seek to re-focus attention on learning outcomes and suggest new tactical guidelines for developing technology supported constuctivist learning environments. This paper describes how an award–winning interactive learning product incorporated cognitive tools and problem-solving challenges for learners, including both task/deductive and data/inductive driven scenarios, has been used in a classroom. It presents the results of a study to investigate the use of several cognitive tools which were devised to support learners when they were faced with complex scenarios (ill-structured problems), which might have multiple "correct" solutions [Jonassen, 1997].

Constructivist learning environments with embedded cognitive tools make assumptions about the actions of learners. [Hannafin and Land, 1997] have identified the lack of understanding of the problem solving and data exploration processes that learners undertake in such environments; and the motivation that learners might have to complete tasks. Hannafin has proposed that learners need to constantly apply a theory-action model as they investigate issues and view data, that is, they will develop a theory about the solution to a problem or about data access, and take action to test that theory. We sought to investigate the theory-action model through setting a structured and ill-structured problem solving [Jonassen, 1997] and log the construction of ideas by collaborative pairs of students.

Exploring the Nardoo: A Constructivist Learning Environment

The approach used to develop *Exploring the Nardoo* has been supported by close links between classroom teacher practice, innovative software tools, and learning strategies, which allow students to construct their solutions to the challenges posed. *Exploring the Nardoo* is a software package that provides a dense information landscape of resources based on general issues in ecology. The resources provided consist of a number of different media formats (data, text, graphic, audio and video). Additionally, a number of tools are provided to assist learners in the collection and manipulation of those resources such as: simulators;

measurement tools; a media viewer; a Personal Digital Assistant (PDA) for resource collection and note-taking; and, a Text Tablet for manipulation and editing of information collected [Harper *et al*, 1995]. The purpose of the package is to engage students in long-term studies using the skills of problem solving, measuring, collating, elaborating and communicating. The package was designed for high school use, for students aged from 14 to 18 years, and is based on current Australian state and national curriculum documents for Biology and Geography.

The information landscape design of *Exploring the Nardoo* uses spatial and geographic metaphors: a Water Research Centre and a navigable fictitious river environment. On entry to the environment, users are challenged by three researchers in the Centre to help them solve problems and carry out investigations on the river. The challenge posed by the researchers encourages active learning and supports students to construct their ideas in teams from measurements taken, resources reviewed, maps interpreted and data analyzed. By providing a metaphor easily linked to the real world, students are encouraged to apply scientific concepts and techniques in new and relevant situations throughout the problem-solving process within this ecology-based application. In so doing, the learner is likely to become more interested in developing questions, ideas and hypotheses about the learning experiences encountered. A broad range of investigations are presented to the user and include issues such as fish dying from pollution, weeds infesting the river, and communities discussing farming practice.

Students need to extract ideas and information from what can often be a complex and bewildering array of resources. Software applications (tools) to help with this task should be readily accessible for both extraction of information and for representation of ideas and information. Recent research on learning endorses the use of such mechanisms to facilitate and support learning [Lajoie and Greer, 1995]; especially in conjunction with existing and new interactive multimedia titles. The study sought to investigate how school students use complex cognitive tools to solve task/deductive and data/inductive problem scenarios.

Phase I: Two Classroom Experiences of a problem-based package

In order to gain awareness of the types of cognitive tools that might assist students, the researchers needed to develop an understanding of the way students use the range of tools currently available in *Exploring the Nardoo*. The first two phases of the study were intended to investigate student use of the package in two different modes. Both studies took place in Science classrooms at Smith's Hill High School in Wollongong, New South Wales. The first study was intended to observe students using the tools and to examine their solutions to a number of different problems in a classroom setting that offered a constructivist learning environment. The second phase of the study involved students being oriented to the tasks in two different ways; setting the problem in a structured framework and setting a task that was ill-structured.

In phase I, the researchers had access to two classes (n=47) of year 11 Biology students. Prior to the first class in which *Exploring the Nardoo* was introduced, members of the research team met with the teachers to discuss the roles of the teachers and researchers in the classroom and develop a strategy for using *Exploring the Nardoo* for the subject. It was decided that students would work in pairs (where possible) and be asked to complete one of the investigations in the package. Additionally, teachers were asked to take the role of mentors, helping students with any difficulties with the package and essentially limiting instruction to classroom management. Phase I was implemented in the classroom over a two week period and consisted of a total of eight hours exposure. At least one member of the research team was present at each lesson to provide technical assistance and observe the implementation process. Data collection consisted of observations of students using the package, a group log book that was to be completed at the end of each session, electronic versions of the PDA and writing tablet for each group after each session, final student reports and teacher interviews. Students were also asked to draw up a knowledge map of the package after their second lesson and their final lesson to gain insights into the students understanding of the package structure.

Observations of Student use of the Package

Student groups were asked to fill out a log book on a lesson-by-lesson basis to record what they did during that lesson and what they would do the next time. The log books were not well used, with most students preferring to record their ideas for the next session in their electronic note book, and abandoning the use of the log books after the first few sessions.

Initially, many of the student groups went directly to areas of the river and began to explore by clicking on the highlighted sections. A few groups explored the Water Research Centre in depth. Students often used the search engine/computer database as method of collecting information. In the first lessons, student groups played the sound and video files. Many student groups experimented with editing the text font, size and colour in their Text Tablet and PDA. Some groups minimized the PDA and moved it around the screen so as much of the river system or Water Research System could be viewed as possible. As the groups progressed the groups became more involved in completing the investigation, they made more use of the linked media, examining the text as well as the visual and audio components and focused on resources that would help with their solutions in an organized way.

Analysis of knowledge maps

Knowledge maps were analyzed qualitatively with attention to such attributes as the format (use of text, pictures or, concept map structure); concepts about *Exploring the Nardoo* (i.e., identification of: information resources; tools; environmental issues; river segments/time zones); learning process; and, "reviews" of the package. Not all students completed a pre- and post- instruction knowledge map. Many of the students noted the resources, tools, time zones/river segments and issues in their knowledge maps. There were not clear differences between the first and second maps in terms of these concepts.

In summary;

- Often times, the environmental issue aspect of the package was identified on the map by a specific problem (e.g., fish kill, pollution, water management) rather than the content.
- The concepts about the tools in Exploring the Nardoo were also specific to particular tools or action of using the tools (e.g., measuring, note taking). Tools most often mentioned were measurement tools and the PDA. One student mentioned the computer when describing "appropriate search engines are available so as to obtain this information".
- A number of information resources were mentioned by many of the students including the files in the cabinet, audio and video files, pictures and descriptions of plants and wildlife, and newspaper articles.
- Many students noted the concept of the river segments and time zones in the landscape of Nardoo.
- Only two students specifically mentioned the researchers in the Water Research Centre.

For some students, it was apparent that they were aware of the learning process embedding in the package and the learning process involved in using *Nardoo*. For the most part this is apparent in the second knowledge map (i.e., after students have been though the process of the investigation). However, a few students noted this in their first map.

Some students commented on the use of the information in the Nardoo to "make conclusions" or "formulate your own ideas on what you think of the changes" or "help understanding of the issues". Furthermore, a few students noted that the package is a "learning aid" and that it "makes you think instead of thinking for you". One student went so far as to note the concepts of open and structured learning when she described that students can "simply explore the Nardoo and take notes or you can choose an investigation". Some students mentioned the concept of the virtual experience with such descriptions as: "hands on experience"; "simulated excursion"; "exploring an imaginary place but learning about real issues"; "develop research skills without going out and physically measuring" and, "designed to give high school/tertiary students a 'feel' of what responsibilities and duties an Environmental Scientist/Biologist is responsible for/incurs during their day-to-day work".

Teacher Interviews

After the conclusion of the implementation of the learning activity in the classroom, members of the research team interviewed the two teachers individually. After reflecting on the process of the learning activity and reviewing the student group reports, one teacher believed that the students collected all the relevant resources but felt that, when it came down to putting it together and making all that abundance of information something more concise, the students had difficulty. She explained that even though she reminded her class "don't just copy slabs of information and regurgitate it in your report, make sure you read it , understand it, relate it to a question", based on the student reports presented, she felt that she could have reinforced this concept of analyzing the information more. She commented that she was impressed with the speed at which students engaged in the activity and the range of ways they used the package, and suggested that, the next time she used the Nardoo for a learning activity, she would provide more direction or assistance on how to handle the information collected.

The other teacher also believed that the students picked up on how to use the package quickly and made good use of most of the resources. However, he believed that the students could have made better use of the measuring tools . He noted that the students tended to just copy measurements into their notes and rarely analyzed the measurements.

Phase II: Concept Mapping and Problem Structures

The outcome of phase I led us to understand that, while students have no difficulty navigating through Nardoo and collecting information, they do have some difficulty in synthesizing the information and arguing for a solution. The research team decided to provide students with a concept-mapping tool, Inspiration, as a cognitive tool for argument development. The focus of this phase of the research was to understand differences in how students use *Exploring the Nardoo* when given either a structured or ill-structured problem task. This phase was implemented in the classroom for a two week period, amounting to eight to nine hours of exposure for each student. At least one member of the research team was present at each lesson to provide technical assistance and observe the implementation process.

The students in phase II came from an Environmental Studies elective class (n=22) for year nine and ten students. It was decided that students would work in groups of two. Half the class was given a structured problem (Blue-Green Algae) and half the class was given an ill-structured problem (Water Plants and Weeds). To facilitate this, a special version of *Exploring the Nardoo* was pressed with the investigations button disabled. An instruction sheet for each of the structured and ill-structured problems was developed. Both instruction sheets explained that students were to: analyze the problem and write a report that clearly identified the problem and argued for potential solutions to the problem in the region. They were also asked to produce a concept map of their solution.

Concept Map Analysis

The concept maps were reviewed both qualitatively and quantitatively. Measures of the concept maps were calculated [Ferry *et al*, 1997] and scores ranged from 39 to 143, with the structured problem students averaging 96, and the ill-structured problem students averaging 55. It was noted that:

- Groups with the structured task tended to categorize the concepts into causes, impacts and solutions.
- Some groups with the ill-structured task had difficulty defining the problem; two of the five groups with the ill-structured task identified a number of problems (e.g., weeds, chemical pollution, logging,) in the area of the river system.
- Groups with the structured task were more likely to include specific solutions to their problem than those groups with the ill-structured task. Of the six groups with the structured task, five included specific solutions, while only two of the five groups with the ill-structured task included specific solutions to the problem on their concept map.
- Male students tended to use single or few words for concepts while female students were slightly more descriptive and detailed in their concepts.
- Two groups with the ill-structured task seemed to have pasted chunks of text from their report into the concept map.
- Females in both the structured and ill-structured task groups tended to create traditional, tree-structure concept maps. Males in both the structured and ill-structured task groups did not use a tree structure but tended to compartmentalize concepts in a more loose structure.

There is evidence of gender issues that will need to be investigated in further studies.

Student Work

Student groups were asked to save their work in a unique file after each lesson. These were analyzed to understand which resources were collected and how those resources were utilized to support the students' final argument. Students with the structured task tended to focus on the radio, television and newspaper information resources while students with the ill-structured task were more likely to collect all the resources on their problem including information about plant and animal life which related to the area of the river being investigated but did not relate to the problem to be solved. Students with the structured task tended to manipulate the information collected at a very early stage in the learning activity (within the first three lessons) while the complete raw information resources appear in the files of the students with the ill-structured task until the last lessons of the learning activity. The final report was marked by an experienced teacher, who evaluated them in terms of quality of argument, overall quality of their answer, use of inferences and use of concrete supporting details. The marker found that overall, students who attempted the structured task produced higher quality work in terms of related resources and solutions to the problem.

Student Interviews

Each pair of students was interviewed about their use of *Exploring the Nardoo*. In response to the question: "Did you find it difficult to solve the problem?" none of the groups, who had the structured task, found it difficult to solve the problem. Most mentioned that all the information made it easy to solve the problem. One group with the ill-structured task in their concept map identified a number of issues rather than one specific problem, and mentioned that there were "lots of small problems but not one problem to solve".

When asked the question 'How did you go about solving the problem?' most students mentioned that they first went to the river to explore but collected most of their information from the Water Research Centre. Groups with the structured task (blue-green algae) mentioned returning to the river to take measurements. Two of the groups with the ill-structured task, who had difficulty both identifying the problem, and generating a solution, noted that they used the concept map in an attempt to solve the problem.

All groups worked out how to use the package though exploration and trial and error (i.e., clicking on things to see what happened). No groups used the help files/videos to get to know the package, although some groups mentioned that a little instruction on how to use the package (e.g., measurement tools) would have been helpful. This information was available in the help menu as a walkthrough movie for all groups.

When asked 'When did you use the concept map?,' most of the groups explained how they first collected information from the package, then developed their concept map, and finally wrote their report. Two groups, both with the structured task, noted that they developed their concept map and report at the same time. Generally, students felt the concept-mapping tool helped them to develop their report. Only one group (with the structured problem) mentioned that they wrote the report before developing the concept map.

Discussion

From the data collected, it is apparent that learners have no difficulty using *Exploring the Nardoo* in general and, more specifically, accessing the information in the package. The navigation was well understood and students' knowledge maps of the structure of the package supported their apparent understanding of the information structure. However, when provided with a structured or ill-structured problem-solving task, students tended to spend time discovering how to use the package and then focused on the task provided. Structured-problem solvers tended to approach their task in an organized fashion, they focused on the resources that supported a solution and constructed concept maps that were clear representations of their solutions. The ill-structured problem solvers tended to spend more time accessing resources that did not directly support problem solution, but did, in the main, identify a problem and possible solution. Their concept maps were not as rich as those developed by the structured problem solvers.

The results obtained from the use of this product in schools have shown that students need to be supported when dealing with complex and many-optioned situations. The learners' skills required to work effectively within these environments have been shown to require an understanding of idea construction tools, such as concept mapping and their abilities to re-focus and extend their information is critical in success. Several of these learning environments have been constructed to allow the representation of ideas with not only text and pictures but also dynamic models of relationships between variables, and information displays in multiple media forms. The results also indicate this process can support hypothesis generation, but it may require some more constrained problems before being effectively employed.

In terms of the [Jonassen, 1997] model for the design of ill-structured problem tasks, the students had no difficulties with the early steps in the process. They were able to articulate the problem space and the contextual constraints, and they also identified in greater detail than the structured problem solvers, the opinions and perspectives on the problem. However, as they tried to generate possible solutions and assess their viability they failed to focus their solutions on precise aspects of the problem. It appeared that they did not want to "let go" of the information they had collected. Additional support tools to assist their process to aggregate information and create meaning aggregations would appear to have been useful. Creating groupings and testing the options for best solution "fit" were not really attempted. Most groups simply found the first one that worked. Tools which could suggest options and let students test each option before it was discarded would also be useful.

These further tool development directions would help students to identify patterns, links and similarities in complex information environments. It appears that to support the implementation of elements of constructivist learning frameworks such solution finding tools might prove invaluable [see also Savery and Duffy, 1996]. These tools might also tap into the socio-dialogical approaches to problem solving and support the call by constructivist to facilitate alternative ways of generating understandings rather than the traditional focus upon the printed text.

While interactive multimedia packages that support student-driven exploration and investigation have captured many multimedia designer's imaginations, they have not yet realized the extent of support for the generation of meaning that is required when the task is ill-structured. *Exploring the Nardoo* is an example of a product, which, while providing some cognitive tools to support student investigation and consolidation, works well for the tasks, which are structured, but as the complexity of information and lack of structure increases, some students are unable to identify with what key elements they are dealing. It would seem that cognitive tools which scaffold effective problem-solving will need to be more dynamic, and assist with some procedural what-if sequences.

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Guidelines for Media Selection

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Abstract: Media selection is a key step in the educational design process. We present two types of approaches to media selection: *rational-choice approaches* and *social-influence approaches*. We argue that designers should combine these two types of approaches in a combined bottom-up/top-down media-selection process. Furthermore, as examples of the two types of approaches, we describe two conceptual frameworks: *task/media fit* and *core/complementary media*, respectively. These may help designers in finding a balance between an 'objectively' optimum choice and factors in the implementation context.

1. Introduction

A new machine, a new course... Marian is a training developer in the company that introduces this new machine, and she takes on her task in a thorough way: after analyzing the problem and the task, she uses a well-known model for media selection to decide on the instructional medium. A computer simulation is developed, with a series of built-in assignments, which allows operators to develop insight into the production process and the ways in which they may control this process by using the features of this new machine. Operators may use such a computer simulation independently, in the work place, at those moments that suit them best.
The computer simulation, once ready, yields many positive responses from Marian's colleagues. However, it is never really implemented. Operators do not have any experience with computer simulations, and their managers prefer to send them on a half-day course, from which they return with a file of course materials and a manual.

What went wrong in this example? Something in the introduction process? Or was the media-selection decision not feasible? Media selection: a second example.

Jack develops and gives management and communication training. Role play is a common ingredient: it is effective and cheap to implement. For a new course about managing immigrant employees, Jack develops a number of role plays. Course members take turns to play the roles of, for example, a young Moroccan shop-girl and her manager.
Already the first time that the course is given, the decision on role play as the educational medium does not appear to be such a good one. Course members have difficulties identifying themselves with the role of the foreign shop-girl, and doubt whether they are able to apply the theory from the course materials in their work settings.

Media selection, often it is a decision taken implicitly. "Management wants more computer-assisted instruction", and thus the training design includes CAI. Or it is force of habit that determines the media selection, as in Jack's case. A quite different approach is the systematic, conscious and explicit media selection process. All those media selection models in the literature are there to be used, aren't they? Marian, in the first example above, utilizes such a model. However, the products of both Marian and Jack fail.

In both cases media selection is a critical success factor. In this paper we focus our attention to media selection as one step in the process of educational design. In doing so, we acknowledge that the concept 'media' is hard to define: sometimes hardware aspects are critical in the selection, sometimes aspects of the organization of information and communication – the software. We will not go into this distinction, as this seems not to be a concern of instructional designers in practice.

In this paper we introduce two types of approaches to media selection, of which Marian's and Jack's way of working are examples. Marian's approach is what we call a 'rational-choice approach', while Jack's is an example of a 'social-influence approach' to media selection. The examples above show that neither of the two approaches is superior – the 'truth' will be somewhere in the middle. Where exactly? That is something that instructional designers will best be able to determine themselves, per specific situation for which they have to select media. This presentation does not contain any prescriptions – just because prescriptions do not apply to all cases of media selection: every concrete training situation is different. We are convinced, however, that insight into the foundation of the arguments that designers use (maybe unconsciously) in selecting media will help them find the optimum middle more effectively.
We thus aim to contribute to the toolbox of frameworks, methods and techniques that educational designers use in their daily practice. Besides an introduction to the two types of approaches, we present two specific conceptual frameworks which we have experienced to function well in practice. The framework of 'task/media fit' is an example of a rational-choice approach, while the 'core/complementary media' framework fits within the social-influence approach. In addition, we will argue that educational designers should always combine a rational-choice approach with a social-influence approach, making the media-selection process a combined bottom-up/top-down design process.

2. Rational-Choice and Social-Influence Approaches to Media Selection

Media selection is an important step in the design process for education and training. We distinguish two types of approaches to making decisions on media to use: rational-choice and social-influence approaches [Fulk et al. 90]. For reasons of clarity of our argumentation we will draw the differences between these two approaches more into extremes than is common practice.

Marian's media-selection decision is made according to a task analysis and a model for media selection, and as such is an example of a *rational-choice approach*. Characteristic to rational-choice approaches is [Fulk et al. 90]:
- every medium has fixed, inherent characteristics
- every task can be defined in terms of objective characteristics
- media selection is an independent, rational task
- media selection is motivated by a strive for efficiency

Media selection according to a rational-choice approach is often a matter of finding a best 'fit' between characteristics of the task and characteristics of the medium. In practice, this means:
- media selection takes place for specific educational tasks
- media selection is a bottom-up design process that starts from considering the educational tasks

Rational-choice approaches are often worked out in the form of prescriptive media-selection models. [Reiser & Gagné 82], [Romiszowski 88] and [Sorenson 91] collected a large number of such models. Many of these are in the format of a flow-chart, a matrix, or a worksheet. This makes them look very practical, but the large collection of models indicates that this is not the same as being applicable in a large variety of situations.

Jack's 'unconsciously made' media-selection decision is an example of a *social-influence approach* of media selection. Characteristic to this type of approach is [Fulk et al. 90]:
- characteristics of media and of 'good media selections' are determined in and through a social context, and thus are variable
- social influencing of media characteristics may take place...

- through overt statements of various people (e.g., colleagues) about media characteristics, task characteristics and media selections – statements which decision makers consider in their own evaluations of media characteristics
- if decision makers subsequently express these opinions to their colleagues in the context of specific decision-making situations, thereby making them even more salient
- through vicarious learning, through observations of success or failure of others' media selections
- media selection is not an independent task; however, selections can be rationalized retrospectively for the specific situation to which they applied – thus media selection is a subjectively rational task
- media selection may be motivated by a strive for efficiency, but this does not need to be so.

Media selection according to social-influence approaches is again about finding a 'fit' between characteristics of the task and of the medium. However, unlike rational-choice approaches, various interpretations of these characteristics and of the final decision are considered, all of which are constructed in a social context. This makes media selection a subjective process. In practice this implies that:

- media selection takes place for a larger whole of educational tasks
- media selection is a top-down design process which starts from current ideas about 'good' media selections for the educational setting

In general, social-influence approaches to media selection are not worked out in the form of handy, ready-to-use models. Recognition of social-influence processes, though, may help to rationalize, understand, appreciate, and accept or improve 'practice'.

We have introduced two types of approaches to media selection: rational-choice and social-influence approaches. Next we will discuss two specific conceptual frameworks that each are an example of one of these two approaches, and that offer a limited but useful perspective in the practice of media selection:

- task/media fit (a rational-choice approach)
- core/complementary media (a social-influence approach).

3. A Rational-Choice Approach to Media Selection: Task/Media Fit

The 'rational-choice approach' for media selection discussed below is based on the idea that characteristics of the educational task and characteristics of media used to accomplish this task should be aligned in order to achieve the best 'task/media fit'. The task/media-fit framework is based on 'media richness theory', which has been developed within management theory and communication science (see for example [Daft & Lengel 84], [Daft et al. 87]), and was adapted for educational settings by [Heeren 96].

With regard to the educational *task*, its complexity as a communication task is considered (the form of communication is determined by the educational method). 'Complexity' refers to the extent in which it is necessary to reduce potential differences in interpretations of the task content. Knowledge transfer of a series of concepts is an example of a moderately complex communication task between knowledge source (teacher, book) and learner. Transfer of motor skills is already more complex, which also deals with the communication between knowledge source and learner, but probably much more fine-tuning is required for a satisfactory transfer. Examples of rather complex tasks are negotiation among learners, or collaborative decision making – tasks in which differences in interpretation of case elements existing among participants need to be solved.

Media are considered with regard to the 'richness' they offer. Various dimensions of richness are distinguished, which also differ in importance depending on the specific situation. Examples of medium richness include: an audiovisual medium is 'richer' than a medium that offers audio only, which is again richer than a text medium. Also, a medium that supports direct interaction, such as an interactive computer simulation, is considered richer than a medium that offers feedback only after some time, such as a written test.

In order to derive a good fit, task/media combinations should be chosen within a '*band of good fit*', indicated in [Fig. 1]: complex tasks require a rich medium, for simple tasks a 'lean' medium is a better choice. An example: for a negotiation task a face-to-face role-playing game (rich medium) is a good choice; for knowledge transfer which requires reflection activities in the learner, relatively lean media such as written materials are a good choice.

In practice, often the 'richest possible' medium is selected. Rich media are most often also more costly. If the richness of the medium is not necessary to achieve the learning goal, too much money is spent (*efficiency loss*).

The costs which determine efficiency are measured not only in terms of money, but also in terms of time or effort. For example, adding moving images to a simple presentation is not only more expensive, but also diverts a learner's attention.
In case of a too lean medium, however, *effectiveness loss* may occur. Selecting electronic mail as the only medium for team work on solving a problem, for example, is asking for trouble – the medium is not interactive enough to support this process well, and will lead to loss of quality and effectiveness.

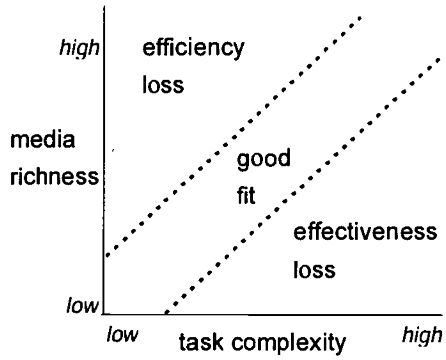

Figure 1: Task/media fit according to media richness theory.

Admittedly, the danger of effectiveness loss should not be overestimated. People have the capacity to easily adapt to a somewhat too lean medium by exerting more effort (a precondition is that they possess the skills to compensate for the lack of richness of the medium). It is interesting to relate this to a motivational and instructional-design aspect: if learners are challenged to utilize their skills, they will be more motivated to fulfill the task and to exert more effort on their task performance, which in turn may lead to deeper processing and, as a result, to better learning [Salomon 84]. Of course, the extra effort should be 'well spent': for example, effort exerted on overcoming the shortcomings of a badly designed user interface does not contribute to learning [Heeren 96]. Furthermore, [Heeren 96] showed that various media may be effective and efficient in a certain situation, or fall within a 'band of good fit'; see [Fig. 1]. Therefore, for achieving optimum learning effect, the leaner of these media should be chosen.
According to the task/media-fit framework in [Fig. 1], for each of the communication tasks within the series of educational tasks of a course a well-fitting medium should be selected. This means that media selection should take place when the instructional design is worked out in detail, often at the same time as the educational method for each task is chosen. Media selection thus is an activity in a bottom-up instructional-design process. The final media mix for a complete course then is the sum of a series of media selections for different educational tasks.
In summary, media selection according to the rational-choice task/media-fit approach is balancing between effectiveness loss and efficiency loss, by choosing a medium that is rich enough but not too lean to fit the complexity of the task. Media selection according to this framework, taking place separately for each educational task within a course, may be characterized as a bottom-up design process.

4. A Social-Influence Approach to Media Selection: Core/Complementary Media

The second conceptual framework which we present in this paper, core/complementary media [Verwijs 98], is an example of a social-influence approach to media selection. Central starting point for the core/complementary media framework is that, in practice, the main medium for a course is often decided in advance, before the instructional-design process starts. Possible reasons for this are, for example, that a certain medium has been used for years already in the particular course or in similar courses; that the instructor is used to the medium; or that the medium selection has been 'imposed' by others (management, a client). The major part of the course will then be carried out through this medium: it is the *core medium* (the 'major' medium) in a media mix.
Limitations of the core medium are then dissolved by utilizing one or more *complementary media*. Using only one medium is often insufficient to attain all course goals; it is more efficient to add a specific medium that is

more appropriate for carrying out particular tasks or reaching certain goals. The educational tasks or goals for which the core medium is not particularly appropriate are then performed or achieved through complementary media.

For example: in recent years computer-assisted instruction has often been used in education and training. In general, these computer programs are very suitable for knowledge transfer, but are not very effective in the teaching of social or motor skills. Different media will need to be used which complement the CAI.

A second example is derived from distance education. Written materials have been the core medium in distance education for many years. With developments in information and communication technology (CAI, WWW, e-mail, computer- and video-conferencing as complementary media), certain course goals can be achieved better without requiring students to travel to face-to-face meetings.

The approach of combining core media and complementary media is not only applicable to hardware (such as selections between television, computer, book), but may also be used for software decisions. For example, if a decision has been made to use CD-I for a certain course (hardware), still decisions on how to design the CD-I (software) have to be made. In this regard a core medium, such as image stills with text, can be taken as a starting point, and the shortcomings of this medium can be complemented by using, for example, moving images and communication media for consulting a remote teacher. Now that multimedia is being used more and more, we expect that decisions on core and complementary media will be made more often on the software level.

Thus, in the core/complementary-media framework, a media mix consist of a core medium and one or more complementary media. The decision on the core medium is not made in a rational way, but is determined by influences of the decision makers in interaction with their social environment. Especially in the case of new technologies, decision makers appear to be sensible for influences from their social environment [Webster & Trevino 95].

The selection of (core) media is made on the course level, in an early stage of course development. In this regard, media selection is a step in a top-down instructional-design process; the selected core medium determines to a large extent the design of the course.

In summary: According to the social-influence approach, media selection is determined in the decision maker's social environment, and decisions are based on their preference and experience. Media-selection decisions are made on the course level and often in advance; media selection may thus be characterized as a design decision in a top-down educational-design process. The medium selected in this way is the core medium in a media mix. Besides the core medium one or more additional media are used to compensate for the limitations of the core media in certain educational tasks; these are the complementary media in the media mix.

5. Complementarity of the Approaches

We have distinguished rational-choice approaches and social-influence approaches, and have discussed an example of both approaches: task/media fit and core/complementary media, respectively. These two conceptual frameworks should be considered as guidelines which instructional designers may use in deciding on media. In particular, we argue that designers should view rational-choice and social-influence approaches as complementary, and should combine frameworks such as task/media fit and core/complementary media. In doing so, their media selection process becomes a creative, heuristic process, in which they combine bottom-up and top-down ways of working. By combining rational-choice and social-influence approaches disadvantages of one type of approach can be dissolved by applying the other type of approach. The approaches thus complement one another [Webster & Trevino 95].

By applying a rational-choice approach such as task/media fit, optimally effective and efficient media selections can be made for each educational task. However, this may easily result in a large, diverse, fragmentary, and hard-to-implement media mix for the whole course. Also, rational-choice approaches do not take into account the media and facilities which are already in use or available in the educational setting; this applies even more to the media-selection models we mentioned earlier. For implementation this is a disadvantage, both from a social-organizational and from a cost perspective. These disadvantages may be taken care of by applying rational-choice approaches in a flexible way. By applying a social-influence approach, such as core/complementary media, at the same time, a core medium for the whole course and other available media may direct the process of media selection per task.

Vice versa, the application of only a social-influence approach, also if this occurs in a conscious way, has an important disadvantage. The educational designer is not easily inclined to look beyond the collection of familiar media or the new media which the client likes to see used. This may easily result in sub-optimal media selections.
This disadvantage may be relieved by considering the best medium for each separate educational task, followed by a cost/effectiveness estimation of the replacement of the medium that would otherwise, from a social viewpoint, be preferred. Furthermore a rational-choice approach to media selection may provide convincing arguments to experiment with media which have the potential to yield better learning results, or to prevent decision makers from wasting money on fancy but inappropriate media.

In practice media selections often seem to be made impulsive or badly-reasoned, which some may judge as 'wrong'. We doubt if the latter can be justified: in such cases the designer may be acting on a basis of educational knowledge and experience combined with knowledge of the actual and aimed-at situation [Verwijs 98]. [Webster & Trevino 95] found that for new media the social-influence factor is more important than for traditional media, because the application and way of using of traditional media are well accepted and clear. A client may view a certain type of medium as an important element of the aimed-at situation; a medium in a particular educational situation which is selected based on trends or hypes that a client wishes to join ("We must have multimedia!"), may be viewed as a decision that can be rationalized in retrospect.
Rational-choice and social-influence approaches thus cannot be viewed separately from one another in practice. Their application though may be made more effective. Instructional designers who have to decide on what media to use should be conscious of the advantages and disadvantages of both rational-choice and social-influence approaches, and act upon this. This implies combining bottom-up and top-down design processes, in which the optimum middle will be different for each educational situation.

6. Summary

In summary, we have presented the following guidelines for media selection:

1. Consider for each particular educational-design situation what is an 'objectively' optimum choice for each particular task (rational-choice approach), and combine this with the best choice within the social context (social-influence approach)
2. Consider task/media fit as a rational-choice framework, and core/complementary media as a social-influence framework for thinking about media selection
3. Approach media selection as a creative and heuristic, combined bottom-up/top-down design process, in which the guidelines above may serve as resources

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An Interactive Intelligent Language Tutor Over The Internet

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Abstract: This paper describes an Intelligent Language Tutoring System (ILTS) for German. The German Tutor is the grammar component of a comprehensive multi-media course, specifically adapted for distance education over the World Wide Web. The Intelligent Tutor parses student's answers to introductory language exercises. The system analyzes the linguistic source of an error and reports its description to the student. Through this analysis it infers an approximation of the learner's competence and adapts the instructional strategy accordingly. The main advantage of the system is its ability to individualize instruction and to provide insight to the student as an inherent feature of learning exercises.

1. Introduction

The project describes an Intelligent Language Tutoring System (ILTS) for Distance Education over the World Wide Web. The predominant characteristic of Distance Education is the separation of student and instructor in space, and consequently, time. One-way communication media, such as radio, television, film and video came to dominate the field of distance learning because of their ability to deal at least partially with this difficulty. While broadcasting technologies using a single-source/multiple-receiver model, greatly enhanced print-based instructional media, feedback within the model was awkward or non-existent. It is, however, commonly accepted that the most effective education, particularly in second-language learning, requires two-way communication. For this reason, Computer Mediated Communication (CMC) has become to play an ever more important role in both traditional and distance education.

The *German Tutor*, an Intelligent Language Tutoring System is conceived of as the grammar practice module. An Intelligent Language Tutor over the World Wide Web combines the flexibility and intelligence of an ILTS with world-wide availability of WWW applications [Brusilovsky et. al 1996]. Predominantly, existing second language learning applications use simple grammar practice and their feedback mechanism is more restricted than their off-line counterparts.

The goal of the German Tutor is to provide meaningful grammar practice for foreign language learners through computer-mediated communication. Meaningful grammar practice requires intelligence on part of the computer program. Without intelligence the system is merely a method of presenting information, one not especially preferable to a static medium like print. In order to go beyond multiple choice questions, relatively uninformative answer keys, and gross mainstreaming of students characteristic of workbooks, the *German Tutor* emulates two significant aspects of a student teacher interaction: it provides error-contingent feedback and allows for individualization of the learning process.

Generally, Intelligent Tutoring Systems consist of 3 components: the domain knowledge, the student model, and the teaching module [Wenger 1987].

The domain knowledge in Intelligent Language Tutoring Systems is modeled by Natural Language parsers. The strength of Natural Language Processing is that the student tasks can go beyond multiple-choice questions and/or fill-in-the-blanks while still allowing for a sophisticated error analysis. Simple drills are based on string matching algorithms, that is the student response is compared letter by letter against an answer key. With meaningful grammar practice, however, one obviously cannot enter arbitrarily many sentences into memory for purposes of comparison. Natural Language Processing allows for more than a mere indication that an error has occurred: it can give a description of the error, and go to an even deeper linguistics analysis in order to isolate the source of the error. Thus a Natural Language parser provides the analytical complexity in an Intelligent Language Tutoring System.

Students all learn at their own pace and the student model provides the "key to individualized knowledge-based instruction" [McCalla & Greer 1992]. The student model keeps track of the learner history and provides learner model updates. It is used by the system to inform the teaching module and allows the system to adapt to individual student needs and alter the instructional process accordingly.

2. Grammatical Formalism

The *German Tutor* parses students' answers to introductory German exercises. Typically Intelligent Language Tutoring Systems augment grammars that parse grammatical input in one of three ways. They may augment rules such that if a particular rule does not succeed, specific error routines (meta-rules) force application of the rule by systematically relaxing its constraints, or they may augment the grammar with rules which are capable of parsing ill-formed input (buggy rules) and which apply if the grammatical rules fail (see [Liou 1991], [Weischedel 1983]). With feature grammar formalisms, they may also alter the unification algorithm itself such that in the event of conflicting feature values the parse does not fail, but instead applies a different set of procedures [Hagen 1994]. In particular, parsers designed for language instruction typically contain components which <u>search</u> for errors in the event that the grammatical rules are not successful.

Unlike other systems, the *German Tutor* does not seek errors, but instead records whether or not grammatical constraints are met. The system returns structures which provide possible feedback and student model updates of different level of specificity. The computational analysis reflects the underlying pedagogy of the system. The goal is to analyze students' language input rather than the more modest requirement to recognize ill-formed construction.

The *German Tutor* is written in ALE (The Attributed Logic Engine), an extension of Prolog. ALE is an integrated phrase structure parsing and definite clause programming system in which the terms are typed feature structures. Typed feature structures combine type inheritance and appropriateness specifications for features and their values [Carpenter & Penn 1994].

The grammatical formalism used is derived from Head Phrase Structure Grammar [Pollard & Sag 1994], a unification-based grammar theory. It is one of a family which share several properties. Linguistic information is presented as feature/value matrices. Theories in this family are to varying degrees radically lexicalist, that is a considerable amount of grammatical information is located in the lexicon rather than in the grammar rules.

3. Program Architecture

The pedagogical goal behind the *German Tutor* is to provide error-contingent feedback and allow for individualization of the learning process. For example, if a student chooses a wrong article in German the error might be either incorrect gender, number, or case. In such an instance the program must be capable of distinguishing between the three error types since "... for almost all cognitive learning, instruction is enhanced by evaluative feedback" [Venetzky & Osin 1991, p. 9]. In addition, inexperienced students might require detailed instruction while experienced students benefit from higher level reminders and explanations. To achieve this, the *German Tutor*, consists of four components: the Domain Knowledge, the Analysis Hierarchy, the Student Model, and the Filtering Module, given in Figure 1.

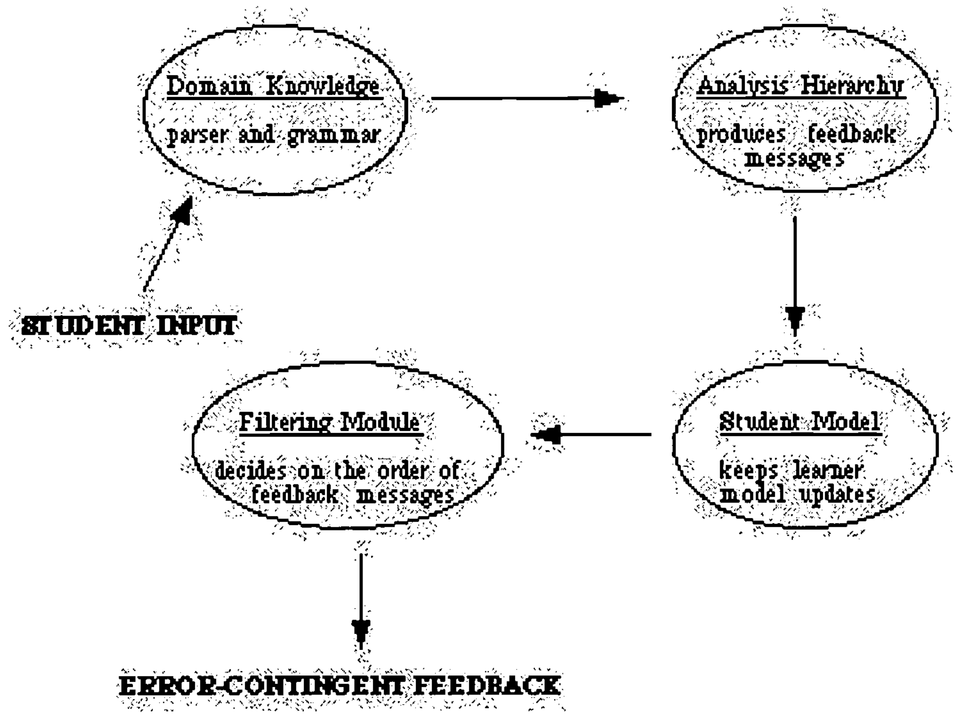

Figure 1: The *German Tutor*

The Domain Knowledge consists of a parser with a grammar which parses sentences and phrases to produce sets of *phrase descriptors* [McFetridge & Heift 1995]. A phrase descriptor is a model of a particular grammatical phenomenon such as case assignment or agreement. A phrase descriptor records whether or not the grammatical phenomenon is present in the input and correctly or incorrectly formed. The second component is an Analysis Hierarchy which takes a phrase descriptor as input and generates sets of possible responses to the learner's input. Since the phrase descriptors record both successful and unsuccessful attempts at practising grammatical knowledge, the student model can record mastery of grammatical structures as well as structures with which the learner has problems. The system tracks the student model. On the basis of the student model, the Filtering Module, and the Analysis Hierarchy the program interacts with the learner.

3.1. The Domain Knowledge

The goal of the parser and the grammar is the generation of phrase descriptors. A phrase descriptor is implemented as a frame structure that models a grammatical phenomenon. Each member of the frame consists of a name followed by a value. For example, number agreement of subject-verb in German is modeled by the frame [number,_] where the underscore represents a value for each number. Consider examples (1) and (2):

(1) *Die Familie gehen nach Paris.

(2) Die Familie geht nach Paris.

The family is going to Paris.

The phrase descriptor for (1) is [number,error], while that for the phrase in (2) is [number,none]. A system presented with (1) will instruct the learner on the nature of number agreement while the successful number application in (2) will be recorded in the student model.

In addition to the grammatical features defined in HPSG the grammar uses a type *descriptor* representing the description of the phrase that the parser builds up. This type is set-valued and is initially underspecified in each lexical entry. Thus *descriptor* not only tracks whether the input is ill-formed but also records whether the sentence is grammatical. During parsing, the values of the features of descriptor are specified. For example, one of the members of descriptor, *vp_num* in Figure 2, tracks the number agreement of subject-verb in a main-clause. Its value is inherited from the *sg* feature specified in the verb *geht*.

$$\left[\begin{array}{l} \text{cat} \begin{bmatrix}\text{head } v\end{bmatrix} \\ \text{content} \begin{bmatrix}\text{index}\begin{bmatrix}\text{num}\begin{bmatrix}\text{sg } \boxed{1}\end{bmatrix}\end{bmatrix}\end{bmatrix} \\ \text{descriptor}\begin{bmatrix}\text{main\_clause}\begin{bmatrix}\text{vp\_num } \boxed{1}\end{bmatrix}\end{bmatrix}\end{array}\right]$$

Figure 2: Descriptor *vp_num* of the verb *geht*

3.2. The Analysis Hierarchy

The second component of the system is an Analysis Hierarchy. The purpose of the Analysis Hierarchy is to take phrase descriptors as input and generate possible responses that the instruction system can use when interacting with the learner. A response is a pair that contains a message the system will use to inform the learner if a phrase descriptor indicates there has been an error and a student model update. The student model update is a name of an error category in the student model with an increment or decrement.

The Analysis Hierarchy generates sets of responses of increasing abstraction. As an example consider the ungrammatical phrase in (3). An experienced student should be informed that *Ball* is a masculine noun, that the preposition *mit* is a dative preposition and that the determiner *der* is incorrect. A student who has mastered case assignment (as indicated by the student model) may be informed only that the case of the prepositional phrase is incorrect.

(3) *mit der Ball.

mit dem Ball.

with the ball.

The Analysis Hierarchy is implemented in DATR [Evans & Gazdar 1990], a language designed for representing multiple inheritance. The language is well suited to constructing responses from phrase descriptors. The Sussex version of DATR is implemented in Prolog and consequently the interface between the parser and the Analysis Hierarchy is a natural one.

3.3. The Student Model and the Filtering Module

The two remaining modules of the *German Tutor* are the student model and the Filtering Module. The student model keeps track of the learner history and provides learner model updates. On the basis of the learner model, it decides on the specificity of the feedback messages. There are three different kinds of learner levels considered in the system: the novice, the intermediate learner, and the expert. The student model passes feedback messages to the Filtering Module suited to the level of the learner.

The Filtering Module has two tasks: it filters all parses and feedback messages. Due to language ambiguity parsers generally produce more than one interpretation. The first task of the Filtering Module is to decide on the desired parse. The second task is to determine the order of the feedback messages showed to the learner. The Filtering Module displays one error at a time and once the student makes the required correction, the whole evaluation process starts from the beginning.

4. Conclusion

The system described is the grammar component of a Distance Education course for German on the Internet. The *German Tutor* creates error-contingent feedback and learner model updates of different levels of specificity thus allowing for individualization of the learning process. The *German Tutor* contains grammatical constructions of an introductory course for German although at this point the lexicon is limited and needs to be expanded to fully encompass students' input in such course.

The suitability of the computational analysis used in the *German Tutor* is two-fold: first, the grammar is sufficiently general that it does not distinguish between grammatical and ungrammatical input for the phenomena it is designed to handle. This generality has the advantage of reducing the number of rules required by the grammar. Second, the decoupling of the parsing system from analysis of whether or not the input is grammatical has the practical advantage that development of each can proceed independently.

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A Multimedia Authoring And Annotation System For Learning Environments

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Abstract: In this paper we introduce a new application called multimedia annotation, which is currently developed in the EU-funded ACTS project DIANE. We describe a system for instant multimedia authoring with special features for supporting the creation and annotation of multimedia documents in a distributed working environment e.g. distance education. It gives both teachers and learners the capabilities for multimedia authoring, which makes learning to a collaborative effort with the important feedback from the learners to improve the quality of the teaching material.

1. Introduction

The decreasing cost of computers with multimedia capabilities and the increasing availability of high-speed networks like ISDN or ATM emerge new possibilities for distance learning and teaching concerning the use of multimedia [Abowd et al. 96, Muehlhaeser 95, Luther 94, Edwards et al. 92]. Several approaches how multimedia can be used to support teaching at universities and schools were proposed (virtual university, authoring on the fly, use of whiteboard applications as a replacement of chalkboards) [Ottman et al. 95, Bacher et al. 96, Bacher et al. 97, Will 96, Will 97], but they are often not general enough to be applied to other distributed working environments without problems or changes.
The possibilities of multimedia allows to adapt the content of a teaching course to the preferences of learners, but in a distributed learning scenario this flexibility is not taken into account due to the missing contact between teachers and learners: a teacher in a classroom scenario can vary the content or the structure of his course or lessons according to his experience with the learners and can fine-tune or adapt the course to the specific needs and interests of the students. In a teleteaching scenario this possibility of positive feedback is very limited, although it would enhance the quality of learning considerably.
Most teleteaching courses on the Web are HTML-based documents [Langenbach et al. 97, Kutschera 96]. The only possible feedback of the learners is email to the teachers or WWW-based forms to allow suggestions or questions. Both methods have the drawback that they are completely text-based and referring to the course or its content is difficult.
Teletraining and distance education typically require a lot more preparation time than traditional classroom teaching. Incorporating the feedback of students and the adaptation of the course are features, which would result in an enormous increase of time for course preparation.
The annotation system [Fischer 96, Benz et al. 97a, Benz et al. 97b, Benz et al. 97c] described in this paper is being developed in the project DIANE.[1]

[1] The project DIANE is being funded by the European Commission under the *ACTS* Contract AC082

Actually, a system based on annotations offers a solution to the problem above: the course material can be annotated by the students with all the media available, each part of a document can be referred to or changed by adding questions, suggestions, thoughts or comments. This feedback of the learners results in annotated documents, which can be taken as the basis for a refined course. This interaction between teachers and learners is an essential point for improving the quality of the teletraining material. The learners are not left to study by themselves, but get tutors assistance and are able to collaborate with other participants of the course via DIANE.

The teacher plays more the role of a coach or moderator (as in moderated newsgroups) for providing the basis for a discussion, while the final course material with all the contributions from the students itself is developed during the lessons and is more or less a by-product of the learning process.

This approach has turned out to be very successful especially in collaborative working environments as it can be seen from the increasing number of newsgroups and mailing-lists, which support the annotation feature in a text-based form. The extension of authoring to a variety of media as offered by DIANE results in flexibility in the selection of the appropriate media and a shorter document creation time both for instructors and students.

2. The Annotation Engine

The engine shown in Fig. 1 can be seen as a series of players, each one capable to present a multimedia document. The synchronised output of the players is sent to the various devices in the system: audio, mouse display, windows system, etc. The annotation process, however, implies the creation of a new document Di+1 based on the presentation above plus additional live media (such as audio, application output, video, etc.). The new document is stored in the document database.

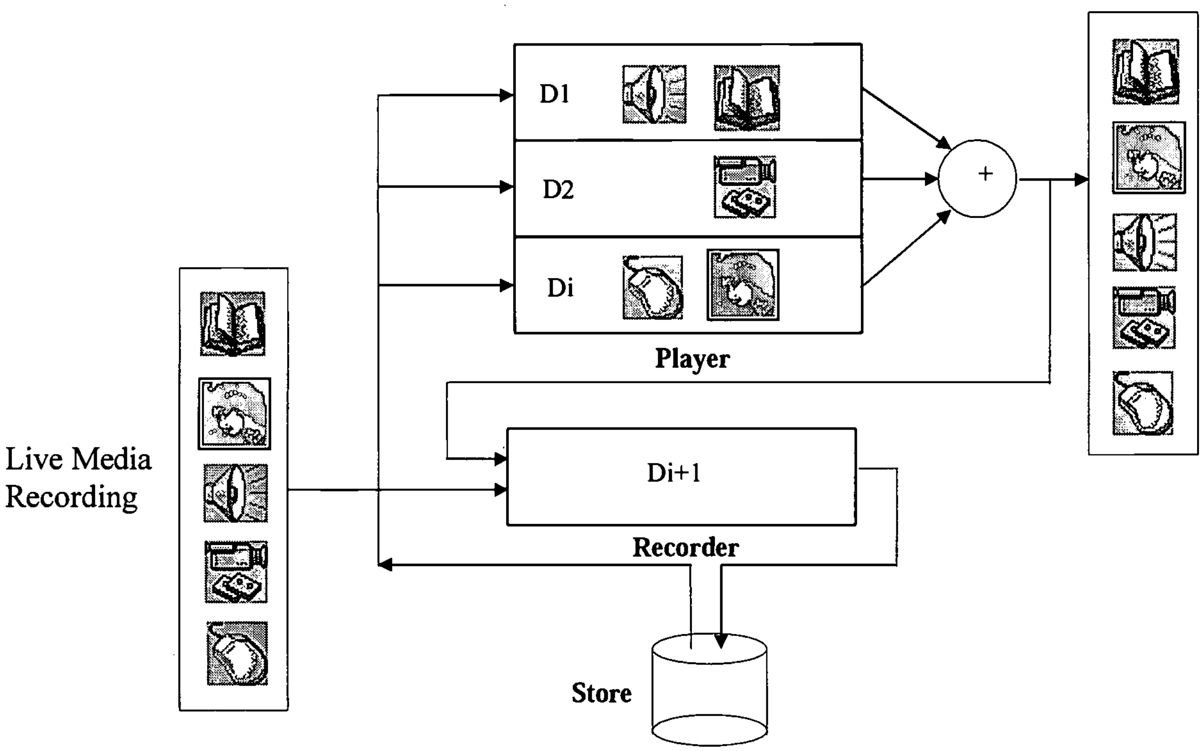

Figure 1: The annotation engine

The set of documents D1, D2, Di feeding the players in Fig. 1 are not selected arbitrarily; they represent a thread linked by special links, the annotation links. Assuming in this example that Di is an annotation of document D2, the semantics of the link Di->D2 is to combine the presentation schedules of both documents according to time and spatial reference points (created while recording Di). Therefore, when the user selects Di for presentation, the engine loads Di, D2 (and recursively D1 since D2 is an annotation of D1), resolves the references and creates one, combined presentation schedule.

3. System Usage

The annotation system was designed to be general and support almost any distributed working environment. Other multimedia authoring systems have the drawbacks of being either too application specific, too complex to use, or have no support for distributed environments.

These limitations are not present in DIANE:

- application output recording (screen grabbing) in a continuous or frame-by-frame mode creates a media which is integrated into documents in form of an animation or slide show. Therefore, any external, available tools can be used for authoring.
- the user interface to DIANE follows the VCR paradigm, being easy and intuitive to use.
- the client-server architecture with a central server for document storage and management and clients for authoring and annotation is appropriate for distance learning.

Annotations in DIANE are comments, suggestions, thoughts, questions or markers realised with text, images, slide show, video, audio, mouse movements). Actually, DIANE can handle and retrieve multimedia streams from various sources like camera, microphone, applications screens or files without the help of third-party tools. This makes it particular easy for a user to integrate any media object into his documents.
A DIANE document with slide show media (collection of frames from the screen output of an application), audio, pointer, text and image can be seen in the following figure. The VCR-type buttons on the top of the window allow the replay, pausing and recording of annotations.

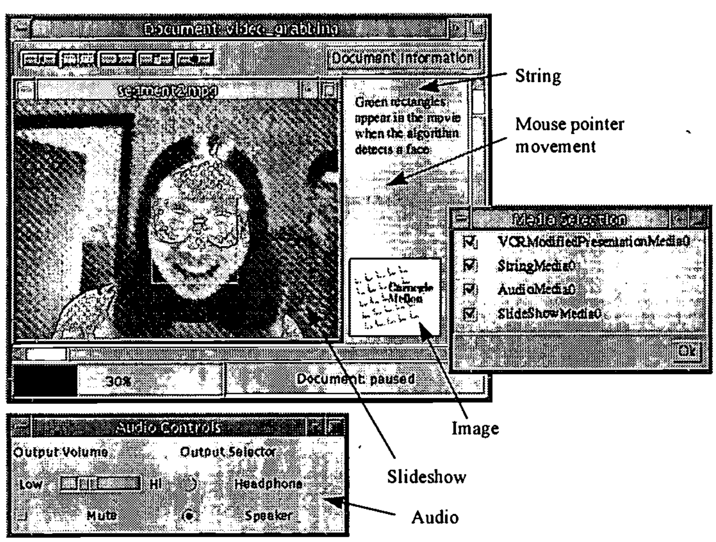

Figure 2: DIANE Document Viewer

Annotating a document like the one in Fig. 2 is done by pressing the (red) annotate button. The presentation is paused and a new document with the original and new media is created. The added objects become visible when the replay time of the annotated document is equal or greater than the annotation time.

4. Use of DIANE in distance learning scenarios

DIANE is also well suited for various learning scenarios and can be customised to any working environment when necessary. In order to answer the needs of data security in corporate environments like companies, hospitals or research centres, authentication and encryption of the communication over the network has been combined with a role-based access control applied to each document. Thus, viewing of whole threads of annotations can be restricted to certain closed-user groups.

The first step in distance education is always the preparation of the course material. The system is content neutral and provides:

- hyperlinks for linking DIANE documents
- media recorders for the integration of text, graphics, video, audio, application output, mouse pointer movements, markers on arbitrary positions in the document
- integration of HTML documents in a DIANE document

In addition to the annotation link semantics mentioned in section 2, a hyperlink with a similar behaviour to that of a HTML link is provided: if the link icon is pressed during a certain (visibility) period, the presentation is interrupted and the new target document starts playing; otherwise the presentation is continued. This feature allows it to combine documents in a common context without displaying them simultaneously (e.g. examples, references).

The integration of HTML documents makes it possible for the multimedia author to use the elaborate text formatting techniques of Hypertext or to include already existing WWW documents without changes.

Additionally to these generic functions, the instructor can also grab any portion of the computer screen displaying for example the output of an application or third-party tool and integrate it into a document. This feature is of particular interest, when instructors, as experts for a subject, intend to teach the use of special applications not available to the learners. Therefore, application output recording removes most restrictions on the subject of a teaching course, provided that the material is available in digital form (data or computer application).

On the other hand, the general document model used in DIANE can pose some problems to authors of educational material. An annotation document has always a time dimension extending static documents (text, HTML). This feature requires the authors of multimedia documents to think spatial and temporal dimensions (an displayed object, i.e. a window can not only be placed somewhere in the document, but appears at a specific time during the replay).

Nevertheless, the annotation feature reduces the gap between traditional and multimedia document composition by letting both tutors and students insert intuitively media during the replay of annotated document solely through the use of VCR well-known controls. Instructors do not have to build up a perfect teaching course from the beginning, they can do it gradually (e.g. it would be sufficient to create a minimal multimedia course containing no more than essential keywords like in transparencies with a soundtrack containing explanations of the teacher). This flexibility reduces the production time of multimedia documents considerably without reducing the quality of the course.

The second step in the teleteaching scenario with DIANE is the information exchange between teacher and learners based on the course material created in the first phase, and as mentioned above, this step is also an update and online-refinement of the course according to the special needs of the learners. DIANE offers the same capabilities for multimedia authoring to all users regardless of their roles. The same recorders necessary for integrating multimedia objects in the document, can also be used for annotations. The annotation feature of DIANE favours the asynchronous usage and is therefore appropriate for on-demand learning, learner support,

courses and lectures without loosing the collaborative element. In addition, synchronous sessions which make use of videoconferencing and application sharing applications can also be annotated for later processing.
The annotations of one learner can be made visible to the instructor, but also to other learners. Therefore, the information flow occurs not only between teacher and learners, but also between learners themselves, which is as important as the first one.

5. Conclusion

The DIANE user combines the roles of provider and consumer of multimedia information (or teacher and learner in a teleteaching scenario). Therefore, both sides can play an active role in the learning process, which is closer to traditional classroom teaching with its synergetic potential.
Through annotations, we have not only a way of producing educational content, but also building teaching scenarios and incorporating the collaborative component of conventional classroom education .
DIANE is being currently tested at VCPC with respect to the preparation of courseware for parallel programming tools and methods and to its ability to use this courseware in collaborative teaching sessions with students. Collaborative work scenarios are tested between two researchers teams in Vienna and Graz using broadband ATM network.

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Increasing Teaching Productivity withEuropeMMM

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Abstract: EuropeMMM- The Efficient Use of Remote and Online Publications of Electronic Multi-Media Materials addresses the challenge of custom publishing of multi-media on the Internet.

A EuropeMMM catalogue is designed specially for teachers and trainers who need to save time and effort in putting together courses which include multi-media elements. Authors and educators can select multi-media material from such catalogue and produce their own custom material for teaching or other purposes. Through the use of EuropeMMM and W3, RBL becomes widely accessible to students while at the same time reducing the costs of production through shared intellectual capital.

In this paper we describe how EuropeMMM (http://wbt.iicm.edu/EuropeMMM) allows authors and educators to select multi-media materials from a central, transnational W3 site to produce their own custom material for teaching or other purposes. We also provide details on how multi-media content can be contributed to the central repository.

1. Introduction

The issues of teaching, productivity, and instructional technology can be considered from a number of differing perspectives. The need for increased productivity in tertiary teaching is driven by an internet-based, international level of competition and constrained institutional budgets. It would appear that more instruction must be delivered to more students in more physical locations within existing budgets or there will be significant restructuring within academia.

Marketplace forces have come to the ivory tower. Fortunately technology may have a role to play in the solution. The Dearing Report [Dearing, 1997a] has noted a need to shift from teaching methods with high variable costs to those with lower variable costs. It also noted that investment in new technology has led to higher costs but without immediate improvements in efficiency. Teaching methods were considered across three major categories: lectures, small groups and resource based learning (RBL) The argument that institutions must increase enrolment without encountering a high marginal cost for each additional student is supported by the analysis of costs associated with the development of resource based learning. RBL, as defined by Dearing, is a combination of lecture notes, courseware, CDs, and customised spreadsheets - not the powerful multi-media products currently available. Yet the financial impact of RBL is such that adding interactivity and communications technologies to a course of study, with its attendant increased development costs, can be realistically amortised over a larger student enrolment. The net result is "a better cost curve that is capable of withstanding expansion". [Dearing, 1997b] The optimism for an RBL solution to the cost / service squeeze may be overly optimistic given a stated maximum 200:1 ratio for development time to a student's time-on-task (contact time). Industry experience would place Dearing's development ratio in the lower quartile based upon our current capabilities for highly interactive, multi-media products. [Golas, 1994] Thus, development costs could be much greater; in fact, by a factor of three. Fortunately, the Dearing Report embraces the notion that RBL can be developed using internal and external resources and a mixture of these sources. Change agents in education and industry well understand the impact of the NIH syndrome. For personal and practical reasons instructors insist on adding their own content - placing their personal *imprimatur* on the deliverable.

Fortunately, instructional technologies can make a positive contribution to RBL by allowing the instructor to mix and match materials developed by themselves or departmental colleagues with resources developed elsewhere.

It has been argued that information technologies (IT) have not resulted in the expected increase in productivity. [Landauer, 1995] [Hitt and Brynjolfsson, 1996] In several studies, thousands of US companies have reportedly not received the expected benefits from their IT investment. Yet in less than ten percent of the cases was the problem traced to technical reasons. The principal reasons were found to be human and organisational [Griffith and Northcraft, 1996]. In education, instructional technologies often fail because of a lack of subject matter expertise, peer review, student (end-user) involvement, and multi-faceted usability testing. [Mauldin, 1996].

2. EuropeMMM

EuropeMMM – The Efficient Use of Remote and Online Publications of Electronic Multi-Media Materials – addresses the challenge of custom publishing of multi-media on the Internet.

A EuropeMMM catalogue is designed especially for teachers and trainers who need to save time and effort in putting together courses which include multi-media elements. Authors and educators can select multi-media material from such catalogues and produce their own custom material for teaching or other purposes. Through the use of EuropeMMM and W3, RBL becomes widely accessible to students while at the same time reducing the costs of production through shared intellectual capital.

Reuse of MM materials means to be able to use a piece of such material in different contexts. Generally, the term "different contexts" can be seen as different parts of a single application or different systems. In this paper, we discuss only the later part of the definition – reuse in different applications.

The main motivation for reuse is *cost*. Producing quality multi-media material is expensive and time-consuming; thus, using the same material for several applications is important, since the new applications will require less time for their development and will cost much less than developing their content totally from scratch.

Finally, reuse may be implemented with two techniques, *by-reference* or *by-value*. By-reference means that an item is referenced from two or more different contexts. By-value means that at least two copies of the same item exist in different contexts [Garzotto, Mainetti and Paolini 1995] [Garzotto, Paolini and Schwabe 1993].

Since the project deals with generating new applications we consider the By-value reuse as the most likely method.

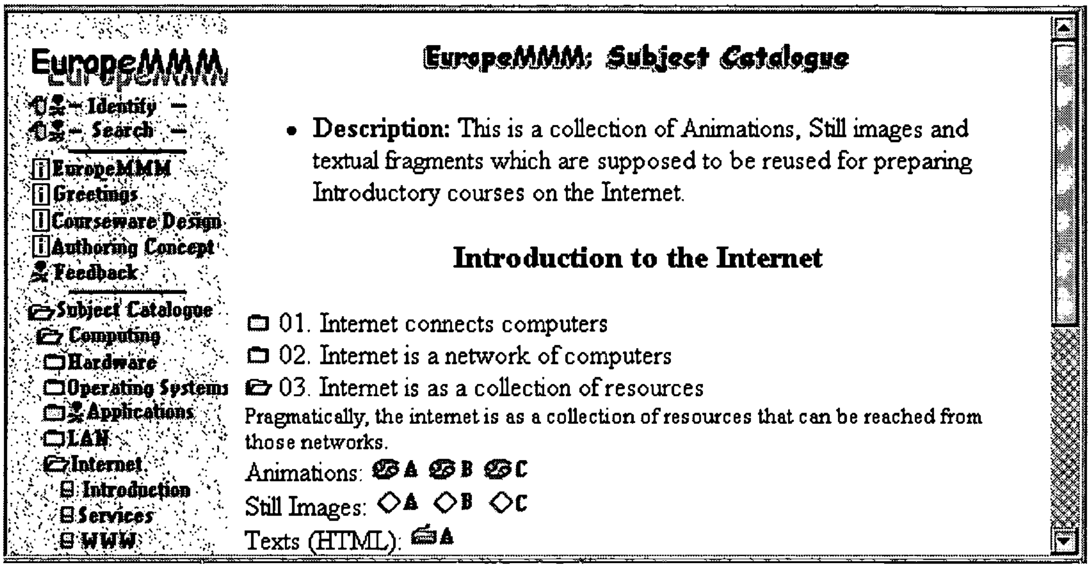
A system to support Net-based reuse of multi-media materials requires at least three components:

- a mechanism that allows individuals to access, search and browse the catalogue of existing multi-media materials to locate items of interest;
- a simple yet powerful reuse engine which allows users without any additional know-how, to reuse multi-media components;
- an interface which allows different authors contribute to the catalogue.

In this paper we describe these three components as they have been implemented in the project. It should be especially noted that the current interface, as it is presented in the paper, has received many critical notes from users and currently is a subject of re-consideration.

2.1 Browsing the Catalogue

The catalogue is built as a hierarchy of so-called indexes of reusable MM Materials. The following toolbars are used for navigating:

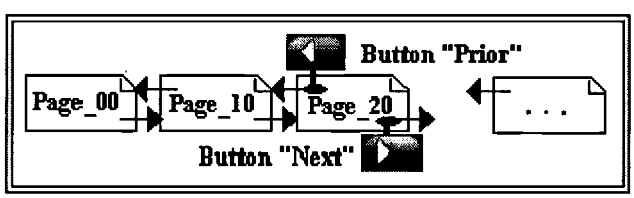


Note, the search engine on the left side toolbar which provide a convenient possibility to access a MM material of interest.

2.2 Reusing MM materials from the Catalogue

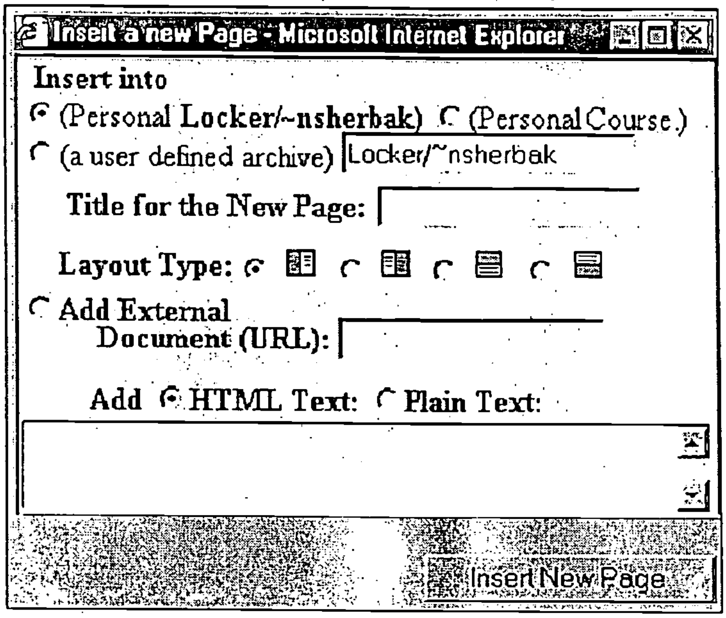
The catalogue serves so-called registered EuropeMMM authors. Each registered EuropeMMM author receives a particular User ID and Password from the catalogue administration.

The EuropeMMM authors are supposed to create their own online courses by means of reusing the material available from the catalogue. Each course created with the system, gets a unique name which is an course ID. Thus, an author having ID "Course_1" is working on the course named "Course_1". Of course, one and the same person may ask for different IDs to work on different courses. Each course is a sequence of so-called pages. Pages have names (i.e. titles) and are sorted in the ascending order of their names to automatically generate links for the forward and backward traversing of the course. Thus, for example, if there are three pages named "page_10", "page_20" and "page_30", each will be presented in the same order to users.

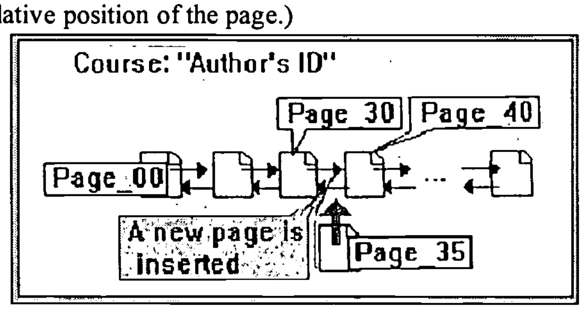


Course structure

Pages can be created from scratch and uploaded into the server, or pages can be created by means of reusing MM materials from the supplementary catalogue. The process of reusing multi-media material is a fairly simple one: whenever a user accesses reusable materials that are suitable for a particular course, he/she might press a button "reuse", and a special form containing 5 fields appears:

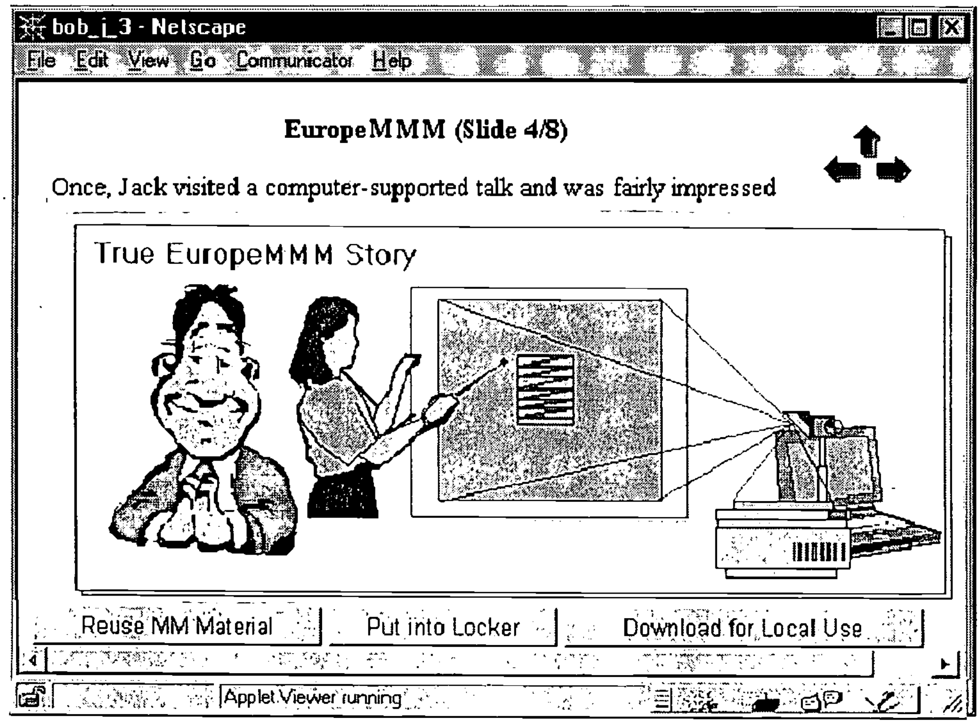


- **Personal Locker/Personal Course** - appears automatically and corresponds to the current user's ID;
- **Title for the New Page** - a very important attribute, since it defines an order of pages within the course. (In a simple case, authors can use the following naming schema: Page_xx where xx is a number defining a relative position of the page.)



- **URL** - this field can be used by advanced users to provide direct access to some pages;
- **HTML Text /Plain Text** - actually this an author's main contribution. It is the "content" or explanations for students. It is also possible to mix existing MM material (from another source) with the author's own HTML material. The author's contribution (in HTML) may have been prepared by means of some other system, editor, or application.
- **Layout type** - defines how the applet will be mixed with your explanation. Currently there exist four predefined templates, but this number is easily extendable.

Once these steps have been completed the author is only one mouse click from the creation of a new, good looking HTML page.

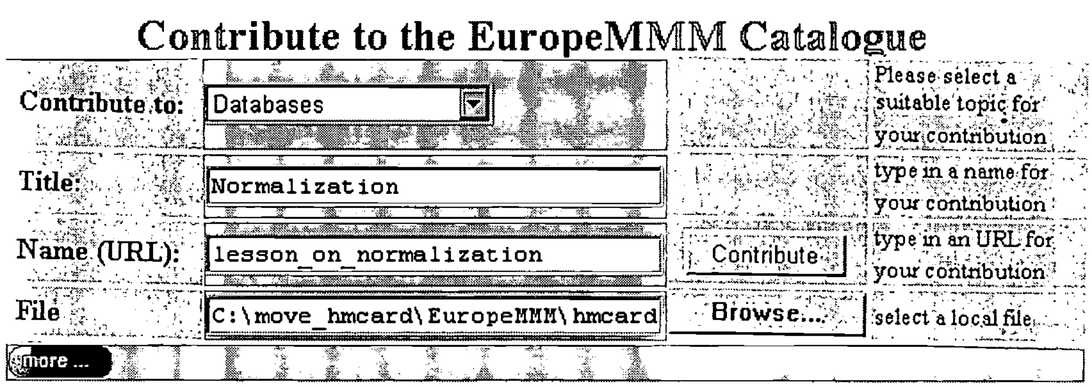


Please note that the reusing mechanism mentioned above can be applied recursively to add more MM or HTML elements to such documents.

2.3 Contributing to the Catalogue

Contributing to the catalogue can be seen as a threefold task:

- the author physically uploads a multi-media element into the server and provides some guidance for visualisation the file and embedding it into HTML documents;
- the author places the file on a particular position within the hierarchy of catalogue indexes;
- the author provides necessary key words to simplify locating of the material by means of the search engine.



EuropeMMM utilises a simple approach to these three tasks. Thus, the system supports a list of so-called registered formats. There is no need for authors to define any additional rules for visualisation and/or reuse of files belonging to such registered formats. Obviously, such standard MM elements as still images, sound, movies, etc. are automatically recognised and uploaded using special predefined rules.

Moreover, the system automatically assigns a necessary plug-in, determines the geometrical configuration and sets up other additional parameters for such external MM applications as Shockwave, Authorware, Flash, MM Toolbook, HM-Card and many others. Thus, in the case when an author is intending to contribute with a file in such standard formats, only a name of particular file residing on a local drive needs to be specified (see the uploading form above) and the system determines all other parameters automatically from the known extension. There exists also a rather sophisticated form for defining a new MM format (which is not discussed here).

The system uses the current user's position within the catalogue as a default place to insert information on a new contribution. If the author is not satisfied with the current position, it can be modified using the combobox on the top of the form.

After successfull uploading of the new file into the catalogue, a special form is offered to define a description of the material including ist of keywords.

3. Conclusion

EuropeMMM is a environment to assist instructors and institutions in improving instructional design and instructional delivery through the cooperative development and exchange of instructional content. Using vehicles like EuropeMMM, instructors can move beyond the book and the lecture to better engage their students, and to generate in them a genuine enthusiasm for learning and self-discovery.

As it was mentioned above, while a general idea of creating a catalogue of reusable MM materials has been enthusiastically accepted by test users, the concrete user-interface solutions were a target for substantial critical comment.

It should be noted that system's functionality is based on CGI scripts and HTML forms which do not support such advanced GUI as click and select, drag and drop, etc. Hence, it was agreed to develop a new version of the user's interface using Java programming language and, hence, supporting all the advanced features mentioned above. We hope to report on the new version of the system at the next ED-Media conference.

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VISTAS ECOLOGICAS: A COLLABORATIVE CD-ROM SPANISH PROJECT FOR TEACHING ABOUT ECOLOGY

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Abstract
This paper reports on a collaborative CD-ROM project between an Intermediate Spanish class and Alándaluz, an ecological group in Ecuador. The main goals of this international class project were to integrate language, culture and literature around the theme of the environment and to establish a partnership with Alándaluz. A preliminary assessment of this 10-week class project suggests that electronic media development is a feasible curricular strategy to help the foreign language profession embrace cross-cultural communication and collaboration with communities at home and abroad.

1. INTRODUCTION

Foreign language professionals at the secondary and post-secondary levels lack a uniform vision regarding the role of modern technology in language teaching and learning. Between highly-publicized initiatives such as the development of the foreign language proficiency guidelines at the post-secondary level and the National Standards for Foreign Language Learning (NFLS) at the secondary level, educators have yet to agree on how to assist language students acquire the skills needed for the next millenium: linguistic, social and technological competence with an environmental conscience. This paper describes a cross-cultural CD-ROM project which illustrates how language educators can integrate modern technology along the NFLS, aim at enhancing their learners' overall proficiency and, at the same time, allow students to take part in an international, ecological collaboration.

2. LANGUAGE LEARNING: COLLABORATION THROUGH TECHNOLOGY

Following the publication of the *National Standards for Foreign Language Education* in late 1996 by a consortium of professional organizations under the leadership of the American Council on the Teaching of Foreign Languages (ACTFL), teachers have begun to emphasize language learning and teaching along five main standards: communication, cultures, connections, comparisons, and communities. These interconnected standards, also known as the five C's of foreign language education, clearly redefine goals and content of the foreign language classroom. Students are expected to:

- communicate in languages other than English,
- gain knowledge and understanding of other cultures,
- connect with other disciplines and acquire information,
- develop insights into the nature of language and culture,
- participate in multilingual communities at home and around the world. [National Standards 1996]

In order to help foreign language practitioners implement the standards, the ACTFL project team included in the publication a total of 34 learning scenarios from pilot sites across the country. Each describes the projects and the standards that were targeted. Surprisingly, many of the project descriptions fall short on collaboration and technology, the very two core characteristics that seem to connect all five standards.

2.1. COLLABORATION

Methodological, curricular, as well as professional needs have been the driving forces behind many collaborations. The *NFLS* as well as *Collaborations*, the title of the 1997 Northeast Conference report, are prime examples of such collaborative efforts. Two articles in *Collaborations* illustrate how teachers can target the national standards at the high school level through video materials [Schwartz & Kavanaugh 1997] and e-mail communication [Haas & Reardon 1997]. Both collaborations involved high school and university teachers and resulted in media and technology-enhanced projects on Guatemalan immigration and Chilean folk art. These two articles emphasize the cultures standard of the NFLS and show how video and e-mail can help integrate various curricular experiences such as reflection, critical thinking, and learning strategies. A recent example on how educators at the college level might employ e-mail to enhance student-student collaboration can be found in [Fischer 1996]. Using the metaphors of "tourist" and "explorer," the author urges teachers to help students move away from superficial learning, the "tourist" mode, toward the "explorer" approach in which students engage in engage in purposeful learning. All three examples suggest that collaboration has a social dimension. Moreover, it appears that collaboration, whether aimed at improving language proficiency or (cross-) cultural competence through working relationships among teacher and/or students rests on social interaction. According to [Skillen 1993], the construction of knowledge through collaboration is deeply rooted in the work of Vygotsky's who claimed that social experience precedes all higher level cognitive processes.

2.2. LANGUAGE LEARNING TECHNOLOGIES

What is the role of modern technology in teaching and learning foreign languages? What should it be in light of the national standards and the fundamental importance of collaboration? These were the two main questions that guided the design and implementation of the CD-ROM project with Alándaluz.

Regarding the first question, several of the publications on technology and language education over the last four years suggests that researchers and teachers have started to explore new ways of using technology. The contributing authors to Bush's volume on technology-enhanced language learning [Bush 1997] voice optimism regarding the effectiveness of multimedia, the benefits of technology to enhance receptive and productive skill learning and in using technology to improve teacher education. In [Boswood 1997], the authors provide the reader with practical suggestions on how to use technology for word processing, desktop publishing, e-mail and MOOs, working with the web and other applications. The article by [DeWert & Heining-Boynton 1997] describes how technology literacy has become crucial in improving teacher preparation programs. [Finnemann 1996] and [Warshauer 1995] describe the potential of the Internet and the Web and illustrate how teachers and students can benefit from working with these technologies.

As to the second question, modern technologies should enhance the teaching and learning foreign languages according to the national standards. For example, [Garrett 1997] encourages teachers to use technology-based materials to enhance interactive language learning. Her recommendation clearly aims at the communication standard. [Moeller 1997] argues in favor of collaborative learning and exploring with technology as opposed to using technology merely for instructional purposes. The author advocates having students and faculty work together to determine the best use of technology in the language curriculum. A similar collaborative approach is favored by [Lange and Wieczorek 1997]. They invite teachers to (1) connect each project with a cultural aspect; (2) promote communication among the collaborators which uses purposeful, authentic language; (3) incorporate technology to allow students to see the real, global aspect of communication; (4) help their learners make connections to other disciplines, and (5) incorporate elements of action research with its key elements of reflection and action. As the next chapter will show, these suggestions were not only helpful in facilitating learning around the national standards, but also helped design around the project several elements of active collaboration.

3. THE VISTAS ECOLOGICAS CD-ROM PROJECT

3.1. DESCRIPTION

This CD-ROM project was conducted during the Winter Quarter of 1998. Over a period of 10 weeks, second-year Spanish students at Santa Clara University (SCU) worked together with *Alándaluz*, an ecological center on the coast of Ecuador. For the partner in Ecuador, the development of the CD-ROM was one of the motivating factors; however, the group also wanted to promote its ecological philosophy regarding self-managed and self-sustainable local community development among students in the United States. As described in the previous chapter, the main goal for the Spanish class was to target the national standards; however, since learning about Ecuador in second-year classes and textbooks is often reduced to abstract summaries and brief chapter notes, a secondary goal was to show the country's rich cultural patterns and traditions around the theme of the environment. For this purpose, the various ecological groups which form Alándaluz (a hotel and restaurant, a construction company, a biological farm, and a travel agency) turned out to be very beneficial. In support of the overall course goals and to frame student learning and project development, the following objectives were developed :

- obtaining information from Ecuador in Spanish using e-mail
- providing feedback to written communication in Spanish and to report responses orally to class
- group discussions of articles from abroad on the environment
- designing Web pages and pressing the beta CD-ROM
- establishing a cross-cultural collaboration.

Based on the motivation and particular needs of both partners as well as the availability of unique resources/skills on either end—subject-matter expertise and print/video information about ecology (*Alandaluz*) and technological resources and development/instructional time (SCU)—the goal was to make the *Vistas Ecológicas* project a mutually beneficial collaboration between North and South America.

3.2 IMPLEMENTATION

The *Vistas Ecológicas* project was implemented in three stages: pre-production, production, and post-production. The actual development work was primarily carried out in the university's multimedia lab, whereas the discussion of product rationale, content, and dissemination was integrated into the regular classroom. During the quarter, classes (of 65 minutes each) met twice a week in the regular classroom and once a week in the media lab. Since students were required to spend two lab hours per week on the project, they placed themselves into one of these five project (thematic) teams: Centro Alándaluz (lodging), Pacarina (travel), Amingay (consulting services), Lotización (housing development), and Cantalapiedra (biological farming). In order to provide ongoing support for the various teams, a resource expert as well as a student aid accompanied the CD-ROM development during all three stages. In light of the short development time, several arrangements had been made in conjunction with the university's instructional resource expert. First, it was decided to develop the CD-ROM as a Web-based application to facilitate ongoing feedback from Ecuador as well as for the convenient and efficient pressing of the disc itself. Second, a shared directory was set up on each of the lab computers to give all student team easy access to the resource materials. Third, an account on the web server was established for each project team to store all the data and files (image, text, video) in the lab. Finally, Front Page 98 was chosen as an authoring tools because of its easy of use.

Pre-production began with setting up the five development teams each of which consisted of three students. After they had discussed in class the rationale for such collaborative products, each team began to examine the available resources from Alándaluz and to introduce themselves via e-mail to their collaborators. The students described their role in the project and included several questions about each of the center's different activities. By the end of pre-production, they all had received responses from Alándaluz and were eager to start the actual development process.

The *production* stage began the second day of the third week. In class, students had just finished reading web articles on the floodings in Ecuador and the draughts in Colombia caused by El Niño, when the first delay occurred. As it turned out, this weather phenomenon led to dramatic emergency measures in Ecuador and severely impacted the communication between SCU and Alándaluz. For two weeks, the e-mail contact between the two collaborators was interrupted. In the meantime, however, the student aid was able to design with each project team a template to give each project a uniform appearance. During this "outage," students digitized segments from a promotional Alándaluz video and scanned postcards that had arrived from Ecuador at the beginning of the quarter. Fortunately, by week six, students once again received e-mail from Alándaluz via Quito. While they were pleased to receive more content information and a few design suggestions, the news about the structural damage El Niño had inflicted on the hotel, the farm, and the beach was terrible. The last two weeks of the production phase, student were asked to incorporate an "interactive comprehension" element into their project pages. Students were reminded that their collaborator did not want an electronic travel brochure but an interactive medium that was promotional as well as educational. With this in mind, and with more content to work with, all five teams developed such a comprehension feature. Not surprisingly, the most popular feedback format was called "examencito."

Week nine marked the beginning of the *post-production* stage. All teams were asked to correct their pages for content and linguistic accuracy and to remove all hyperlinks from their projects. With the help of the student aid, this worked rather well. The last week of classes, members of each team reflected in class upon the value of such cross-cultural collaborations, the problems they encountered and how this project may have helped them gain a better understanding of environmental challenges from a Latin American perspective. Before pressing the final version of the CD-ROM, all project pages were proofed one more time and a preliminary copy was pressed. The following week, students then pressed their own personal copy of the final beta version of the CD-ROM.

3.4 RESULTS AND DISCUSSION

To what extent did the *Vistas Ecológicas* class project meet some of its ambitious goals: targeting the NFLS, facilitating local and international collaborations, and incorporating modern technology? In order to answer this question from several perspectives, this section includes observations from two students who were invited to comment in writing on their overall experience with this project-driven Spanish class.

Regarding the NFLS, students were able to address the *communication standard*. Using e-mail to request information in Spanish from the partners in Ecuador and making reports in Spanish to their class- mates helped the students to practice written as well as spoken Spanish. However, both students indicated that they would have preferred a complete immersion experience even to the point of exclusively using Spanish in the multimedia lab. One of them wrote: "I feel it is crucial to use the time of technological integration to the learn the language more fully." In targeting the *cultures standard*, students read information about the ecological efforts of Alándaluz and other groups in Ecuador. They also discussed newspaper articles on this topic in class. It appears that learners increased their cultural knowledge about Alándaluz as well as Ecuador. Did students gain cultural understanding? Judging by one of the student comments who wrote that "I was challenged to discover that technology could be used to promote the conservation of the environment, contrary to the many fears that the technological world will overrun the natural world," it seems that this student's reflection did allow him to understand part of the environmental philosophy of Alándaluz. As to the *connections standard*, students clearly recognized the link between the Spanish component and the environment. One of students found the project interesting because "we were working directly with people who were thousands of miles away... I learned a great deal about Ecuador and the challenges they [Alándaluz] are experiencing due to environmental dangers." Moreover, this experience allowed learners to compare environmental efforts underway in Ecuador to the several ecological controversies in their home states. This *comparisons standard* helped learners develop insights in the nature of language and culture. For example, following the bad news from Ecuador, students were asked to discuss how newspapers in Ecuador described the reactions of the people in the affected area to these three forms of precipitation: *llovizna* (drizzle), *aguacero* (downpour), and *tormenta* (thunderstorm). Finally, this project reflected the *communities standard.* At SCU, students created a multilingual community and communicated with the various Alándaluz communities in Ecuador. As one student described it, working directly with Alándaluz allowed her to receive "the most up-to-date information as possible" and to gain "real-life experience."

Did the project facilitate both a local and international collaboration? What began as a working relationship between SCU and Alándaluz, soon showed signs of a partnership. A few of the students realized that the process of collaboration was more important than the final product. However, as one of the student comments illustrates, the majority of them was more interested in the product: "Some of the development groups did not receive information until very late in the development process. This hindered their ability to effectively create a product according to their wishes." Of course, the hope was that students would demonstrate an awareness of the cultures and communities standards and the importance of collaboration for building cross-cultural competence. At the local level, students proved to be more versatile collaborators. Most students interacted well with each other in their respective teams, with the exception of one group as this student comment highlights: "...when working with a group, one always runs the risk of having a group that does not work well together. However, this is one of the difficulties the group must overcome if they wish to be successful." Indeed, that group finished their work as well.

Finally, with respect to integrating modern technologies into the Spanish class, the project seems to have achieved this goal. A preliminary appraisal suggests that technology did not override the course objectives of the class. At the same time, the overall course theme—ecology—was integrated in such a way into the regular classes that it provided constant thematic links to the development work in the multimedia lab. For example, students could easily see how the discussion of the role of nature in a specific short story related to some of the environmental issues they described in their own development groups. Of course, it took learners several weeks to recognize some of the advantages of incorporating technology into the Spanish class. Selected student comments indicate that they were initially skeptical and apprehensive as to how both components would fit together. Looking back, one student wrote: "Upon entering a Spanish class that included the use of technology, I was skeptical of how the class would function. I had never used any recent technologies in any high school Spanish class... I feel that the whole class learned the basics of how to use technology in an integrative learning process." Toward the end of the course, Initial uneasiness about using technology had turned into proud ownership of having created a CD-ROM. This became evident a few days prior to pressing the trial CD, when one student brought a friend to the lab to show off her group's work.

4. SUMMARY

The *Vistas Ecológicas* project has shown how teachers can modify intermediate-level Spanish classes in order to target the national foreign language standards. Through technology-enhanced learning projects, students can become involved participant learners and acquire, at the same time, the technological skills needed to become developers and teachers of their own.

The collaboration between SCU and Alándaluz has also illustrated the potential of international partnerships. Rather than simply leaving a partner empty-handed or merely learning about each other, such projects can pave the way for learning with each other.

Finally, technology-supported collaborations can empower the partners at either end and allow them not only to think globally and to act locally, but also to help them join forces on behalf of a common good, the environment.

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Educational multimedia implementation in schools: Producer-teacher-student links.

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Abstract: The paper presents findings demonstrating benefits of cooperation between a commercial multimedia production company and an United States elementary school district that resulted in an unique curriculum integration project. The results of the study indicate a positive impact of the curriculum-tailored, interactive multimedia simulation on both the teacher's perceptions and teaching methods and the Grade Two students' motivation, understanding, and thinking skills. Conclusions based on the results should assist curriculum designers, teachers, and multimedia producers achieve better integration of educational software in school curriculum.

During the last decade we have witnessed a significant rise in the number of computers in schools and in the amount of sophisticated instructional software in the commercial education market. However, the integration of educational technology in school curricula still lags behind earlier expectations. Several reports and researchers [Drazdowski 1997]; [Maddux, Johnson & Willis 1997]; [Szabo & Schwarz 1997] have tried to explain this gap, usually in terms of a failure by colleges of education to expose students to educational technology and to train them adequately in this area, budget limitations, the teachers' fear and reluctance to incorporate computer technology in their classrooms, and infrastructure organizational difficulties. These explanations ignore the relationship between software producers and educational consumers (schools, teachers, and students). An alternative explanation - and solution - for the limited success of educational technology in schools involves, not just the factors highlighted above, but the mismatch between available software and teacher requirements. Because teachers have increasingly to integrate commercial multimedia products into the existing curriculum, the products can inadequately fulfill the teacher's specific learning objectives. An obvious solution to eliminating the mismatch is a collaborative partnership between software producers and teachers. Some educational multimedia software companies acknowledge the possible mismatches and employ ex-teachers or consult practicing teachers. However satisfactory this practice may be in the resultant stand-alone educational CD-ROM, it still ignores the need for significant systemic and curricula rethinking and restructuring between the stakeholders and within their organizations: the software company, school boards or government education departments, individual schools, and teachers.

Such creative restructuring occurred between an educational multimedia producer and an American school district, its schools, and teachers. In 1993 the Plano Independent School District (PISD), Texas, decided to shift the teaching methodology and segregated discipline-based curriculum of its elementary school system into a thematically integrated, computer-based curriculum [Jacobs 1989]. Edunetics, a multimedia production company, was contracted to help redesign the curriculum, inservice teachers in the area of computer technology, and develop educational computer software that would serve as the backbone of the new integrated curriculum. The participating K-5 teachers were released part-time to work cooperatively with the pedagogical and content experts in Edunetics. Together they identified 36 topics based on six themes stipulated in Texas-wide elementary curricula and structured around different core Organizing Ideas. In essence, the production process was designed so that the PISD teachers expressed their curricular needs. The multimedia company was responsible for translating those needs into a computer product. The collaboration represents a unique enterprise where an educational software company and teachers equitably shared decisions to produce digital and non-digital educational products that focus appropriately on curricula needs. Through such cooperation, the teachers were empowered through having a major stake in the conceptualization, content, and user-learner interface design of each CD-ROM.

Our project was not concerned with ascertaining whether learning with particular software produced better test scores than learning without the software. Rather, the research examined the incorporation of educational multimedia as part of a newly-designed integrated curriculum in the "messy" environment of a classroom over a period of time. The researchers were interested in how the use of the software impacted the classroom teaching-learning community. The paper focuses on particular aspects of the wider research, distinguishing between findings which contribute to (a) a clearer understanding of the learning process in an authentic context, (b) the teacher's role and the classroom computer culture, and (c) the production knowledge of the producer.

Methodology

The qualitative interpretive research was designed to assess aspects of the educational implementation of the PISD curriculum integration project. Dependability and confirmability of the data were enhanced through triangulation of varied data collection instruments; site engagement for the six week duration of the integrated curriculum unit; and researcher observations authenticated by video and audio taped data.

The research was conducted in a Grade Two class in one of the PISD participating elementary schools in Plano during the Spring quarter. The teacher had trialed the Beta version of "Message in a fossil" (MIF) in her Grade Two classroom two years before, and used the final product in the year previous to, our research. The class was chosen because it was the most ethnically and socio-economically diverse compared with those of the other volunteering teachers; even so, it was still significantly middle America. From the 20, seven year old students, the teacher was asked to select three, same-sex groups of two children based on ability. The study used these pairs for indepth study. The outcome of the teacher's selection was one pair of two high achieving female students; one of two low achieving male students; and the third comprised two male students, one high achiever and one low achiever. Based on research [Inkpen 1997]; [Inkenpen, Booth, Gribble & Klawe 1995), it was thought that for the scope of this investigation, mixed gender groups would provide one too many variables.

The software, MIF, is a simulation [Rieber 1996] in which the student is a paleontologist who excavates in virtual grid dig-sites, discovers plant and animal fossils, predicts what they might be, identifies them by comparing them with those in the fossil collection, and, based on the uncovered fossils, reconstructs the prehistoric world by constructing a museum diorama. In this interactive environment, the student emulates a scientist and practices science skills. "Message in a fossil" was incorporated into a six week integrated curriculum unit with "Evidence" as the Organizing Idea. The major theme of the unit was gathering, interpreting, and communicating evidence to solve mysteries and problems, particularly those that inform our understanding of the past. For approximately 45 minutes each day, the class worked in stations where each small group activity integrated the Organizing Idea and theme across curriculum areas. One of these daily rotating stations was learning with MIF. The teacher also included MIF into the time allocated for reading. This meant that each student used the software each day for 20 minutes during reading, with some using it twice a day during their station activity time. In addition, when they finished other work children could choose to work with MIF, if a computer were free. The classroom had seven computers and a printer that were networked to a fileserver through which the children accessed the software.

Global data were obtained from pre and post, written and interview questionnaires with the students and teacher. The student written questionnaires were administered by the teacher who read out each question at a suitable answering pace for the children. The researchers felt that it was appropriate for Grade Two children to have test items that utilized hands-on activities which were administered via pre and post audiotaped interviews. Pre and post audiotaped, flexible open-ended structured interviews were conducted with the teacher. Data were also obtained from the teacher's anecdotal and assessment sample records. Indepth data were obtained by narrowing the research focus to the small sample of six students. Each student in the three paired groups was administered a pre and post open-ended structured interview. Additionally, each pair was video and audio taped and observed whilst working together on the computer: twice in the first week and once a week for the following five weeks. Based on the recorded observation notes, retrospective recall interviews were conducted by a researcher with both students at the end of each video and audio taped MIF session in order to prompt recollections of their thinking, reasoning, strategies, and feelings during the activity.

RESEARCH FINDINGS AND ANALYSIS

Student Learning Outcomes and Processes

Some of the findings are grouped into the following subthemes: acquisition of scientific concepts and processes; independent decision-making and conflict resolution strategies; and motivation and enthusiasm.

The first subtheme grouping is the students' acquisition of scientific concepts and processes. From the pre and post questionnaire test items, there was a 28% improvement in students' scientific conceptualization and processes. From the data it is clear that all the children could correctly identify a fossil from rocks at the end of working with MIF and the other Organizing Idea integrated curriculum activities. However, only 56% could verbalize how a fossil was formed. Although there was a video about the formation of fossils in the software, less than half the class appeared to have visited that site other than during the whole class tour.

Comparison of the pre and post tests revealed a significant improvement in the students understanding of the complex concept of decay and longevity. They were required to identify which of six items (an apple, wooden door, shark tooth, bread, a sea shell, a book), presented as labeled pictures, they could still dig and find if the items had been buried a long time ago. Of the six items, two were correct. Out of a possible 36 correct answers (2 questions by 18 children), 35 correct answers and 1 incorrect answer were recorded in the post test. This was a substantial improvement on the pre test results with 26 correct answers and 37 incorrect answers recorded.

There was improvement in the students' ability to sort items into logical categories. Logical categories included such things as "mammals" and "have fur" whilst illogical groupings were given labels like "all part of nature" and "the remaining animals". Out of 18 students, nine provided significantly more logical groups out of their total number of groups in the post test compared to what they had in the pre test. Seven students had the same number of logical categories in the pre and post interviews whilst two gave fewer logical groups in the post test. We also analyzed the students' answers in terms of the scientific groupings used in MIF. In the post test, all students used the criteria utilized in the software, with six using more software criteria in the post test compared with the pre test; three students used fewer categories in the post test. It would seem that MIF and the other activities helped most students internalize what constitutes logical and scientific criteria and how to appropriately categorize that criteria.

The simulation, MIF, required the students to construct dioramas with fossils found in various habitats. To ascertain their ability to conceptualize which fossils belonged in the same habitat, the students were presented with four labeled pictures of fossils and asked to identify the fossil that did not belong in the same habitat as the other three. There was an improvement of 17% from pre to post test.

The results of the children working with the same partners with MIF for the six weeks are worth comment. On the days when the research was not being conducted, the students either, with few exceptions, chose the same partner or worked individually (Student interviews). There was an improvement in results from pre to post tests. In comparison with the classroom results some items revealed a significant difference. For example, as mentioned above, explaining how fossils were formed was answered poorly by the class; this makes the post test results for the pairs significant: 80% of the five students (one did not do the post test) answered correctly in comparison with 45% of the rest of the class. It is possible that the interactions between relatively permanent partners when working with MIF may have helped their understanding.

An analysis of an individual writing activity on dinosaurs and fossils that was set by the teacher at the end of the six weeks reveals internalization of content. The target was three facts - which they all achieved - and as much as they could write in five minutes. As the teacher pointed out, the topic was of "very high interest to them" so the quantity was no real surprise. Their answers did not reflect the traditional focus on listing the names of dinosaurs and the facts. They wrote more generally, even the lower achieving students. They talked about evidence and problem solving as well as correctly using paleontologist, diorama, and interdependence (a "buzz word for them"). Their writing included such things as: using a digging grid; measuring and labeling fossils; fossils were evidence that dinosaurs existed; "if you want to find out about them you can look at fossil remains"; the fact that "dinosaurs lived a long time ago and that some lived in the ocean and some on the land". A few students included the idea that dinosaurs and people did not live at the same time. Their writing overall contained high level information and embodied concepts presented in MIF and the other integrated activities.

Working with partners with MIF promoted student independent decision-making and conflict resolution strategies - the second subtheme. The teacher gave an example of the former: "Knowing where to go next, when to proceed to the next level of difficulty, and what to do if they couldn't finish their diorama at a single sitting, they totally took care of that themselves. And I've never had a group like that before. Usually, I spend the first few weeks hovering, giving directions." The students also resolved potential conflict issues about who to work with and how to work together equitably. For instance, sharing control of the digging and building the diorama were quickly decided and occasionally renegotiated amicably between the female and the high/low achieving male partners. However, in the second week the low achieving male partners took their shirts off and threw a few punches. As commonly reported in the literature (Inkpen, et.al., 1995), one of them explained that "we were trying to fight over control"; each took credit for solving their dilemma by being the one to establish taking turns on the mouse after each fossil find.

The third student learning outcomes and processes subtheme is motivation and enthusiasm. What the preceding discussion does not provide is any sense of the atmosphere or what occurred in the classroom learning community during the six weeks. The students' unanimous perceptions were that "you learned a lot" working with MIF, which was "cool", "lots of fun", "interesting", and "never boring". Data from the interviews, observations, videos, and teacher records confirm a consistently high level of enthusiasm, on-task behavior, friendly competition, supportive cooperation, use of appropriate language, and transference. There are three major interrelated reasons for these ingredients in the classroom learning climate and outcomes.

(i) Working with partners on MIF was the reason the teacher singled out as probably the most significant. All students mostly worked with partners and, depending on how they felt or the availability of their partner, they would choose to work with another person or, occasionally, alone. The six teacher-selected students were also allowed to choose other partners or work alone during non-research times. Irrespective of the set-up, there was discussion, requests for help, and unsolicited advise, between partners and neighbors as well as up and down the computer row.

In comparison with previous years, working with partners "made an incredible difference." Previously, it took the six weeks for any student in the participating schools to complete a certificate and it was "really frustrating for them ... I have never had anyone do expert level before." This year in the research class, there were certificates and dioramas at the end of the first week; by the end of the unit, a whole classroom wall was covered and all students had got to the expert level of difficulty. This permitted "better internalization of the vocabulary. They were not just listening by themselves; they were communicating" their understandings. Having partners "kept them focused" and provided "security so they could take risks" in their decision-making

(Teacher post interviews). Working with partners also seemed to have an effect on the classroom learning culture: "They all wanted to get the dioramas and they wanted to get the certificates. But when someone put up a certificate everybody would hover around them: 'What did you get?' 'What did you put in it?' 'Where did you find it?' You know, they really were interested in a very positive way, a very supportive way." (Teacher post interview). There was not so much a competition as a collaboration.

(ii) MIF itself promoted motivation and enthusiasm. The user interface design is unproblematic with meaningful navigational icons, and is enticing. The learner interface [Reeves 1993] contains various pedagogic elements that may have been influential in the children's learning outcomes. The software provides the necessary intrinsic motivational ingredients for an effective simulation: challenge, curiosity, fantasy, and control (Malone 1981]; [Rieber 1996). The children were "actually in control; they had so much ownership of it" and "felt like they were scientists doing it ... it was very real life for them" (Teacher post interviews). The challenge for self-improvement triggered further reading in order to do better in MIF. A number of students researched dinosaurs and fossil-related topics at home in order to "learn more about how to put the bones together" or "know what some of the things were when I got onto MIF."

(iii) The final contributing reason to student motivation and enthusiasm was the integrated curriculum. The teacher believed that MIF would produce meaningful learning outcomes if used as a stand-alone but its real value was enhanced through appropriate curriculum integration of software and other classroom activities. Indeed, one of the girls in the research pair explained that one reason she enjoyed MIF was "because it fits in with our integrated [sic]." The teacher further elaborated: "Even though Communication was the Overarching Concept and Evidence was our Organizing Idea, it was almost like 'Message in a fossil' was the organizing idea. It was the heart of everything." The teacher believed that this allowed them to make bigger connections within and between the activities.

The Teacher and the Classroom Computer Culture

This study identifies the teacher as a key component in the successful incorporation of computers and multimedia into the classroom. Her three year involvement in the PISD project had strengthened the teacher's enthusiasm for incorporating computer technology in the classroom: "I think it's the most wonderful thing that has happened ... and having the software that supports our curriculum has been fantastic, because it really makes a difference, particularly in what they [the children] like." Obviously, the number of computers was a bonus that supported the computer culture.

The research influenced the teacher's usual practices with respect to individual versus partnered work with the computer. Previously, all the PISD teachers using MIF decided that there would be a one to one ratio of child to computer: "We have wanted everyone to have, this American thing, you know, their own dig site; they had to own it." Because of our research request, the teacher changed strategies and organized for the remaining children to choose their own partners or work alone. During the post interview the teacher argued that partners allowed her to put into practice her pedagogic philosophy to maintain a facilitator role with an emphasis on student responsibility for their own problem solving. Instead of directing, data revealed that the teacher asked questions in response to the students' questions. Even when the paired low-achieving students resorted to throwing punches, the teacher suggested they solve their conflict in non-physical ways and (seemingly) confidently walked away. At the end of the six weeks, the teacher was adamantly committed to using partners when working with MIF and other similar computer software because "I can see nothing but benefits."

Contributions to the Production Knowledge of the Producer

The findings have practical and economic implications for multimedia producers. "Message in a fossil" is a pedagogically effective simulation, and could be viewed as an exemplar. Importantly, if the questions that were answered poorly on the post test are of curriculum significance, for example, how a fossil is formed, then they need to be woven into the simulation more substantially. Teacher support materials could contain possible strategies for student to computer ratio usage.

Another issue for multimedia producers concerns a post questionnaire item that required students to link a picture of the computer interface icon with its topic label (eg., Museum). Half the students incorrectly matched some of the icons. These incorrectly identified topics (including fossil formation) were extraneous to completing the diorama or achieving the three certificate levels. Only seven students said they visited these topics. This implies something about the willingness of students, at least Grade Two students, to diverge from the mainstream of the simulation activity. In such cases, the educational multimedia producer has options: if the content is considered important, then it needs to be a mandatory part of the simulation rather than nice-to-have extension activities; decide to exclude these non-simulation sections thereby cutting production costs; or produce a multipurpose CD ROM, like MIF, that combines a simulation with an extension database for multi-age level usage.

Conclusion and Challenges

The research suggests that producer-teacher cooperation in the planning and development of interactive multimedia products has a number of positive outcomes that could help redress the reluctance by schools and teachers to incorporate more extensively educational software into the class curriculum. First, the software that was produced proved well-tailored to curricular, teaching, and learner needs. Second, classroom implementation of the software in the way in which it was intended, ie., within an integrated curriculum, produced positive outcomes in terms of students' content knowledge and process skills and the teacher's teaching strategies. Third, the interactive multimedia simulation and the use of computer partners promoted a classroom computer culture and learning climate that was enthusiastic, motivated, and cooperative. Of course, there are limitations in generalizing this study. To augment the findings, further research is planned in various classroom contexts; for instance with differing cultures and grades, teachers with little to advanced computer expertise, and using the software as a stand-alone activity compared with its incorporation in an integrated curriculum.

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Teaching effectively with electronic databases: Paradigms suggested by interactive changes in teachers' mental models

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Abstract: The paper explores the runability cause-effect patterns of teachers' mental models when involved in one-on-one teaching-learning episodes using electronic resources in the context of authentic school assignments. The findings describe where variations existed in the mental models with respect to the perceptions of themselves as teacher and learner with electronic databases, their students, lesson planning, teaching strategies, and goals.

Introduction

Economic, political, and educational progress depends on strong electronic information literacy skills for global access and effective use of information. Productive teaching of computer-based electronic resources requires teachers to have appropriate mental models or schemas of the characteristics and protocols of these resources and strategies to teach effective access, research, and retrieval skills to meet individual students' needs. One method for constructing an appropriate teacher profile paradigm is to explore those mental models in situ. This involves studying changes to the schemas during and after teaching episodes. It also requires a further step that is usually not taken in mental model computer database studies. The paper demonstrates that formulating a relevant teaching paradigm involves examining the impact of changes in one mental model on another mental model or, indeed, other mental models. It reports the study of the cause-effect interconnectivity of various mental models utilized by ten American and Australian teachers when involved in one-on-one teaching-learning episodes using electronic resources in the context of researching information for authentic school assignments.

Mental models

A mental model is defined as a schema or internal domain-specific representation of an object or event that may be incomplete. Mental models can be conceptualized as tools that allow individuals to understand problem situations and predict outcomes as a consequence of their actions [Johnson-Laird 1983]; [Bliss & Ogborn 1989]; [Renk, Branch & Chang 1993]. In a teaching/learning situation where new information is added to the student's and teacher's knowledge, mental models will consequently be in a state of change. They are continuously processing their current schematas as a "runable" event by attaching new information to them and deleting context-irrelevant information from their mental models. This concept of "runability", or the changing state of mental models, is a core defining characteristic of a mental model; in some sense, runability is a processing mechanism itself, a process rather than a product [Jih & Reeves 1992]; [Randell 1993]; [Rogers & Rutherford 1992].

The notion of users' mental models is an accepted concept in the human-computer interaction literature although it is often given different terms such as conceptual models, cognitive models, and component models [Staggers & Norcio 1993]. Even so, the research literature dealing with mental models and usage of electronic databases tends to have a narrow focus. First, it mainly concentrates on the learner or user rather than the teacher or librarian, for example, [Stine & Wildemuth 1992] and [White 1994]. Second, it often attempts to establish whether there was a transition in the user's mental model conceptualization from naive to expert, and proceeds to explain why this did or did not occur [Carmel, Crawford, & Chen 1992]; [Doomen & Leuven 1997]; [Jacobson & Jacobson 1993]; [Moray 1986]. Third, the literature significantly focuses on mental models as product rather than process [Randell 1993]. Indeed, although the literature does not deny, it devotes little attention to the multiplicity of mental models simultaneously held by the participants and thereby ignores how these various mental models interact to impact on runability. Thus this paper does not concentrate on the teachers' beginnings or arrival (ie., comparison of their initial and final mental models) but examines the teachers' dynamic mental model adaptations to a complex changing environment [cf. Carley & Palmquist 1992] and [Randell, 1993].

Research Goals

The researchers investigated runability, that is, if and how the teachers' mental models changed during the teaching-learning episodes in order to build a profile of appropriate mental model elements. Those selected for discussion are mental models of: (a) the electronic data base, (b) the role of the teacher, (b) their lesson goals, and (c) their teaching strategies.

Methodology

The following methodologies were chosen to achieve the research goals:
(a) individualized interviews using structured, open-ended questionnaires at the beginning of each individual's participation. These open-ended questions were grounded in the data from a pilot interview and the work of researchers who had previously investigated mental models.
(b) video-taped teaching-learning episodes. In order to obtain a realistic situation, the teachers were asked to structure the teaching episode so as to replicate their normal practice. Thus, the teaching/learning sessions lasted for however long the teachers maintained the instructional interaction.
(c) individual process-tracing stimulated recall interviews based on the videotaped episode. The methodology adhered to the strict protocol developed in Australia for text and interactive multimedia qualitative studies [Marland, Patching & Putt 1992]; [Putt, Henderson & Patching 1996]. Each teaching episode videotape was replayed to the teachers to stimulate their recall of their thinking during the episode.
(d) two individual post interviews containing a set of open-ended questions. One was conducted immediately after each stimulated recall interview while the final, smaller post-interview was administered to each teacher at the conclusion of all previous data collection sessions.
(e) analysis of the data with the aid of the qualitative software package, [QSR NUD*IST 1997]. First, the teachers' mental models were identified. Second, the extended network of concepts within each of these overarching mental models [Carley & Palmquist 1992] were identified from the data and entered into NUD*IST within the identified coding category nodes. Third, the researchers pulled data from any of the nodes in any combination desired.

Sample

The researchers employed a purposeful sample in the United States of one elementary, one middle school, and four secondary media specialists, each with two student participants. These media specialists, selected by the differences in experience and teaching background, were located in Georgia. The study was replicated in Queensland, Australia, with media specialists chosen by their availability and level as closely replicating the United States media specialists as possible. (In Australia media specialists are designated teacher librarians but the term, "media specialists", will apply to both sets of teachers.) The students were chosen by the classroom teachers at the request of the media specialists and had an authentic assignment that required the use of an electronic database resource. By having the media specialists each teach two students, the researchers could identify any adjustments in the teachers' mental models in response to each student's needs and the teachers' reflections on the first teaching/learning episode.

Findings and Discussion

From triangulation of the data it was possible to construct a "before", "during", and "after" profile of the media specialists' mental models as teachers of electronic databases. This paper is concerned with examining some of these mental models in the "during", runability stage of the profile of the teachers. Hence, the before and after profiles are summaries of the findings that, nevertheless, help provide a contextual overview.

The "Before" Profile

The before profile contained the following sorts of mental models. All media specialists held perceptions that their mental model of the database was satisfactory. Their mental models of the role of teachers contained samples of teacher-as-expert, teacher-as-director-of-events, teacher-as-colearner, and teacher-as-facilitator. Their teaching strategy mental models advocated a hands-on approach with the student in control of the keyboard and mouse. Their mental models of what constituted appropriate planning resulted in the following sorts of preparation: only a couple had one or more practice sessions on the database; none developed pencil-paper lesson plans; most reactivated their schema to massage certain teaching strategies into some sort of mental procedural list; and some relied on their years of experience to allow them to utilize effectively their mental model "on the fly". There was variation in the teachers' mental models of their lesson goals: some saw student procedural understanding as the outcome; a few aimed for a conceptual framework in which were located the procedural steps of access, research, and retrieval; many saw having a tangible outcome - a print-out of a list of references or information - as the appropriate goal. The summary details an incomplete list of the teachers' mental models. It nevertheless provides a conceptualization of the number of mental models that teachers utilize for any teaching-learning episode and the range that occurred within the research sample.

Runability: An Examination of the In-Situ Profile

An examination of the "during" teacher profile stage highlights what impact the cause-effect changes in some mental models had on the runability of other mental models.

Not surprisingly, all the teachers perceived they had an adequate mental model of the electronic database they chose to teach to meet the students' assignment needs. The teaching-learning episodes exposed discrepancies with these perceptions. Analysis revealed there was a range from a superficial working knowledge to robust conceptualisation of their database mental models. Significantly, the same range existed within several individual teachers' mental models of the database, thus exposing a fluctuating understanding of the complexities of the databases. Such inconsistencies in their mental models of the database had repercussions for the teachers' mental models of (a) the role of the teacher and (b) the teaching strategies utilized during the lesson. The following helps clarify this example of mental model runability.

Two media specialists experienced near-replica "technical nightmares", that is, breakdowns in their mental model conceptualization of the database protocols when attempting to establish dial-up access through the Internet to the university and public libraries, respectively. One media specialist's mental model of herself as a teacher of electronic databases was that of co-learner with the student. Putting her mental model into practice, she openly discussed her bewildered lack of success and ensured that the student was co-solver of the teacher's predicament. During the stimulated-recall interview, the teacher stressed that she consciously thought that her teaching strategy demonstrated her mental model of the teacher as co-learner and that it would help the student create a new, or reinforce her existing, mental model of the legitimacy of the teacher as a continuing learner. In contrast, another media specialist's ambiguous mental model permitted her to admit errors while still maintaining the role of director-of-events, thereby overlooking the possibility of inviting her student's involvement in finding solutions. She reported that her overriding consideration during technological "moments of panic and discomfort, because of unfamiliarity with the database," involved a mental model of the role of teacher as expert: "I was concerned a little bit about my own image ... I didn't want to come across as if I didn't know what I was doing." Her mental model involved her normal immediate preference for "abandoning ship" and asking the student to come back later. Time-out would allow her to develop a more consistently robust mental model of the database that, in turn, would reestablish her mental model of herself as teacher-as-expert of electronic databases in both in her own and, ipso facto, the students' eyes.

Most media specialists' mental models of the lesson goal were for the students to acquire procedural understanding, that is, be able to repeat the procedures for access to the database and location of appropriate content. This mental model dovetailed smoothly with the added goal of obtaining the best immediate resources for their students' assignments. Too few of the media specialists helped their students form a mental model or image of the resource itself in its broader dimensions. According to researchers [Borgman 1984] and [Brown, Collins & Duguid 1989], students need to be exposed to the use of a domain's conceptual tools in authentic activity for robust mental model acquisition. Teaching with the goal of obtaining a successful product, such as a list of appropriate resources, has been a traditional approach for resource location and access. The goal has concentrated on imparting a set of procedures for the student to follow. Thus, its transferability to teaching with electronic resources, as demonstrated by some of the media specialists, is problematic. When confronted with electronic resources users do not have the opportunity to see everything that the database contains as they can with print resources. They are confronted with one computer screen with one page of information. A mental model of the information and all the various linkages to the information is necessary before students can create their own mental models of the procedures they need to follow to retrieve information successfully.

All the media specialists held mental models of how to teach database access, research, and retrieval that reflected an important tenet in Piaget's and Bruner's learning theories, that of direct experience. Students were to have hands-on experience with the computers. Some teachers shared this mental model with their students thereby making the rationale visible in terms of student learning outcomes: "... you will remember more if you do it yourself instead of my just telling you how to do it." Most initially had a mental model of sitting beside the student who had control of the keyboard; some did not succeed because their mental model in operation was affected by their mental model of the student's ability: "The temptation to touch the keyboard was too much given the student's hesitancy and I sort of jumped in." Others encompassed a show-and-tell-then-copy-me strategy whereby the students took control during the latter half of the lesson in order to demonstrate their ability to replicate the teacher's procedures. Although all allowed hands-on, many teachers used directive statements or questions; only a few adopted a questioning technique that involved procedures, predictions, and consequences of the database's navigational and/or hypermedia features.

An examination of the interconnectivity of two of the teachers' mental models with respect to their lesson goals, teaching strategies, and role of the teacher helps clarify these points. One media specialist concentrated on the student's acquisition of procedural skills while the other saw conceptual as well as procedural understanding as the important learning outcome. Both used questioning strategies. A simple tally of the number and types of questions from the transcriptions of the taped video lessons reveals significant differences. The former teacher asked 79 questions of which 30 (38%) required a yes/no answer and a further 34 (43%) were also of the closure type needing the correct answer. The latter teacher asked 54 questions of which 11 (20%) required yes/no answers with a further seven (13%) being closed-answer questions. For the former teacher that left a mere 15 (19%) questions that demanded higher level thinking from the student; for the latter, a substantial 36 (67%). Both sought answers requiring deduction, prediction, and interpretation; however, the teacher whose goal was for the learner to be able to conceptualize the relevance of the hypermedia and navigational features of the database also required the student to compare, explain, synthesize, and extrapolate. Neither media specialist experienced conflict among their teaching strategies and lesson goal mental models and their mental models of the role of the teacher. It was no surprise that the data revealed the former teacher's mental model held the teacher-as-director-of-events whilst the latter depicted the teacher-as-facilitator.

Conclusion

The profile of the teachers' mental models at the conclusion of the study revealed that some media specialists made dramatic changes to some of their mental models, for the better, in their perception; others made modifications to counteract weaknesses; and some maintained the status quo. This last group retained a mental model that essentially held that there was one way to teach electronic database skills regardless of the student's age, learning style, level of computer/database expertise, student outcome needs, and, significantly, the database itself. Data suggests that they did not recognize the inappropriateness of these mental models, particularly when teaching the lessons. Data also revealed that the "status quo" group and a few of the other media specialists had no perception that their mental models as carried out in practice did not reflect their "before" mental model. Interestingly, some media specialists did perceive this, and acknowledged this verbally in their first post-stimulated recall interview. However, the mental models evidenced during their second teaching-learning episode did not reflect their earlier statements and belief that they had now, indeed, incorporated the changes to their mental models. Our study suggests that mental models are ingrained during initial experience with print resources and the procedures used to teach access of information in print resources. Transition to electronic resources requires of acceptance of changes in mental models to incorporate consistent robust conceptualization of the hypermedia features of electronic databases.

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The Highschool Project Mobile Classroom in Baden-Wuerttemberg

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Abstract: In the German federal state of Baden-Wuerttemberg, extensive tests on the use of computer algebra systems are going on since 1993. With the beginning of the school year 1996/97, we have started a pilot project that is at present unique in Germany. All students of five 11th grade classes (age 16 - 17) from different towns in Baden-Württemberg have been equipped with a modern notebook and will work with MAPLE for three years until their final exam. One of our major goals is to bring more applications and modelling into every day teaching experience.

1 Introduction

The Federal Republic of Germany consists of 16 federal states which are all independent in matters of education and culture. I will talk about my native state Baden-Wuerttemberg, where I am responsible for the training of future high school teachers. Deficiencies of our teaching that have already been known before TIMMS make it necessary to reflect on the ways of contents, methods, and didactics of teaching in its present form [see Blum 1995]. After TIMMS brought mathematics teaching into public view we hope and believe, however, to be able to change something over the next years [see Henn et al. 1998b].

2 Computer Algebra Systems (CAS) in the Classroom in Baden-Wuerttemberg

We regard the sensible use of computers as a new didactic and methodical dimension. Especially computer algebra systems alleviate the numerical and algebraic „burden" and thus make it possible to concentrate on modelling activities [see Henn 1998a]. In Baden-Wuerttemberg, extensive tests on the use of computer algebra systems are going on since 1993 [Henn 1996]. We will examine the influence of such systems on school mathematics and their educational goals and the ensuing consequences for a mathematics education fit for the 21st century. We will investigate questions such as the following: What exactly are the real potentialities for the use of CAS to support mathematics teaching? Which conditions favor its use? Where do obstacles lie, are they located in the hardware or the software, at the cognitive level, in the didactic practice, or in the daily use? Luckily, we have in principle a free hand as far as the ministry is concerned. The excuse „I would like to do it but the guidelines don't allow it" isn't valid any more. First, we started to offer courses for *Mathematics with CAS* at the higher secondary level in more than 40 schools. We work with the software DERIVE and MAPLE. Normally, the students work in the schools´ computer labs.

3 Framework of the Pilot Project

With the beginning of the school year 1996/97 we have started our most ambitious pilot project *Mobile Classroom* which is up to now unique in Germany. In order to optimize assessment of the long term consequences of CAS, all students of four 11th grade classes (age 16 - 17) in different towns in Baden-Wuerttemberg have been equipped with a modern notebook, a fifth school has joined this school year. In Year 11 students can choose between advanced-level and fundamental-level courses, then work with their notebook until their final examination, where they will receive special examination problems. The CAS MAPLE is used. „Normal" teachers

teach these students. It is exciting to watch this teaching and to discuss with all who are involved! The teaching project receives high public attention - a fact that is also appreciated by the respective members of the local state parliament. Often newspapers and local TV stations report on such project classes. The project received no recommendations regarding contents from the ministry (apart from allowing students to transfer into a „normal" Year 11 class). Project teachers reported regularly and in detail on planning, teaching, results, and experiences with their classes.
We mathematicians of the Karlsruhe seminary provide pedagogical advice for the project, especially with regard to educational concepts, proposals for teaching, exchange of experiences, design of syllabi, joint meetings with project teachers in Karlsruhe or other meeting locations, and informative classroom observations. The Internet is used as an electronic filing system for all reports, material, exchange of information, and e-mail contacts. Participating students and teachers are interviewed and a detailed annual report is provided for our ministry.

4 First Experiences From the Instruction Experiments

In general, students are much more motivated, there is a lively working atmosphere that differs pleasantly from the usual bored, receptive behaviour in Year 11. Mathematics teaching, however, becames more challenging.
Demands on teachers are high. Getting to know the CAS used and subject-related teaching preparation are very time consuming. The teacher rôle is completely different, away from being the central mediator of mathematical content towards the planning of courses and worksheets and giving advice to classroom workgroups. A high measure of flexibility is asked for.
During the first year the chronology of teaching in all four classes was motivated by the regular grade 11 curriculum, apart from the topic binomial distribution and tests which had to be omitted because of lack of time. For quite some time the handling of the CAS dominated teaching. The desired open approach were realized more and more towards the end of the school year. Typical problems then included, for example, the reinforcement of traditional teaching content by the transition to two-dimensional functions, the investigation of curvature as important curve characteristic, and the development of problem-solving competence using real life problems. These insights into methods of mathematical modeling are neglected in traditional teaching and therefore pose special difficulties for students.
Obviously, the new tool was to be used as often as possible, which also conformed with students' exspectations. Thus, teaching contents such as equations of straight lines, simple manipulations of expressions or the schematic curve discussion was treated in too much detail with the CAS - topics where paper-and-pencil methods make much more sense. In some cases MAPLE syntax was learned as a purpose for itself, in few cases students got lost fooling around in computer programming aspects.
The CAS proved to provide a special advantage for mathematical concept formation through its features for visualization, animation, and the automization of calculation processes. Problems resulted from the high technical and syntactical demands which left little time for phases of explanation. All collegues clearly agreed on this point. In future this will have to be remedied by changes in the selection and weighing of teaching contents. Also, one must carefully pay attention to a correct mathematical language, students tend to talk in MAPLE commands.
The chosen schoolbook was rarely used. Teaching methods were characterized by the use of worksheets, an instructional mode which furthers independent work. However, a danger lies in too thoroughly „pre-thought" teacher solutions that can be followed by students without much thought. („Didactics of the return key"). On the other side a variety of different solution proposals result within classes which can be very valuable from a didactical point of view. Yet often time was lacking for discussion and teacher prepared solution sheets took over the role of learning control. This is contraproductive and leads to a pure consumation of solutions.
As a rule, tests were written in two parts, one part with, the other without computer. Assessment was further influenced by class participation, project papers and coursework. Problems for the final examination in Baden-Wuerttemberg are posed centrally. As some of these problems turn out to be trivial when using a CAS we plan the following: Participating collegues pose two complete problems (consisting of various small problems from all covered topics). One of the problems is given to all students of this teacher. Thus topics can be tested that have not been covered by all classes. An additional problem is worked out by us and given to all students.

An anonymous student questioning at the end of the school year showed that all students would again decide to take part in the CAS project. They experienced the computational facilities of the CAS as a relief and the visualization possibilities to be a great help for understanding. Emphasis on independent and cooperative learning modes were seen as very positive. However, no one wanted to do completely without traditional teacher-centred instruction.

5 Computer Algebra Systems - Challange and Chance

I want to summarize: The CAS computer should be used as a methodical supplement to classical media such as blackboard, exercise book, etc, but it should not substitute them to a major part. As a rule the design of a problem solution has to be done using paper and pencil. The MAPLE slogan „the end of the pencil" is nonsense! This is also emphasized by students' comments such as: „One cannot think behind a computer monitor". The aim is certainly not to perfect computer science aspects. A main point is the didactical reduction to central concepts of the subject, not the accumulation of new contents even if it may be easily accessible from the CAS perspective. Thus, compared to the first course, time can be won, time that is urgently needed to strengthen the explanation aspect. Traditional mathematics teaching is accused - and not without good reason - to put too much emphasis on syntactical skills. It would be a catastrophy if this situation was to be strengthened by an uncritical computer use. The aim cannot be to automize classical curve discussion methods by computer use even if these methods are part of each Abitur examination, but to help understand criteria and concepts and to apply them in appropriate situations. The new tool CAS enables us to do this, because it allows open-ended problems that lead to individual new solution strategies and motivates creativity. This conscious problem solving process usually requires a mathematical modeling, i.e. a translation of the situation under discussion into mathematical language [see Henn 1997].

6 A Look in the Classroom

6.1 The CAS helps to solve problems ....

The following problem is typical for a relatively open-ended problem formulation that is still stated in a way to enable all student to work on it according to their individual abilities:

Discover and prove!

a. f is a polynomial function of third degree with zeros -1, 2, and 5. Draw the tangent to the graph of f for $m = 3.5$. What do you notice?
b. Does your conjecture also hold true for a polynomial function of third degree with three other zeros?
c. Can a corresponding conjecture be transfered if a polynomial function of third degree has only two zeros?
d. Can a corresponding conjecture be transfered if a polynomial function of third degree has only one zero?
e. Are there any generalizations to other functions?

Without much effort students formulate a first MAPLE worksheet. Only little MAPLE syntax is needed. MAPLE draws the graph of f and the tangent. Numerical values have been chosen in such a way that the desired theorem stating that for three zeros n_1, n_2, and n_3 the tangent for $m = (n_2 + n_3)/2$ passes through the third intercept point with the axis $(n_1|0)$, becomes obvious. An abstractly thinking student is going to choose the approach

$$f(x) = a\,(x - n_1)(x - n_2)(x - n_3)$$

immediately and to check with MAPLE that the equation $t(x) = 0$ has solution n_1. She has then already answered question b. and c. by writing down the double zero twice. A more visually minded student will investigate further examples, which is easily done by variating his own worksheet. Question d. can be seen as trivial or in a more difficult direction, our theorem can, for example, be generalized by substituting the three zeros by three arguments with the same function value a. Finally, the last question e. is completely open-ended, for example the question can be reversed to searching functions f with three zeros n_1, n_2, and n_3 with a tangent to $m = (n_2 + n_3)/2$ with zero n_1.

6.2 .... but the CAS can also be contraproductive!

The harmonic series provides a nice example of how a problem can be solved by suitably thinking after the computer has failed. Addition of the first n summands of the series by computer shows on one hand that computation time increases dramatically with growing n, whereas the series seems to converge somewhen. This result should not be withheld from your students. By appropriate addition of the next 2^m summands respectively it is shown by hand that each time more than 0.5 is added to the series sum, making it clear that the harmonic series diverges. The power of MAPLE can create false ideas among students if the system is use meaninglessly: For small values of n MAPLE calculates at once the exact value of $\sum_{i=1}^{n}\frac{1}{i}$. Unfortunately, MAPLE provides a good approximation for any n almost immediatey, because much mathematical knowledge has been worked into the system. MAPLE recognizes series such as the harmonic series and knows that its value can be expressed by means of the digamma function. When the sum is calculated for a variable upper limit n the MAPLE command

```
> s:= sum(1/i,i=1..n);
```

is at once answered correctly by

$$s := \Psi(n)+\gamma .$$

Then, if one asks MAPLE

```
> limit(s,n = infinity);
```

the right answer

$$\infty$$

is given. But, who wins anything if students are confronted with this misunderstood „general abstract nonsense“ without any comment?

6.3 The CAS Supports Concept Formation

Rates of change are an adequate approach to calculus. This idea opens the way to many applications. The rate of change is often known (directly or by modelling) and the function can be reconstructed from this. The right understanding of the basic principle leads to all differentiation and integration rules and clarifies the ideas which are behind curvature and arc length. Just the same as we leave the calculation of sine values to the pocket calculator, we leave the practical calculation to CAS. In principle, it carries out algorithms which are understood and done by hand for the simplest examples. The following example indicates a graphical approach to the derivative as local rate of change and to the integral as its reconstruction. Starting point is a current test report about a new cartaken from a motor journal. In the table of data and measured values, among other things there are the times of acceleration from 0 to v for different velocities v [see Tab. 1].

Meßwerte	
Beschleunigung	
0 - 50 km/h	2,1 s
0 - 100 km/h	3,9 s
0 - 130 km/h	5,4 s
0 - 160 km/h	7,1 s
0 - 180 km/h	8,8 s
0 - 200 km/h	10,5 s
0 - 250 km/h	17,4 s
400 m mit stehendem Start	11,6 s
1 km mit stehendem Start	20,7 s
Höchstgeschwindigkeit	308 km/h
Preis	
Porsche 911 GT1	DM 1.500.000,-

Table 1: Table of Data and Measured Values

You can immediately make qualitative statements like „the car accelerates quicker at the beginning than later". The precisation of this sentence in the sense of a quantitative statement is a typical problem of science!
To improve the first results, we should have more information about the connection between time t and velocity v. We can obtain this information indirectly by drawing a curve through the measured points. The type $v(t) = 1-2^t$ is the most adequate of the function types known from lower secondary level. A corresponding function has first of all to be adapted, using the measured values and the maximum velocity of [Tab.1]. MAPLE takes on the calculation and the graphical representation [see Fig. 1]. With it, we are able to compare the acceleration values in a more meaningful way advising MAPLE to calculate for a fixed Δt the average rates of change

$$\bar{a}(t)=\frac{v(t+\Delta t)-v(t)}{\Delta t}$$

and to represent them graphically. This is done in [Fig. 2] for $\Delta t = 1$ sec.

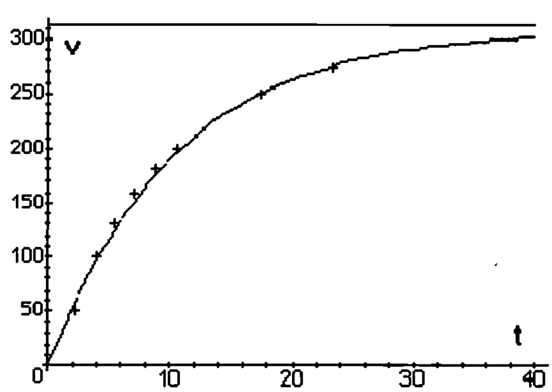

Figure 1: Velocity-Time-Diagram

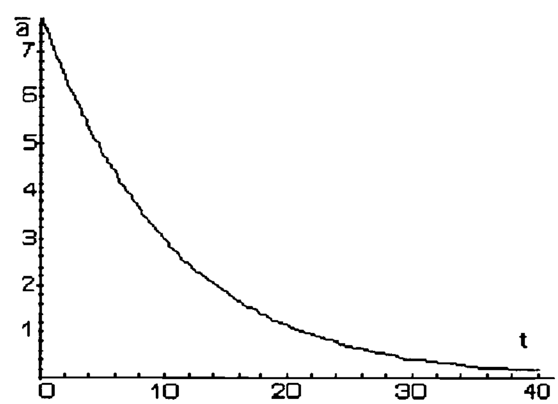

Figure 2: Acceleration-Time-Diagram

Now, the acceleration behavior of the car can be seen much more clearly. For a more precise analysis, MAPLE has to calculate the average accelerations for a fixed value of t and for the time interval from t to $t + \Delta t$. Doing this for $\Delta t = 1$ sec, 0.1 sec, 0.01 sec, and so on, the stabilization of the values becomes clear quickly! The way from the average to the local rates of change with the graphical background of the transition from the secant to the tangent is done informally.
A second question is added to our data of velocities. How far has the Porsche driven by accelerating from 0 to 250 km/h? The basic idea is to reconstruct a function through its rates of change. Here, we get a first estimate, assuming a constant velocity between two points of measurement. That means 0 km/h as lower, 50 km/h as

upper estimation respectively between 0 and 2.1 sec, and so on. Usually, the students propose the starting point with a velocity linearly growing in every time interval, too. The three estimations give first estimations for the total distance. The third leads later to the trapezoid rule.
The method can be improved immediately by reducing the time interval Δt and making use of our function v: The total time t = 17.4 sec has been divided in n equal intervals of length $\Delta t = \frac{17.4}{n}$ sec. Then, MAPLE calculates improved lower and upper estimates for the total distance. Again, some experiments show that the values stabilize with growing n and show the way to the definite integral!
Eventually, we are able to check two further statements of the motor journal: Among the data of acceleration, two times are given in [Tab. 1] for driving a distance of 400 m and of 1 km, beginning at zero velocity and with maximal acceleration. We can control these times with respect to our curve of velocity. We can control these times with respect to our curve of velocity. We substitute n = $\left\lfloor \frac{t}{\Delta t} \right\rfloor$ ([..] means the floor function) in the sums for the time interval $\Delta t = 0.1$ sec and obtain two values to estimate the distance s(t) from 0 to t, accelerating with a stationary start that we can compare with the measured values of [Tab. 1].

Such an approach to the basic concepts of calculus avoids that derivatives are internalized only as tangents and integrals only as areas!

7 Conclusion

In the meantime, the use of computers belongs to the cultural skills. You cannot imagine the professional working day of the 21st century without multimedia applications. You must learn to use the new technologies responsibly. Education cannot shut itself off from it.
„Education is the only raw material, out of which successes may grow in the future for German export", said Prof. Schlafke of the Institute of German Economy. The TIMSS study shows that we have to take countermeasures in Germany to do justice to this claim again. It is one reason that the question about goals of the mathematics education has been drawn into the centre of attention. The crisis of mathematics education has become obvious clear through the advent of computers. „The computer forces us to think about questions which we would have had to address a long time ago did we not have computers", Prof. Schupp pointed out.
The development of mathematical concepts is only possible with many examples and counterexamples experienced at first-hand, then by classifying and organizing. Student's autonomy in thinking and acting, visualizations and dynamic figures support this process. In the States, those ideas are combined in the „Rule of Three":

Every topic should be presented geometrically, numerically and algebraically.

Lessons, which are classical and focused on calculations, loose their importance and with that freedom arises for a reorientation of mathematics lessons. The second basic principle of the American curriculum reform calls this the „Way of Archimedes":

Formal definitions and procedures evolve from the investigation of practical problems.

The computer opens up quite new dimensions for these new approaches to mathematics. Let us take the chance!

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Using situated learning and multimedia to promote higher-order thinking

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Abstract

This paper describes a qualitative study into students' use of higher-order thinking as they use an interactive multimedia program based on a situated learning framework. The analysis of types of talk used by students as they worked with the program clearly shows that the majority of their thinking was higher order, as defined by [Resnick 1987] and other theorists. Social, procedural and lower-order talk was less evident but present in their talk in reduced proportions. These findings suggest that a multimedia program based on a situated learning approach can provide a learning environment capable of supporting and maintaining substantial levels of higher-order thinking.

Introduction

Many educators and researchers discuss the importance of engaging students in activities which require more than the simple application of rules and procedures. [Collins, Brown and Newman 1989] contend that few educational resources (including interactive multimedia) are devoted to higher-order problem solving activities, and few activities require students to use cognitive and metacognitive strategies and processes. [Collins, et al. 1989] suggest that higher order learning—'cognitive and metacognitive strategies and processes'—can 'best be taught' through methods that employ a situated learning approach (p. 455).

While higher-order thinking might most simply be described as 'all intellectual tasks that call for more than information retrieval' [Baker 1990], [Lewis and Smith 1993] give a more comprehensive definition: 'Higher-order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations' (p. 136). Many studies have produced methods and procedures to classify and define higher-order learning. However, as [Newmann 1990] points out, each approach has its own persuasive rationale. He contends that it is not productive to try to choose the best, but more sensible 'to search for a common conception that embraces diverse emphases but which attracts professional consensus' (p. 42).

Situated Learning

To date, there appears to have been scant research into whether higher order thinking is enhanced and promoted by learning environments based on a situated learning framework. The majority of studies that have been conducted to investigate students' use of higher order thinking as they use multimedia packages report little evidence of in mainstream student activity (e.g., [Frampton 1994]. While the proponents of situated learning continue to claim that higher order learning is a consequence of learning within a situated learning environment, very little research has been done to evaluate the impact of situated learning elements on students' thinking, particularly with regard to the use of interactive multimedia programs.

This paper describes a study which investigated students' thinking as they used an interactive multimedia program based on the situated learning approach. The learning environment incorporated nine characteristics of a situated learning model, namely: an *authentic context*; complex *authentic activities*; *multiple perspectives*; *expert performances*; *coaching and scaffolding*; opportunities for *collaboration*, *reflection* and *articulation*; and *authentic assessment* [Herrington & Oliver 1995]; [Herrington, Sparrow, Herrington, & Oliver 1997]. The learning environment was designed for preservice teachers of mathematics. The multimedia program focused on the issue of assessment and presented a number of resources for preservice teachers to investigate from a variety of perspectives, such as short video clips of assessment strategies being used in classrooms, and interviews with teachers and students on the strategies; and a variety of text documents, such as a description of each strategy and mathematics experts' views. As they used the program, the preservice teachers were given a complex and sustained authentic task to investigate in the form of two letters: one from a parent complaining to the school about the number of tests her child is required to take, and the other a memo to the new teachers at the school (the preservice teachers) asking them to prepare a new assessment plan for mathematics in the school. It was hypothesised that the situated learning model, used in the design of the program, would lead to substantial levels of higher-order thinking in its implementation. Four groups of two students were videotaped using the resource over two semester weeks, and their discussion was transcribed for analysis with qualitative analysis software.

Framework for analysis

Several frameworks have been developed for analysis of student cognition within learning environments, which served as a useful starting point for the current study (e.g.,[Marland, Patching, & Putt 1992]; [Alexander & Frampton 1994]; [Nastasi & Clements 1992]. These frameworks use the basis of student talk as a means of identifying cognition and thinking with the nature of the talk being used as an indicator of the form of cognition and thinking undertaken by the student. The work of [Henri 1992] was most useful in providing a model for analysis of the data in the study. Henri developed her framework for analysis of student talk in a computer-mediated conferencing environment. Student exchanges during lessons were monitored and analysed using content analysis. Clearly, the categorisation of spoken messages within learning environments is a practised format for analysis of student talk.

In order to classify students' talk as they used the interactive multimedia program on assessment, a table of indicators was prepared based on the characterisation of [Resnick 1987] of higher-order thinking. To simplify the classification for the purpose of the research, several of Resnick's characterisations were combined to enable more distinct categories to be drawn. It was also necessary to draw up similar criteria for the classification of talk which could not be considered higher order—*Social, Procedural* and *Lower order*—rather than have a simple category of *Non-higher order thinking*. All student talk was classified according to the scheme which is represented diagrammatically below [Fig. 1]:

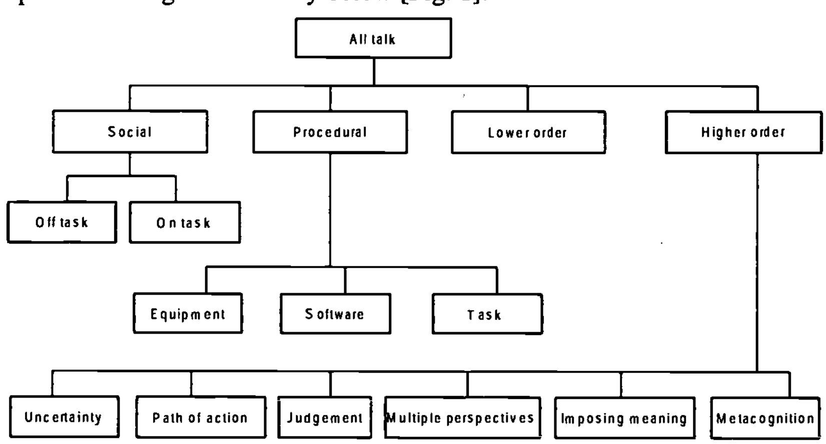

Figure 1: Flow chart of classification scheme of student talk

The unit of analysis

In order to assign student talk to a category, it was necessary to define the 'grain size' of the unit of speech to be classified. The method used was to count each instance of a type of talk as it occurred [Henri 1992] which enabled the detection of types of talk which may have been neglected by other methods, such as the counting of passages of dialogue, turns at talk, or individual words. Each category of talk, together with a definition, a short summary and example of type is given in [Tab. 1].

Table 1: Summary chart of classification of student talk

Category	Sub-category	Definition	Example of type
Social	Off-task	Any statement not related to the subject matter	G: We got caught in a traffic jam ... We didn't see it happen but we saw a van, the side of it was all smashed in.
	On-task	Any social statements which relate in some way to the task	C: Hey I know this guy ... He was my teacher. What a spin. I wonder what he is doing.
Procedural	Equipment	Any exchange of information related to the equipment (such as the operation of the computer, monitor, keyboard, CD-ROM drive etc.)	R: No you won't have a volume on this ... it'd be on the Apple menu. You have to go into systems folder then control panel.
	Software	Any exchange of information related to the software (any functional aspect of the program itself)	C: That didn't work. R: Did you push copy first?
	Task	Any exchange of information related to the task (the formal requirements of the oral or written report).	G: Are we actually supposed to prepare this as a report to staff? D: No, I don't think so. I think we prepare our notes and then just say it.
Lower order		Any student talk which is routine, requiring little thought, or the mechanical application of well known rules.	C: You are missing an r in strategies. R: They are playing dominoes. It is a little primary school class.
Higher order	Uncertainty	Any student talk which involved deciding on an approach to adopt, suggesting a course of action, or any expression of dilemma or uncertainty.	L: So really we want to look at all of them don't we? E: OK do you want to start putting anything into our notebooks?
	Path of action	Any talk which involved decisions about which elements of the program to access, what to save in the notebook and negotiations on how to proceed.	R: We should go right through the whole lot again. We need to make more notes on it.
	Judgement	Any statement or question which referred to students' attempts to interpret and defend their understanding of the issues presented in the assessment program.	G: If you're going to do anecdotal records ... D: You wouldn't carry them around. You'd make notes and put them in later. G: That's the whole point of having them combined.
	Multiple perspectives	A statement or question was classified in this category if it suggested an alternative approach or challenged a conclusion, or previously made point, by providing an alternative perspective.	R: OK investigations, factual ... Ah, factual, factual recall, rote learning. C: No, it's not saying you learn everything by rote, it's just saying that sometimes you want students to respond automatically..
	Imposing meaning	Talk was classified into this category if it referred to a possible solution to a problem or suggested alternative solution, if it expressed a decision about what to believe, or the creation of a new idea, or if it drew cautious conclusions.	G: Obviously we can introduce all of the strategies but not to start with. I think in the lower primary you probably can't expect them to do a mathematical investigation, so if they start out with oral work in the lower school and work towards doing the written ones in the upper school.
	Metacognition	Any comments which showed that students were aware of their own thinking and performance, and comments related to the use of this awareness to improve performance.	G: What was that? I didn't get any of that. E: I don't know what to do. Where is that piece of paper I had before? [The activity].

Discussion

The analysis of the transcripts showed that higher-order thinking was a substantial component in all the students' talk. In each of the four groups observed, the proportion of higher-order thinking to the other major categories observed was quite consistent and was measured at around 70% of the total talk.

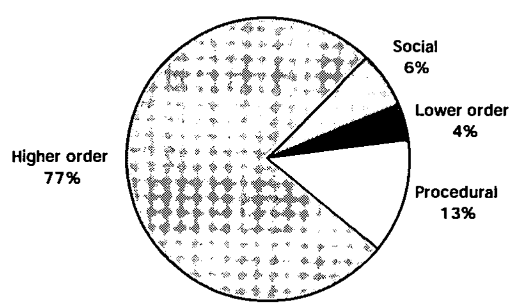

Figure 2: Proportion of categories of talk: Group 1

[Fig. 2] shows the proportion of categories for Group 1. The two students in this group used a substantial proportion of higher-order thinking in their talk as they used the multimedia program. Lower order comments, together with social talk, were kept to a minimum and procedural matters occupied only a moderate amount of their time. Like Group 1, the students in Group 2 used a substantial proportion of higher-order talk (70%), a moderate amount of procedural and minimal lower order talk. Of all the groups, this group had the most social talk, largely centred around discussion of their mutual friends, computers and work from other units of study. The students in Group 3 were least typical in their pattern of talk. There was a complete absence of social talk which appeared to be the result of the fact that they did not know each other prior to commencing work on the program. The amount of higher-order talk was 71%. A relatively high amount of procedural talk was observed in Group 3 and this was largely related to recurring computer equipment problems which were not satisfactorily rectified until the second week of the study. Like the other groups, however, they had a high proportion of higher-order talk, and minimal use of lower order talk. Group 4 were similar to the other groups in their use of a substantial amount of higher-order talk (68%). The remaining categories of talk were also comparable with other groups.

Proportions of higher-order thinking

The high level of higher-order thinking amongst all the groups meant that there was a substantial number of units of meaning in students' talk which could be classified according to the classification scheme (Table 1). While the amount of talk was quite consistent between the groups, there were many differences in the extent and levels of the various forms of higher-order thinking evident in the talk. The proportion of each of these types to the whole of higher-order talk for Group 1 is shown in [Fig. 3].

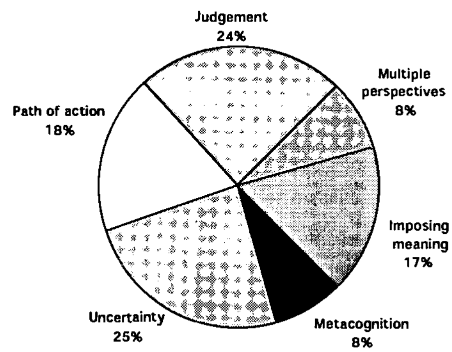

Figure 3: Proportion of categories of higher-order thinking: Group 1

The students in Group 1 used a substantial amount of all types of higher-order talk identified in the classification scheme. As with most of the groups, *Uncertainty, Path of action* and *Judgement* comprised the major part of their talk, with the other classifications making up the remainder. Clearly, these students were relatively comfortable working together, with the total of *Uncertainty* and *Path of action* totalling less than half their talk. The moderate proportion of *Multiple perspectives* appeared to indicate that these students were not excessively argumentative or critical, but were not afraid to challenge each other or the program when they saw the need. These students were also capable of spending a good proportion of their time *Imposing meaning* on their learning and coming to conclusions about the task and the recommendations to include in their reports. As with all the groups, these students' expression of metacognitive awareness was minimal, and it is possible that this is a type of thinking which does not manifest in the spoken word as well as the other categories of talk.

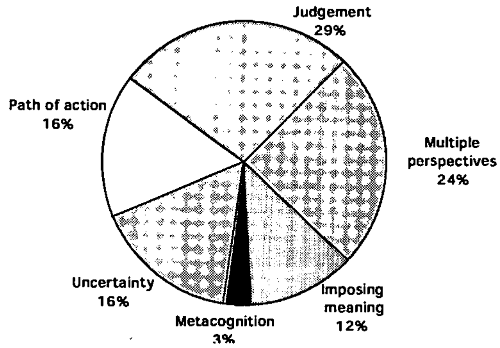

Figure 4: Proportion of categories of higher-order thinking: Group 2

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The interesting aspect of the analysis talk in Group 2 [Fig. 4] is the relatively low proportion of *Uncertainty* and *Path of action* compared to *Judgement* and *Multiple perspectives*. This division indicates that these students were forthright and confident in working out their path through the interactive multimedia program, and that they appeared to very comfortable working together. The high proportion of *Multiple perspectives* indicates that they adopted a very critical approach to the information they were obtaining from the program and from each other. The high proportion of *Imposing meaning* also seems to indicate that they were then readily able to consolidate the information into a meaningful form.

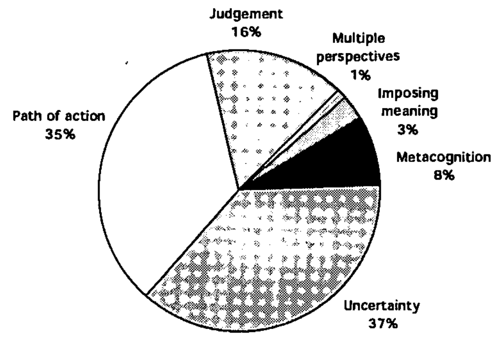

Figure 5: Proportion of categories of higher-order thinking: Group 3

While it is difficult to nominate an optimum spread of talk to categories within higher-order thinking, clearly Group 3 had difficulties which become apparent with closer scrutiny of their types of talk. The high percentage of time spent in both *Path of action* and *Uncertainty* reflects the tentative nature of their collaboration [Fig 5]. Almost three quarters of the total talk fell into one or other of these categories. As they were unaccustomed to working together, the students appeared to spend a relatively large proportion of their time consulting with each other about the nature of their collaboration—how they were to proceed, how to interact, and the responsibility each was to take in the process. Another interesting finding in the proportion of talk for this group was the almost complete absence of *Multiple perspectives* talk between the two students. Their collaboration was characterised by a reluctance to challenge each other's ideas or to challenge the perspectives that were presented in the multimedia program.

The students in Group 4 [Fig 6] used relatively little talk which was classified as *Uncertainty* and *Path of action* indicating that they needed minimal talk to establish a working relationship and a proposed plan of action. Like others, they demonstrated a high proportion of *Multiple perspectives* as they used the program. However, a large proportion of this talk was an argumentative style of interaction they used as they worked together, rather than a thoughtful disagreement with ideas presented in the program. This is possibly evident in the fact that there was a minimal proportion of talk which was classified in the category of *Imposing meaning*. These students, unlike Group 2, did not use the multiple perspectives they offered each other to inform the meaning of the task.

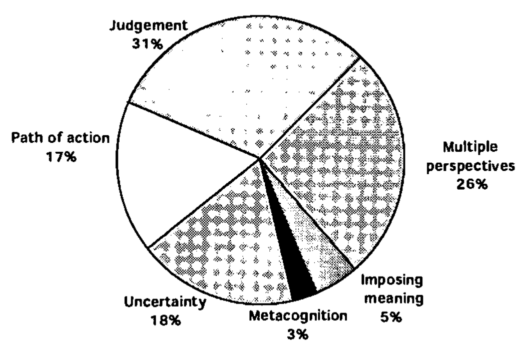

Figure 6: Proportion of categories of higher-order thinking: Group 4

Discussion

It is interesting to note the wide disparity between types of higher-order thinking used by the students as they used the multimedia program. The findings show that all the students used a substantial proportion of higher-order thinking in the situated learning environment, where other studies (e.g. [Frampton 1994]; [Oliver &

McLoughlin 1996] have shown little. The possibility exists that the classification scheme developed to analyse students' talk was not a precise enough instrument to truly reflect the cognition of students as they used the program. For example, comments such as 'What do you want to do now?' may be closer to a cliché or automatic response than a thoughtful reflection of the best course of action. However, even with a reclassification of *Uncertainty* and *Path of action* as *Lower order* thinking, *Higher-order thinking* remains a high proportion of the type of talk used by all the groups. An explanation for the amount of this type of talk is that the constructivist nature of the learning environment provided greater opportunities for students' higher-order thinking.

Another interesting finding was the non-sequential nature of the types of thinking used by the students, confirming the contentions of [Resnick 1987] and [Newmann 1990] that higher-order thinking is relative and non-hierarchical, and counter to behavioural theorists such as [Bloom 1956] and to some extent, [Gagné 1985], where progression to each level of the hierarchy is dependent upon mastery of the previous level. If one accepted a hierarchical approach to classification of thinking, it might be expected that students would begin with a little social talk to establish their working relationship; then procedural talk as they worked out the computer equipment, the software and the task; they might then be expected to move to lower order talk before using higher-order talk later in the session. Interestingly, there was no sequence or pattern to their use of talk. From the beginning, the students moved freely and without notice to any type of talk.

The analysis of types of talk used by students as they worked with the interactive multimedia program clearly shows that the majority of their thinking was higher order, as defined by [Resnick 1987] and other theorists. Social, procedural and lower-order talk was less evident but present in their talk in reduced proportions. These findings confirmed our expectations that a multimedia program based on a situated learning approach could provide a learning environment capable of supporting and maintaining substantial levels of higher-order thinking. Our findings contrast with many previous studies exploring students' cognition and thinking in multimedia use. The findings suggest that the instructional design embraced in the situated learning program and its implementation in this study successfully integrated a number of elements and components often missing in applications and uses of multimedia in contemporary learning settings.

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Context-Sensitive Filtering to Support Learning from Surfing

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Abstract: In this paper, as the first step to realize support facilities for learning from surfing, we propose a filtering method to support surfing. In surfing, a user is often provided too many choices to reflect the collected information. In such situation, learning from surfing is inefficient. We propose a filtering method where shifting interests in the surfing are modeled and the choices are ordered following the interests. The user can easily find the choices which are nearer to his/her interests. Because the load to find adequate information is reduced, the user may afford to learn from the collected information.

Introduction

Browsing is one of the most popular ways to gather information in database with hypertext structure, for example, digital libraries or WWW [Kaplan 1993; McKnight 1993]. Although the purpose of the browsing isn't learning, a user can get much knowledge from the collected information [Salder 1993]. Because this learning is a secondary effect of the browsing and isn't organized, it is difficult to control from the educational viewpoint. However, the amount of the knowledge acquired from browsing cannot be neglected. We believe the way to support learning from browsing is an important issue in learning systems.

Usually, the browsing is carried out under a clear task [Balabanovic 1995; Carmel 1992]. In such browsing, to complete the task should take precedence to learn. To support learning from the collected information may interrupt to complete the task. Therefore, the browsing with a clear task isn't an adequate target of the support.

Every browsing, however, doesn't always have a clear task. People often browse WWW or encyclopedia in CD-ROM format without clear tasks. Such browsing is often called "surfing." Because the purpose of surfing is usually to surf, educational interruption may be allowed. Our research objective is to support learning from surfing.

Although user's interests often shift depending on the collected information, it's not haphazard one(so, we often call surfing "context-sensitive browsing"). In this paper, as the first step to realize the support facilities for learning from surfing, we propose a filtering method to support surfing which named Context-Sensitive Filtering, CSF for short. In surfing, a user is often provided too many choices to reflect the collected information. In such situation, learning from surfing is inefficient. In the filtering method, the shifting interests in the surfing are modeled and the choices are ordered following the interests. The user can easily find the choices which are nearer to his/her interests. Because the load to find adequate information is reduced, the user may afford to learn from the collected information.

In this paper, we propose a model of the shift of user's interests. Then, we describe a method to filter information based on the model of the interests. We have implemented the filtering method for encyclopedia in CD-ROM format and confirmed that it is useful for free browsing [Hirashima 1998]. CSF on WWW is also discussed.

Context-Sensitive Filtering

Outline of Context-Sensitive Filtering

Figure 1 shows an example of browsing history. Here, an ellipse is a node: letters included in the ellipse are indexes

an index, nodes including the index are shown in the selection window as candidate nodes.
Selection Window: In the selection window, titles of the candidate nodes are shown and a user can select one as the next browse node. Our research objective is to order candidate nodes by relevance to the user's interests inferred from the browsing history. In the list of the candidate nodes, more relevant nodes for the user's interests are placed upward in the list, so the user can select them easily. When the user clicks a title in the list, the node content is shown in the text window.

Figure 2 is the snapshot where a user had read the explanation of "Client Server System" shown in the Text Window. He/she had then checked the "Useful Node Check" box. In the Index Window, a list of indexes of the "Client Server System" node has been shown. By clicking "personal computer", which is an index shown in the Index Window, the content of the Selection Window is renewed. The Selection Window contains 91 candidate nodes which have "personal computer" as an index, but only 20 can be displayed at any one time. After selecting a node in the Selection Window, the content of the node will be shown in the Text Window.

We have confirmed that CSF is useful for free browsing in CD-ROM encyclopedia [Hirashima 1998].

Context-Sensitive Filtering on WWW

Nodes in CD-ROM encyclopedia follow basic guidelines to design hypertext. Therefore, one node has one topic and the contents is concise to be able to read through it briefly. Modeling of user's interests of CSF depends on the characteristics of the node. On WWW, however, nodes, that is, pages often don't follow the guidelines, for example, one page has several topics, or the volume of the content is too much. Therefore, modification of WWW pages is necessary to use CSF effectively.

The purpose of modification of WWW pages is to give the two characteristics to the pages: (1) one page has one topic, (2) one page has adequate volume to read through it briefly. To realize the modification, partitioning methods of WWW pages are described in this section. First, partitioning following HTML specifications is described. Then, partitioning by heuristics is reported. Here, although CSF uses the divided pages to models user's interests and to order search results, a browser provides a user with the whole page. So, the part of the divided page is shown first, but the user can see other parts in the whole page in the same way as usual browser.

Because WWW pages written by HTML, every page has the structure defined by HTML specifications. By using the specifications, the content of the page can be divides into several document blocks. The Headings in the BODY elements represents hierarchical structure of HTML document. The TITLE element in the HEAD elements represents the title of the document. Following HTML specifications, Headings and the TITLE element compose a tree structure. Each Heading divides a document into several smaller document blocks. Then, the lowest Heading makes the leaf document block. This leaf document block is a divided page which is dealt with a page in CSF. The divided page is characterized not only by the content of the divided page, but also by the upper structure in the tree structure. Therefore, indexes of the divided page consists of indexes which come from the content of the page and come from the upper structure of the page.

However, WWW pages are often written not following HTML specifications. For example, font specifications sometimes used as headings. In such case, the largest font part is regarded as H1 level, and so on, is an useful heuristics. The leaf document block generated by Headings, often include too much content to read through it briefly. In such case, paragraph tags can be used to divide the document block again. In order to realize CSF for WWW pages, such heuristics to divide HTML documents are important.

By using the above modification, divided pages are listed in Selection Window. As the explanation of a page in Selection Window, a summary of the hierarchical structure of the page are shown. The summary consists of the first one line of TITLE element, H1 element and so on. When a user selected a divided page, the whole page is provided to Page Window and the part beginning with the divided page are shown.

Related Work of CSF

Research on adaptive interactive systems is a very active field, especially in the domain of adaptive hypermedia systems [Brusilovsky 1996; McKnight 1993]. The adaptive hypermedia system builds a model for the individual user and applies it for adaptation to that user. CSF, which can currently deal with only text, is a method to realize the adaptive hypermedia system. The technique of adaptation in CSF is adaptive ordering [Brusilovsky 1996], which orders the links to the next page according to the user model. This technique is used for several adaptive hypermedia (or hypertext) systems [Armsrtong 1995; Kaplan 1993; Mathe 1996], where each page has many non-contextual links. The hypertext for which CSF is implemented has the same feature. Therefore, adaptive ordering is an adequate technique for realizing adaptation, but it isn't the main characteristic of our research.

The user model is the main characteristic of our research. Several systems build a user model, referring to his/her browsing history to adapt the hypermedia links. HYPERCASE [Micarelli 1996] estimates user's current goal using case-based reasoning and Hynecosum [Vassileva 1996] identifies user's level of experience. Since their modeling methods use the structure of hypermedia, only well-structured hypermedia is a target area. Our target area, however, is Information Retrieval Hypermedia (IRH) [Brusilovsky 1996]. In IRH, since the size of hyperspace is usually very large and users have various purposes, it cannot be structured beforehand. Encyclopedia or WWW is an example of IRH.

There are several user modeling methods which are independent of the structure of hypermedia. The main component of the user model in HYPERFLEX [Kaplan 1993] is a matrix of relevance, which stores relevance values between each pair of documents and from each goal to each document. If the user selects the current search goal from the list of existing goals, HYPERFLEX orders links from the current node according to their relevance to the selected goal. WebWatcher [Armsrtong 1995] logs user's successful and unsuccessful searches as training data, and selects an appropriate hyperlink, by using machine learning methods and user's information goal, which is identified by him/herself. Adaptive HyperMan [Mathe 1996] uses relevance network, which records the relevance of references based on user feedback for specific queries and user profiles. The relevancy of information is calculated by using the relevance network. The above approaches are powerful and independent of hypermedia structure, but they should be provided several user features, for example, direct interactions of his/her information goal.

Although such interactions have the effect of making user models more precise, the load of the user significantly increases. Our target browsing, that is, surfing or context-sensitive browsing, has no clear task or purpose, in other words, browsing itself is the task or purpose. In such browsing, the choice of any links in hypermedia isn't a critical decision. If anything, the interactions which disturb user's browsing should be avoided. From this point of view, Letizia [Lieberman 1995] uses the past behavior of the user to anticipate a rough approximation of the user's interests. This is the closest work to us. Lieberman also insisted that "indications of interest probably ought to have a factor of decaying over time" and "some action may have been highly dependent upon the local context, and should be forgotten unless they are reinforced by more recent action." However, in [Lieberman 1995], a concrete method to deal with the shift of user's interests in the browsing isn't described. Besides this, [Lieberman 1997] insisted that Letizia serves the user by noticing serendipitous connections. This means that Letizia also deals with long-term interests. In contrast, CSF is a method which concentrates on dealing with the shift of user's interests in the browsing. Through experiment by real users' browsing, we confirmed this concrete method was promising.

Several researches of student modeling concentrated on the shift of knowledge [Huang 1992; Kono 1994]. Because the student's knowledge shifts as the results of his/her learning, the purpose of modeling is similar to our modeling. However, since educational interactions, which are generated based on the student models, are really critical for the students, the student models are usually required to be precise. To satisfy the requirement, they are usually built based on many interactions with the student and analyses of domain structure. Therefore, the purpose of modeling is similar but the techniques are quite different from CSF.

When a user surfs WWW, he/she often uses search engines (for examples, "Web Crawler" [Pinkerton 1993] and "Alta Vista") in addition to the links designed by authors. The research of search engines, therefore, is also close to our work. They have the ability to order retrieved pages according to relevance to a user's specification. Search engines require users to state their specification clearly. In our filtering method, when a user selects an index, the user's interests are inferred by using the browsing context. The user's specification is complemented based on them.

Concluding Remarks

As a first step to realize "Learning from Surfing," we have introduced Context-Sensitive Filtering. In surfing, user's interests gradually shift depending on the browsing context. The main characteristic of CSF is the model of user's shifting interests. Our filtering method can order candidate nodes according to the model. We have implemented a browser with this filtering method as an encyclopedia in CD-ROM format. The effectiveness of this method was confirmed through an experiment where real users browse nodes freely, following their interests. We also discuss CSF on WWW. Evaluation of educational standpoint is our future work.

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Education in Microwave and Circuit Design Assisted by HTML Based Facilities Using Integrated Simulation Capabilities

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Abstract: The authors have introduced intranet-based training to their university-level courses in electrical engineering, enhancing standard methods of teaching through interactivity and nonlinear reading. Hypertext Markup Language (HTML) is used for platform independence. Two different approaches were studied. One of them is the advancement of lecture notes thereby using the potentialities of HTML documents and modern browsers. The other one has led to a HTML-based hypermedia-tutorial where interactive problem solving is made possible by means of online simulations and other methods. Both approaches foster active learning methods. Evaluation shows that students like the idea of using internet-based multimedia education for adding new value to classical forms of education, as opposed to replacing them.

Introduction

Conventional forms of university education, particularly when delivered to large audiences, traditionally suffer from a lack of interactivity - the subject matter is being presented by the lecturer, the students consume it passively. Additional exercises in small groups only partially fix the problem, as the individual student may still not be motivated to deal with the subject directly.

One possible reason might be the discrepancy between the students' "learning rhythm" and the time table presented by the lecturer.

We are, therefore, offering additional and new forms of education that enable students to create their own time tables and to follow their own needs and interest.

HTML Based Lecture Notes

In classical university education, lecture notes have proven successful in helping students to find their own rhythm and to gain deeper inside into the subject they are studying. Furthermore, lecture notes could serve as reference books.

However, mere transfer of lecture notes into a document file would not add any functionality to the text, nor would it encourage students to become more active. On the contrary, a simple text is more difficult to read from a computer display than from a book, for most people.

It is just one of the disadvantages of classical documents that there is nearly a must to read them "linearly", that means following a prescribed schedule at least for a certain section. Following own mental leaps turns out to be difficult. Once the reader has left the intended reading sequence several times in a row, it will be hard for him to return to the point from which he started to follow his own thoughts.

We have, therefore, not only translated lecture notes on topics of microwave engineering into HTML documents, but also enriched them by *navigational tools.* These documents are accessible via intranet and readable using a browser which is able to handle frames.

In a three-frame browser window [Fig. 1], one frame (Contents-Frame) holds the structure of the document at any time, and allows easy access to arbitrary parts of the text. A second navigational frame provides access to the document's index, providing reference book functionality (Index-Frame). The actual lecture notes are shown in a third frame (Text-Frame) that may be enlarged to cover nearly the whole terminal screen. This is shown schematically in the following figure.

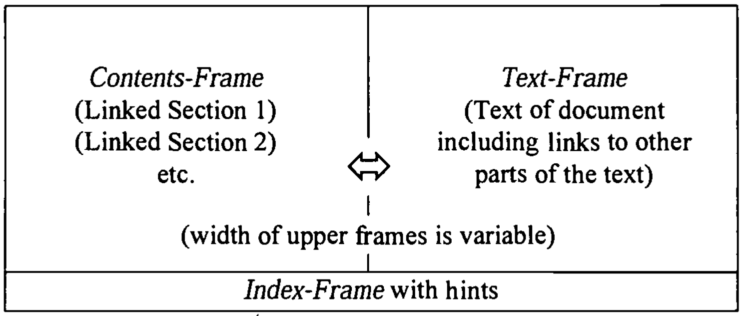

Figure 1: Frame structure of the browser window that gives access to the HTML based lecture notes.

A mouse-click onto one of the section titles in the Contents-Frame changes the content of the Text-Frame that now shows the starting part of the selected section. It is thus always possible to find the section of interest.

The widths of the Contents-Frame and the Text-Frame can be changed in order to gain a better overview.

Explanatory links are available as well from terms being used in the text as within graphics through clickable image maps. Thus, a mouse-click leads directly to an explanation of the term or of an illustration of a figure. Further links allow to find the way back to the starting point.

One particular feature of these lecture notes is that they use intensively mathematical deductions. Since these are on a high level of abstraction, it seems to be necessary to liven up the script by numerous figures and animated graphs. The latter ones are embedded into the HTML-document as animated GIF-graphics.

At the time being, the user of the HTML based lecture notes is not yet able to influence these animated graphics. This will be changed in the near future. It is planned to use forms that are evaluated for parameters. These are the input of a server driven program that in turn produces a new graphic.

Our HTML lecture notes are not interpreted as a substitute for printed material: we would like to use them as an additional offer to students.

The Hypermedia Tutorial

We observe that students often lack an intuitive understanding of the subject at hand. In the example studied next, an introductory course on analog circuit design for second-year students, it was evident that students often memorized the formulae presented during the lectures, but had no concept of how to apply the presented methods to problems not explicitly solved in either lecture or exercise.

Beginning in 1996, we introduced a novel computer-based training method which we like to call "hypermedia tutorial", accessible on the university intranet. It does not replace the traditional methods of education, namely lecture and problem-solving exercises, but provides an additional opportunity for the student to individually test his or her knowledge and gain an improved understanding of the subject matter. In the development of the hypermedia tutorial, we were led by the following fundamental requirements:

1. The program's user interface should not present an obstacle to the student. It should be usable on different platforms.
2. The program should provide a high degree of interactivity, both in testing comprehension and in using simulations to improve the student's intuitive understanding. The testing part should not be exclusively multiple-choice based.
3. For cost reasons, it should be implemented using public domain tools, where ever possible.

In our solution to these requirements, we chose HTML documents to provide the platform independence. Interactivity is realized using a scripting language and CGI scripts developed by our group. It parses user input in

HTML forms, performs server-side evaluations and simulations, and generates dynamic HTML pages (including graphics) returned to the user.

The program has several distinct parts, distinguished by different background colors to facilitate navigation. There is a service section, presenting the accompanying lecture's structure (with hyperlinks to problems and simulations), up-to-date information, and a repository of material distributed during the lecture.

A quiz section tests the student's comprehension of the presented material through small problems where answers are given either in multiple-choice form or, more often, through numeric input entered into forms. The answers are evaluated based on rules, set in a file not visible to the student, and results are returned to the student, including a short description of the proper solution when errors have occurred.

The simulation section uses both server- and client-side simulations of electronic devices and circuits, always with graphics output, to visualize important relationships and concepts. The student may alter parameters and re-run simulations at will. Simulations close to reality, e.g. using SPICE, are contrasted with idealized expressions developed during the lecture to demonstrate ranges of validity and possible pit-falls.

A FAQ (frequently-asked questions) section provides additional in-depth explanations in areas where questions frequently occur, or where errors are often observed during written exams. The FAQ pages are hyperlinked to evaluation documents in the quiz section, but may also be viewed directly. Figure 2 shows the overall structure of the program.

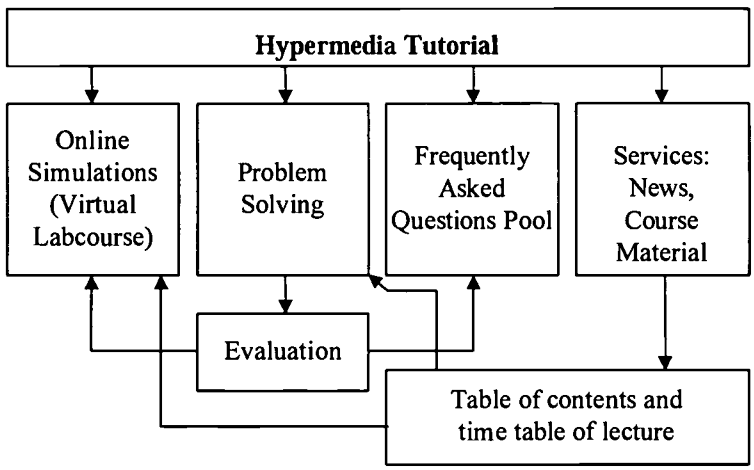

Figure 2: Structure of the program underlying the hypermedia tutorial.

The program is implemented on a Pentium-class PC with 32 Megabytes of RAM. Only standard text and graphics editors where used in the creation of the HTML pages.

Evaluation of responses to questions in the quiz section is achieved through a CGI script written entirely in C. When a user submits an answer, the appropriate script file is read, the rules contained therein are extracted, and the user input is evaluated. Numeric answers do not have to be exact - the rules file defines a window for the proper answer. The set of rules also allows to group wrong answers, and provides different feedback depending on the likely error the student committed, where possible. The evaluation feedback, with explanations of the proper solutions where necessary, are then formatted into a dynamic HTML document and sent back to the student. Clear graphical symbols for correct and wrong responses provide rapid feedback.

After the hypermedia tutorial had been completed, its success was evaluated using questionnaires handed out to all attendees of the "Introduction to Analog Circuit Design" lecture series. Participation in the evaluation was voluntary and anonymous. Of a total population of 80 students, 37 returned the evaluation forms. If we take the returned results as representative of the overall student population, we find that 50 % participated in the hypermedia tutorial on a regular basis.

On the evaluation forms, students were confronted with several statements - positive and negative - whose applicability they had to grade using a scale of 0 (strongly disagree) to 5 (strongly agree). The main results of the evaluation are shown in Figures 3 to 5.

With an average rating of 3.9, most students followed the intended use of the hypermedia tutorial, namely to augment, not replace, the conventional lectures and problem-solving exercises [Fig. 3]. Participants found that the on-line simulations visualized the lectures' subject matter (average rating 3.8) and improved overall comprehension (3.8).

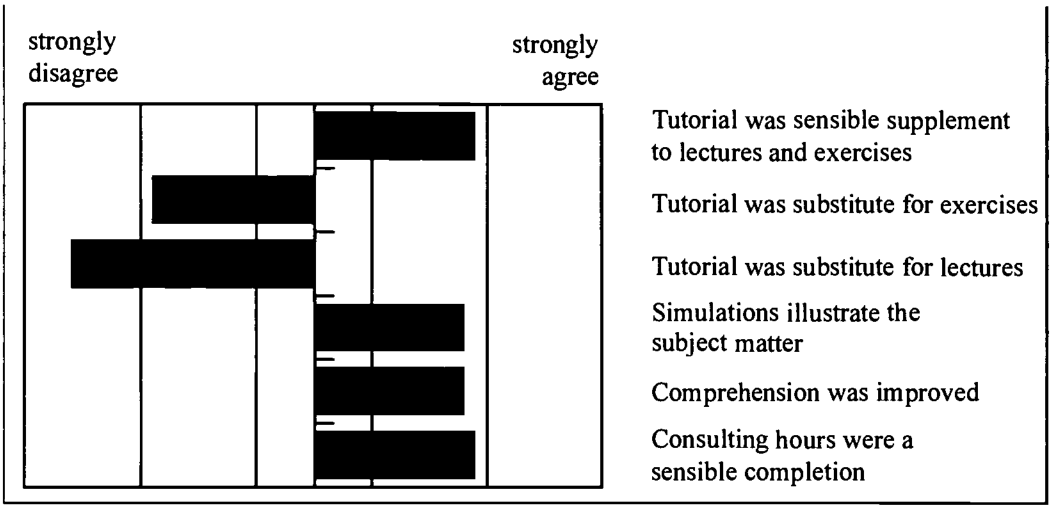

Figure 3: How the tutorial was accepted by students

Those who participated in the hypermedia tutorial were also asked to rate the importance of several possible future on-line educational offerings, along with those already implemented. Here are the results sorted according to the rank and showing the average score in brackets:

1. Frequently Asked Questions Pool (4.7)
2. Problems with evaluation of response (Quiz) (4.1)
3. Additional Course Material
4. On-line simulations (3.8)
5. Tutoring by electronic mail (2.5)
6. Conventional online lecture scripts (2.4)

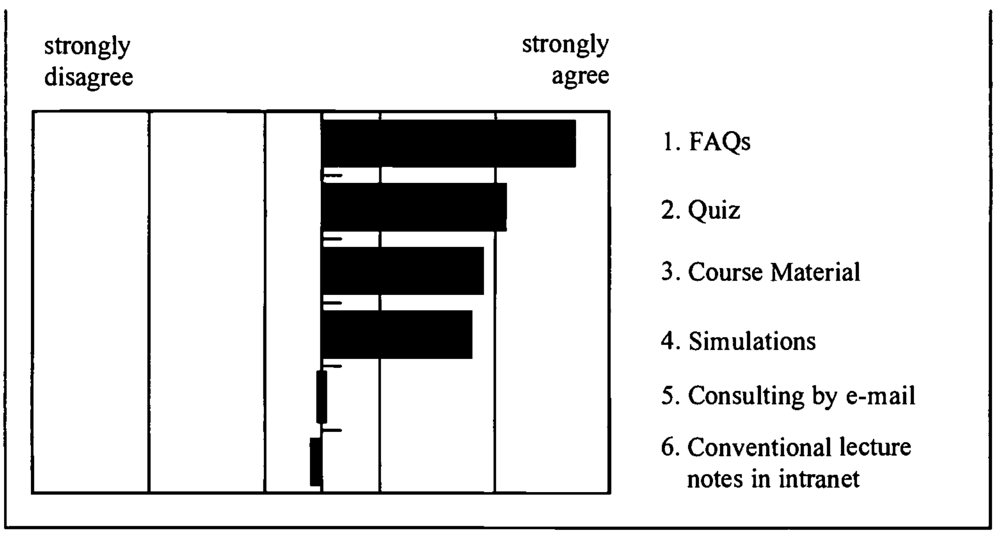

Figure 4: Acceptance of different offerings within the tutorial

The less favorable rating for tutoring by email confirms our impressions gathered in the course of this program - the possibility to pose questions and receive answers by email had been offered and seen no usage at all.

While we readily concede that the results of this particular poll have been biased by what was actually offered, we conclude that students like the idea of using internet-based multimedia education for adding new value to classical forms of education, as opposed to replacing them.

Non-participants were asked to rate questions relating to their reasons for staying away. The results show that they are not opposed to computer-based methods per se, but were not willing to take the additional time necessary to work with the tutorial (results sorted according to the rank and showing the average score in brackets):

1. Not enough time due to other classes (3.0)
2. Lectures and problem-solving exercises sufficient (2.2)
3. Treatment of subject in this form not efficient (1.5)
4. Computer-based training just an irrelevant fad (1.1)
5. User interface to complicated (0.6)

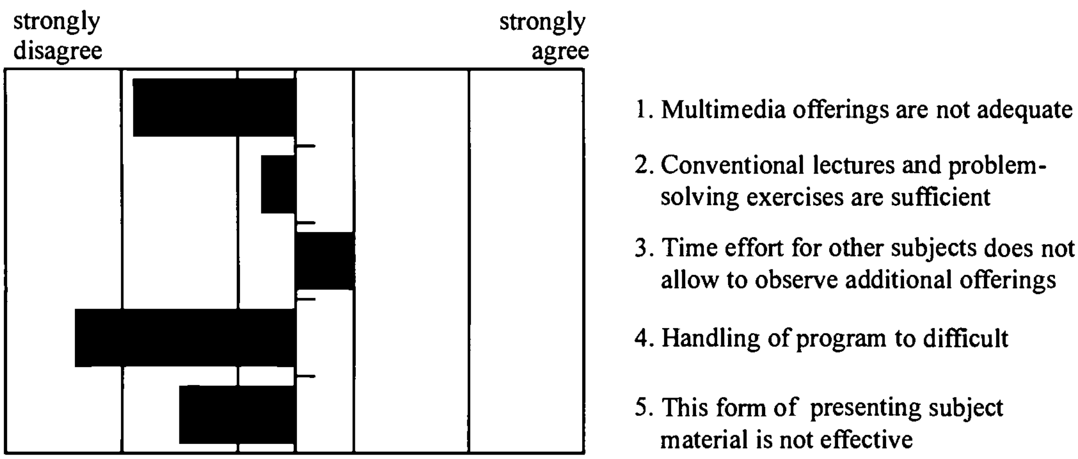

Figure 5: Oppinion of students who did not participate the tutorial

Further Developments

The success particularly of the hypermedia tutorial encourages us to further develop our on-line offerings. Based on the gained experiences, we plan to include simulation tools into the lecture notes on microwave engineering as well. Furthermore, it is thought of including lecture notes to the hypermedia tutorial, thus merging both types of intranet-based education offerings. Similar plans exist for further courses, e.g. mathematics. A course on Fourier series is being worked out at the moment.

Conclusion

Two intranet-based teaching methods, the "hypermedia tutorial", and lecture notes with additional functionality have been successfully implemented at the University of Ulm. Built around HTML documents and CGI scripts, they achieve a high degree of interactivity with the user.

In the hypermedia tutorial, problems with server-based evaluation of responses test comprehension, while server- and client-side simulations are used to visualize concepts and improve intuitive understanding.

At the end of the first term it was offered, the hypermedia tutorial has been evaluated through questionnaires. The results show a strong positive attitude of students towards this innovative educational method, as well as the students' personal impression that it improved their comprehension of the subject matter.

While the method has been developed for a course in electronic circuit design and is being adapted to problems in microwave engineering in the near future, we believe that it holds promise for other subjects as well.

At the time being, similar experiences are collected by our colleagues from the departments of biophysics, anatomy and applied physiology at the university of Ulm [see Gruler et al. 1998]. Since much more students are in their courses, a larger statistical ensemble is available there for evaluation. We are looking forward to their results.

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Evaluation of a Virtual Guided Discovery Learning Environment for Nuclear Medicine

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Abstract

This paper reports on a comparative assessment of a multimedia learning environment based on a guided discovery approach (CORE) with two control conditions (lecture and electronic book). The three learning experiences were embedded in a B.Sc. Diagnostic Radiography curriculum. As part of the normal teaching and learning, three groups of students from year II of the B.Sc. course used one of the learning methods. The syllabi across the three learning conditions were closely matched. Quantitative and qualitative measures were taken of effectiveness and usability. All the groups demonstrated a significant baseline to post learning session knowledge increase. The CORE approach was identified by the students as the most effective method of learning. The students identified a range of factors which contributed to the CORE condition being effective. These factors included: learning in context with real examples that integrate diverse subject areas, engagement in the learning process, and learning from mistakes.

Introduction

Computer assisted learning (CAL), at home and in educational institutions, is continuing to gain popularity. Various reasons account for this including the increased range and availability of software products, competitive prices, falling cost of hardware and increased hardware capability and the need to consider work based education and training. With many educational institutions considering the use of CAL within their curricula it becomes essential that these approaches to learning are evaluated for educational efficacy.

For many years, various forms of CAL have been used in health professional education and training. In the early years the emphasis was placed on enhancing diagnosis by simulated approaches. For example, De Dombal [1969] described a prototype for aiding surgical diagnosis, Brody [1973] proposed a simulated patient for dental student patient history taking and Rosenblat [1984] argued the value of simulations, suggesting that clinical simulations can be used to replicate the actual medical cases. Whilst CAL appears to have had a long history in some elements of medical education and training, Tessler [1989] commented

> *"of all the medical specialities, diagnostic radiology is the most dependant upon computer technology and computer based educational applications in radiology have been noticeably lacking" (p 1169)*

Similarly this appears to be the case for radiographer (diagnostic radiography) education and training and until recent years publications about CAL approaches have been either descriptive or speculative in nature.

Nuclear medicine involves the application of radioactive substances for the diagnosis and treatment of disease in humans. Within the UK elements of nuclear medicine are studied within diagnostic radiography degrees. Diagnostic radiography is a field allied to medicine. It involves the application and integration of several subject areas in order to produce a competent practitioner skilled in the art and science of diagnostic imaging. Clinical practitioners must integrate successfully the diverse subject areas in order that competence can be developed. Traditional approaches to teaching and learning often involve classroom contact, together with supporting personal study. During these sessions theoretical material is presented and assimilated from the fundamental subject areas. Clinical observation and subsequent practice then ensues. For effective learning, the complex knowledge and skills have to be reduced to a manageable form which can then be delivered in a logical sequence within a curriculum. Efficient and successful integration of subjects and the linking of theory to practice may prove difficult with traditional approaches.

Subject integration and linking with [virtual] practice may however be achieved through computer mediated virtual environments. The particular constructivist approach selected here is the CORE method. This is a radical constructivist approach which provides a set of design principles for the acquisition of competence in relatively complex domains [Boyle, 1997]. The CORE approach emphasises the need for a structured curriculum. This feature seemed particularly important for this learning domain. Content is organised into functional units which each culminate in the learner displaying a new level of competence in the domain [Boyle 1994]. The pedagogical emphasis is on learning from examples in context. This approach encourages the learner to infer and develop their own understanding of the domain. This understanding is progressively refined as the learners attempt to answer questions and solve problems. Each learning block then culminates in the learners giving a full expression of the competence they have acquired.

The CORE approach was first applied to learning to program [Boyle and Drazowski 1989, Boyle and Margetts 1992]. The competence was expressed in this domain by the students writing a full program incorporating the language constructs they had just mastered. Multimedia technology supported the creation of virtual environments which permit this approach to be applied to a wide range of domains. It was decided to develop the main prototype using this approach, and to assess its effectiveness against two control conditions: a multimedia lecture and a hypertext based electronic book.

The objectives of this study were:

- To develop a computer based multimedia learning environment for skeletal scintigraphy (an aspect of nuclear medicine) based on a constructivist guided discovery approach.
- To evaluate the guided discovery approach against two control conditions.
- To identify which guided discovery design principles enhance learning.

Method

Three learning methods were developed: guided discovery (CORE) computer assisted learning environment (experiment condition); computer based learning environment based on a book metaphor with hypertext (control condition 1); typical multimedia lecture (control condition 2). The syllabus for each was closely matched. Both computer versions contained extensive use of video with narration, medical images, pictures and text. The typical multimedia lecture used slides and over head projection acetates.

Prior to the comparative evaluation a range of measures were taken to establish learning method quality. For the computer based versions these included various estimates of software usability (eg Software Usability Measurement Inventory (SUMI), Porteous [1993]), robustness, accuracy and content completeness. For the multimedia lecture the lecturer's ability was assessed objectively (using a standard instrument) on two occasions: one during the experimental lecture and one under non experimental conditions. Comparative data was established from other university lecturers.

For comparative evaluation the three learning methods were embedded in the curriculum of a diagnostic radiography degree. Three groups of second year diagnostic radiography degree students experienced one of the three learning methods, various measures were taken to assess group similarity. Twenty five students participated in this part of the evaluation. Three quantitative measures were taken to assess student knowledge. A multiple choice questionnaire (test) assessed baseline knowledge. Post learning knowledge was assessed by the test, essay and case study. Since pre tests may improve learning by communicating what should be learnt from the material the baseline test was administered under examination conditions three weeks before students used the learning experiences. The test was administered again immediately after the learning experiences. The essay was completed under examination conditions within 48 hours of students using the learning experiences. The case study was completed during the five days following exposure to the learning experiences. Marking schemes were developed and applied for all three measures and two assessors marked each script blind.

Qualitative measures were taken after the 25 degree students and an additional 20 volunteers had experienced the CORE software. Observations, interviews and a focus group discussion were conducted. Additionally the 25 students completed a questionnaire after they had experienced all three methods of learning. This questionnaire established their opinion about each of the three learning methods.

Results

SUMI estimates indicate both computer based learning methods were consistent with or higher that state of the art software usability. Observations and user comments support this finding. The software was robust and the curriculum was acceptable both in range and accuracy. Lecturer assessment suggested he performed similarly under experiment and non experiment conditions. In addition the lecturer performed similarly to the comparative data established from other university lecturers. These findings indicate the three learning methods are of an acceptable quality and suitable for comparative evaluation.

All quantitative knowledge assessment measures were marked using the marking schemes. Minor variations between markers were only noted in the essay. For the minor discourses an arithmetic mean was taken between the two marks. Marks were concordant between markers for the case study and tests.

The test data demonstrated a significant baseline to post learning experience increase in knowledge ($p<0.001$, paired t test), see table 1. The case study data demonstrated no significant difference between the groups (table 2). Overriding course management problems precluded the lecture group from completing the case study. The essay data (table 3) demonstrated a statistical difference between the CORE and lecture groups ($p=0.0001$, unpaired t test) and between the CORE and electronic book groups ($p=0.002$, unpaired t test). Time to complete the learning experiences is indicated in table 4.

Table 1: baseline (pre test), post test and knowledge gain (test data)

Group type	n	average % pre test	average % post test	average % gain		Paired t test
		M	M	M	SD	
CORE	8	28	76	48	10	p=0.000001
Electronic book	10	19	67	48	11	p=0.000001
Lecture	7	37	59	22	10	p=0.001

M = mean; SD = standard deviation; n = number in group

Table 2: case study data

Group	n	Case study Marks (%)	
		M	SD
CORE	8	72	7
Electronic book	10	67	6

M = mean; SD = standard deviation; n = number in group

Table 3: essay data

Group	n	Essay marks (%)	
		M	SD
CORE	8	73	5
Electronic book	10	62	7
Lecture	7	60	6

M = mean; SD = standard deviation; n = number in group

Table 4: time taken to complete learning experiences

Group type	Average time (mins)	Fraction
CORE	80	1
Electronic book	67	0.84
Lecture	58	0.73

Discussion

The various measures taken to assess student group similarity indicated: academic abilities were similar; age ranges and means were similar; gender bias was in favour of females. Unfortunately, the three groups had dissimilar knowledge of the domain (established through the baseline test).

The lecture group had the highest baseline test knowledge, being significantly higher than the electronic book group ($p<0.01$). Other confounding factors between groups were however comparable. Age range and mean were similar and the gender bias in all cases was in favour of females. Academic ability, based on year I and year II results was not significantly different. Computer ability [Eachus 1996] analysis indicated, between groups, there was no significant difference. Analysis of group composition suggests that, apart from baseline knowledge, the groups are similar for a range of confounding variables and that differences in learning between the three groups may be attributed to the learning methods themselves.

All three groups demonstrated a significant knowledge increase from the baseline condition ($p<0.001$, paired t test). The CORE group had the highest average post learning score (76%) with the lecture group achieving the lowest (59%). No significant difference exists between the groups, though the difference between CORE and lecture groups was almost significant at the 5% level ($p=0.07$, unpaired t test). Average knowledge gain is the same for both CAL conditions (48%), with the lecture group demonstrating the lowest increase (24%). This difference is significant ($p<0.005$, unpaired t test). As illustrated by knowledge gain, the electronic book and CORE groups both perform better than the lecture group. This may suggest that CAL is more effective than lectures for short term knowledge retention.

On the case study the electronic book and CORE groups perform similarly, with no significant difference between them. For qualitative comparative analysis, during completion of the case study, students were allowed to use any learning resource at their disposal. This may suggest that allowing access to other learning resources can affect the outcome and lessen the difference between the conditions. The essay data clearly indicates the CORE group perform significantly better than the other two groups. This may suggest that this type of assessment, learning using a CORE approach, may assist with internalisation and retention of information, whereas the lecture and electronic book may not promote this as effectively.

A similar comparative study [Boyle 1994], outlines a large scale analysis of a CAL prototype for computer programming. The prototype, based on the CORE approach, involved four groups of students studying four different programming courses. The CORE prototype was assessed objectively by comparing the performance of the volunteer students with previous student cohorts. The previous courses had been delivered by a "traditional" lecture programme. Year I results were used as the performance indicator with which groups and cohorts were compared. Students using the CORE prototype demonstrated a decrease in failure rates for two of the courses: in one the failure rate decreased by 47%, the other by 38%. The Applied Computing course demonstrated a minor improvement in pass rates, the final group however (Higher National Certificate course) failed to show any improvement, though an explanation was offered relating to the lack of planning for the implementation of the CORE method. A mixed response was therefore noted, but generally this was in favour of the CORE approach.

Boyle indicated the methods of assessment were those traditionally used on the courses - a combination of course work and examinations. Boyle's study suggests that CAL for computing may enhance learning and the approach produces similar, and in some cases superior, outcomes when compared to the traditional lecture programme. The data in the current investigation has similarities in this respect. For example, certain elements of the post learning test and case study data indicate similar outcomes. The essay and elements of the test data indicate the CORE condition elicits an improvement in learning.

Qualitative analysis students and volunteers indicated the CORE environment was the preferred method for learning. Factors which enhance learning are varied and establish the value of certain CORE design principles. The CORE approach encouraged volunteers to follow the structure imposed by the designer, whereas the electronic book did not. Many features within the CORE focused learning. For example, assessment improved motivation to learn, allowed for rapid assessment of learning effectiveness and enabled identification of misunderstandings. Immediacy of assessment feedback was considered important in rapid and effective learning, a volunteer indicated

> *"the immediacy of the computer feedback is very important ... when a human teacher assesses me it can take weeks for the feedback and by then I have forgotten what responses I had initially given".*

Mistakes were also seen as opportunities from which to learn, particularly since corrective feedback was offered on incorrect response. One volunteer indicated

> *"I tend to learn from my mistakes".*

The CORE environment was considered engaging, enabling learners to switch off from distractions and even enjoy the learning experience. One volunteer indicated

> *"the CORE held my attention for two hours .... amazing!!"*

Another user was amazed that

> "CORE with headphones sucked me in
> .... I just got cut off from distractions"

The use of real examples which integrated the fundamental and discrete subject areas was important for two reasons. First learners recognised that the examples (particularly the video clips) conveyed important information which they had to identify: they were not to be viewed passively. Second, learners recognised the value of learning from real examples because they assisted in assimilation of the discrete subject areas in context. One volunteer indicated

> *"the use of <u>real</u> clinical video and pictures is better than text alone ... I think you scrutinise it more and it therefore makes you think harder"*

Even though the CORE approach was considered the best method for learning several limitations were noted. Human tutor support was still considered essential, particularly for improving motivation and allowing learners to ask their own questions. Additionally, at times, the lack of 'full multimedia' appeared to detract from learning. Finally the increased time to complete the CORE, compared to the other methods, was considered as a limitation. However if the learning was effective, as suggested by this study, it is clear the additional time invested was time well spent.

Conclusions

The CORE environment was found to be more effective than the two control conditions. Factors which contributed to the effectiveness were varied and included the value of subject integration, assessment and learning in context. Limitations included lack of human tutor support and increased time to learn within the CORE environment.

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HyperMeasure: A Hypermedia Casebook for Teachers

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Abstract: Recently, there has been much optimism about the promise of hypermedia in case-based teacher education programs. For years, the predominant medium by which cases have been communicated has been text. Many teacher educators have become dissatisfied with the difficulty of representing the complexity in an ill-structured domain such as teaching with purely textual case descriptions. In response, many teacher educators have turned to video presentation of cases. Video, it has been argued, can come closer to representing the complexity of a case in an ill-structured domain such as teaching. Video by itself, however, usually lacks organizational structure and can be difficult to work with and understand for a novice. Hypermedia, with its ability to incorporate multiple forms of media, including text and video, has been proposed as an ideal medium with which to communicate cases in teacher education. As with any powerful tool, however, hypermedia technologies must be used in a thoughtful, well-principled manner in order to take full advantage of its capabilities. This paper describes the design of a case-based hypermedia system, HyperMeasure, designed to help teachers further their understanding of how children think and learn about measure.

The work presented in this paper was completed as partial fulfillment of the degree of Doctor of Philosophy in the Educational Psychology department at the University of Wisconsin-Madison.

In recent years, teacher educators have become dissatisfied with the traditional 'theory and methods' form of teacher education [e.g., Lampert & Ball, 1990]. In response to this dissatisfaction, many educators and researchers have proposed new case-based methods of teacher education [c.f., Case Methodology, 1990; Case Methods, 1991; Merseth, 1996]. There is growing concern, however, about the most effective way to present cases to teachers [Vye, Burns, Delclos & Bransford, 1987]. Researchers have become dissatisfied with textual and strictly video presentation of cases and have suggested hypermedia as a powerful medium in which to present cases for teacher education [Lampert, Heaton & Ball, 1994; Merseth & Lacy, 1993]. Despite all of the optimism about case methodologies and the promise of hypermedia, however, there has been little empirical study of the effectiveness of hypermedia case-based teacher education materials.

Case-based Methods for Teacher Education

Traditional teacher education reduces the complexity of the learning process in order to focus on its regularities. New teachers are expected to "apply" knowledge of these regularities to the classroom contexts in which they later find themselves [Lampert, Heaton & Ball, 1994]. New teachers often are thrown into the classroom with nothing but a bag full of general theories and very little practical knowledge about how to handle the everyday specific complexities that they will encounter. Not surprisingly, this mismatch between teacher preparation and practice has led to under-prepared teachers.

There has been much optimism recently about the promise of case-based reasoning [Riesbeck & Schank, 1989] and, by extension, a case-based pedagogy for educating teachers [c.f., Case Methodology, 1990; Case Methods, 1991; Merseth, 1996]. Although there has been little empirical work demonstrating the benefits of a case-based pedagogy over traditional knowledge delivery pedagogies for teacher education, researchers have proposed a number of advantages for case-based methods in teacher education for several reasons. First, as demonstrated in other fields [Carter & Unklesbay, 1989; McNair, 1954; Williams, 1992], case-based instruction develops skills of critical analysis and problem solving which are critical in ill-structured domains like teaching. Second, cases have the power to represent complex situations in a realistic, understandable fashion. Third, cases can provide teachers with key examples of student thinking [c.f., Fennema, Carpenter, Franke & Carey, 1993]. Finally, cases allow students to actively engage in their own learning.

Hypermedia Presentation of Cases

Hypermedia has a number of features that make it a potentially useful learning medium for presenting cases of teaching and learning (Koehler & Lehrer, in press). First, different chunks of information can be directly associated in multiple ways. Cognitive flexibility theory posits that in order to learn and understand complex material, learners must approach the domain from multiple perspectives (Spiro, Coulson, Feltovich, & Anderson, 1986). Second, hypermedia allows for the presentation of cases in chunks that are large enough to capture the real world complexity of teaching, but small enough to be comprehensible by novices. Third, a case-centered hypermedia system allows for multiple viewpoints of the same subject and the active construction of one's own knowledge (Bransford, Sherwood, Vye & Reiser, 1986). Since hypermedia systems are designed as a non-linear, web-like structure of linked ideas, there is no predefined path that a learner must necessarily traverse when navigating through that web. As such, each learner must decide their own trajectory through the web and, hence, decide their own trajectory for potential learning. Learning in a hypermedia system is a learner-centered, constructive process.

In summary, hypermedia seems to be a better medium for case-based teaching methods than either the text-only or video-only methods that have been tried in the past. Text-based systems have difficulty capturing all of the complexity of cases, whereas video-only systems can have difficulty providing a coherent organizational framework for viewers. Hypermedia, by combining multiple media formats, can provide the best of both worlds—rich video with textual annotations and organizational structures.

Teaching Measurement for Understanding

Today, children typically enter school having experienced a great many ideas about space--how to describe it, how to depict it, how to navigate through it, and, most relevant here, how to measure it [Lehrer, Jenkins & Osana, 1997]. In their pre-school years, children frequently hear measurement terms such as "inch" and "foot" and often see conventional tools of measurement such as rulers, yardsticks, and tape measures. Moreover, they are often familiar with the procedures for measuring length. For example, they often know that in order to "measure" something, you "put a ruler next to it and read off the number." This knowledge is typically enough to allow them to measure some objects successfully. The teaching of measurement in the primary grades is usually characterized by giving students rulers, having them measure a few items around the classroom, and asking them to record their results on a worksheet. The introduction to area measure is typically just as sterile. Learning how to measure area usually boils down to counting squares or memorizing a formula.

As Nitabach and Lehrer [1996] point out, this method of teaching 'measurement' falls woefully short in helping children develop an understanding of space. Procedural competence is not the same as understanding. If we are to expect teachers to be able to teach measurement for understanding [not just procedural competence], we must help them identify the fundamental building blocks of an understanding of measurement [Horvath & MIMS Collaborative, 1997]. The purpose of HyperMeasure is to help teachers understand how children think and learn about measure. For a more complete description of the measurement principles which informed the content of HyperMeasure, see Horvath (1998).

Designing HyperMeasure

The design of HyperMeasure was informed by a set of cognitive principles of hypermedia design [Koehler & Lehrer, in press]. Learning with hypermedia is sensitive to a number of factors including the structure of the domain and the design of the interface. Koehler & Lehrer's [in press] design principles take what has been learned from cognitive science and human-computer interaction over the past few decades to describe five principles for designing high-quality hypermedia systems. In the following sections, I will briefly describe each of the five principles and then explain how each is realized in HyperMeasure. For a more complete treatment of these design principles, see Koehler and Lehrer [in press].

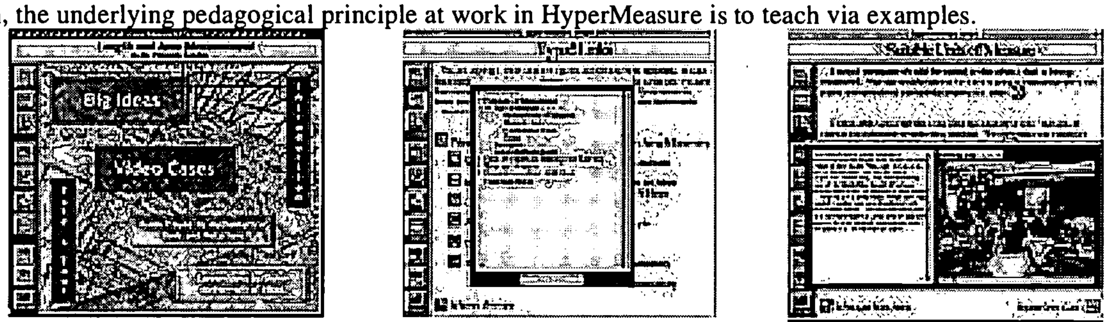
Use Non-Linearity To "Criss-Cross" The Landscape

For complex domains, provide multiple entry points to the information. According to cognitive flexibility theory, learners are much more likely to learn and understand material from complex domains if they can revisit the same ideas from multiple perspectives [Spiro, Coulson, Feltovich, & Anderson, 1986]. HyperMeasure is designed along four thematic strands - Big Ideas, Cases, Tools & Notations, and Connections [Figure 1a]. These four themes provide four different entry points to the information contained in the system.

Provide Learners with Examples

It is important to provide learners with examples of that which is to be learned when the properties to be learned cannot be explicitly stated, or when such properties are highly related and "criss-crossed" in the manner described above. Moreover, examples can play a crucial role in case-based learning [Williams, 1992] and in helping learners construct relationships [Ward & Sweller, 1990].

HyperMeasure is replete with examples, primarily video examples, of students' thinking and classroom activities. These videos exemplify all of the information [e.g., principles of measurement, the role of tools, etc.] discussed in the system. Additionally, the cases in the Case theme are all extended examples of children's thinking and learning about measure. A case can be thought of as a deep, extended example. As such, the underlying pedagogical principle at work in HyperMeasure is to teach via examples.



(a) (b) (c)

Figure 1 - HyperMeasure Design Features

Make the Structure of the Domain Visible

Domain experts typically have more principled and more numerous connections between individual pieces of knowledge than their novice counterparts for any given domain [Chi, Glaser, & Rees, 1982]. To help novices move towards a better understanding of a domain, the representational landscape should explicitly model the conceptual landscape of the domain. To make these connections and associations explicit, and thus more accessible to a novice, hypermedia documents should clearly signal the presence and nature of associations (e.g., typed links). Hypermedia systems should also include navigational tools that explicitly show associational structure to readers (e.g., graphical browsers).

HyperMeasure includes many tools which help make the structure of the domain visible to the user [Koehler & Lehrer, in press]. Many of these tools serve the dual purpose of navigation as well. This will be discussed further in the next section. HyperMeasure includes five tools that help the user understand the structure of the content: (a) main menu, (b) hierarchical outline, (c) searchable index, and (d) typed links. Figure 1b depicts shows the hierarchical outline.

Make Navigation Easy

Navigating in hypermedia systems is different from navigating in traditional learning mediums such as texts because readers of hypermedia are required to select the learning sequence. This sequencing process, called "navigation," is demanding of working memory [Recker, 1994]. When the resource demands of navigation and learning jointly exceed working memory capacity, users can become confused and "lost in hyperspace." To mitigate this problem, hypermedia systems should make navigation as easy as possible.

Many of the structural tools discussed in the previous section serve the dual purpose of navigation [Koehler & Lehrer, in press]. For example, the hierarchical outline [Figure 1b] can be used to navigate through HyperMeasure by selecting items from the outline.

Layer Related Information

In many hypermedia systems, clicking on a link replaces the current screen with new information. The transitory nature of information (i.e., one screenfull of information can be replaced by another) can be problematic to a user when that information is implicitly related. For example, text and video examples should be layered on top of the information that they are exemplifying because examples only make sense in relation to the principles conveyed in the main text. That is, to claim that something is an "example" is to claim that it is an "example of something." For readers to make the connection between an example and a larger principle requires access to both. By "layering" information, there is less "cognitive cost" for accessing information.

HyperMeasure is replete with annotations, most which are video [Figure 1c]. HyperMeasure, as it is currently designed, contains approximately 2.5 hours of video clips, broken down into approximately 100 different clips. Nearly every card in the system uses these annotations to exemplify the information discussed on the card. All annotations are implemented via pop up windows [Koehler & Lehrer, in press]. When a user selects a video annotation typed link, a popup window appears with a brief textual description of the content of the video. The user can then watch the short video clip. All the while, the original anchoring text from the card is still present on the screen so that the user does not have to remember the information and, thus, their working memory should be less taxed.

Integrate Design and Evaluation

It is imperative that the design of a hypermedia application be tightly integrated with assessment and evaluation of that system. It may seem obvious that the designer of a hypermedia learning tool should test the tool to determine if it successfully helps the user learn the content information. However, all too often, designers base their design decisions on what they think will work but never actually take the time to check to make sure that it does. The design of HyperMeasure has been strongly based on the results of formal and informal feedback from users and other design experts during each stage of development.

During the early phases of the development of HyperMeasure, several researchers and elementary classroom teachers provided detailed feedback about the overall design of the system. The type of feedback that they provided typically dealt with the overall design of the system (e.g., card layout, naming conventions, etc.). All of the feedback was incorporated into the early design of HyperMeasure. While these early reviews of HyperMeasure were important, they did not provide a true indicator of how well users could actually learn about measurement. Consequently, as part of the design process, an empirical study was conducted to investigate what type of learning occurred when HyperMeasure was used by pre-service teachers (i.e., the population that HyperMeasure was intended for) for a prolonged period of time. The learner-based results of that empical study [Horvath, 1998] will be used to further refine HyperMeasure.

In summary, HyperMeasure was designed based on a set of cognitively-based design principles. Each of these principles was based on the findings of research in cognitive science and human-computer interaction. However, as in all designs, the application of these principles for the design of HyperMeasure involved successive approximation, not simple algorithm.

Conclusion

There has been much optimism in recent years about the promise of a case-based pedagogy for improving teacher education. Cases are powerful instructional tools which have proven to be very useful in other professional fields. Many researchers feel that hypermedia technology has many advantages that make it a valuable method for communicating cases. Unless these capabilities are combined with a firm understanding of cognitive science and how the two interact, these advantages will never by fully realized however. HyperMeasure is a case-based hypermedia training system designed to help grade-school teachers learn about how children think and learn about measure. It was designed with a set of well-thought out, cognitively-based design principles so as to maximize its usefulness and power as an instructional tool. For a discussion of an empirical study of the success of HyperMeasure in helping pre-service teachers improve their knowledge of teaching measurement to children, see Horvath [1998].

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Digital Zoology: If you build it will they come - or do you have to give a mark?

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Abstract: This paper describes our experience at the University of Ottawa, Canada's largest bilingual University, in creating materials to support the teaching of Zoology courses in both French and English. Over the past four years the project, Digital Zoology/Zoology Numérique, has evolved from a series of digital slides to an electronic atlas that is now used by students for: preparation prior to their labs, support during the labs, and review after the formal lab sessions have been completed. DigiZoo, as the students have named it, consists of approximately 30 modules providing students annotated diagrams and photographs of the same specimens that they use during the lab. It also includes brief descriptions of the major classes and phyla including a hyperlinked glossary for key zoological terminology and additional information on the evolution of the various taxa using interactive cladograms. DigiZoo does not replace traditional instruction but is, instead, provided as an optional resource that is available for student's use. Data on its use indicate that the students spend a significant amount of time using it and do so without requiring any form of academic coercion.

Introduction

As Steve Gilbert (1996) points out in his article "Making the Most of a Slow Revolution" we are, in many cases, still waiting for a demonstration of the effective use of the new technologies in teaching in Higher Education. Although there are a number of reasons for this, one common thread that is emerging from successful applications of information technologies to teaching is the importance of addressing pedagogic, or curricular objectives for using technology, rather than using it for the sake of the technology. As Diane Laurillaurd (1993) wrote:

> "We should return to a consideration of what the student needs. Then we bring the two (student and media) together to see if they fit. The (pedagogic) needs as defined will challenge the media, and clarify the extent to which they fail to deliver what pedagogy requires...In reality, this never happens. Funds are given for the development of materials using a particular medium, and the search is on for the learning objective that best fits it."

New approaches based on technology must be grounded in the fundamental program of the department and have the support of the faculty members involved if they are to succeed. The link to the student's own needs is also just as important. In our own project, Digital Zoology/ Zoology Numérique we were concerned about whether we needed to force the students to use the application with some kind of a participation mark or, instead, let them vote with their keyboards on the effectiveness of the material being created by making it optional. We report in this paper on the reasons for creating Digital Zoology/Zoologie Numérique and the consequences of our decision on how we integrated it into the course.

Pedagogic Ojectives

The role of the Zoology course in the core program of Biology at the University of Ottawa was being questioned by the Department. Its cost, relevance, numbers of students and the availability of teaching materials were all open for discussion along with what potential new technologies had to solve, or at least help with, some of the challenges that we were facing. Among these were:

- **Didactic materials in French**. There is a wealth of zoological material available from North American publishers but very little is available in an electronic format. There was little or nothing available in French in the traditional media, and material in an electronic format was non-existent. What was available in French was more suited to High School rather than Post-Secondary level instruction because of the larger size of the secondary school market.
- **Availability of materials in the new media**. For obvious reasons, scanning existing materials was not a viable alternative for creating the materials we required. In addition to drawings, the special photographs of dissections and laboratory preparations that we needed were not available in either traditional or new media.
- **Student preparation and review**. As is traditionally the case, Zoology students are given a series of stylised drawings, some specimens, and a text based manual with instructions on how to dissect and view the salient features of their specimens. With only one chance to dissect the specimen and only the one lab period to work with it, there is no time for the students to practice and correctly identify what they were expected or see. It should not be a surprise that many students did not find these dissections interesting.
- **Cost of specimens and their effective use**. We felt that we should be able to use the new media to enhance student's understanding of their materials and at the same time link the in-lab experience to subsequent review by the students. We did not want to replace traditional dissection, a fundamental skill in Biology, with virtual dissections.
- **Demonstrators background**. Introductory Zoology courses cover such a wide and broad range of materials that it is unlikely that any graduate teaching assistant has the breadth of knowledge to effectively demonstrate the lab sessions. This is especially true when you realise that the current graduate TA's are the products of the Zoology courses with many of the same problems that we had already identified.
- **Lexicon of Zoology.** Every discipline has its own unique lexicon which it is appropriate to expose the students to whenever possible.

Solutions to the Callenges

BIODIDAC

Because French and English versions of the illustrations and photographs that we needed were not available we created them and catalogued them on a web site: BIODIDAC (www.biodidac.uottawa.ca). The artist agreed to give the copyright for the illustrations to BIODIDAC and these are distributed royalty free on the web site for educational and non-profit applications.

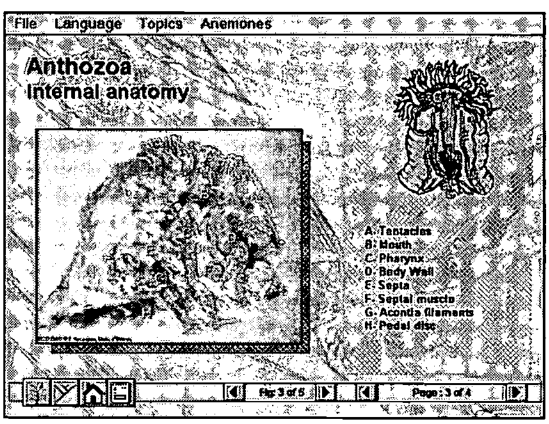

Figure 1. Sample screen showing specimen, diagrams and annotations.

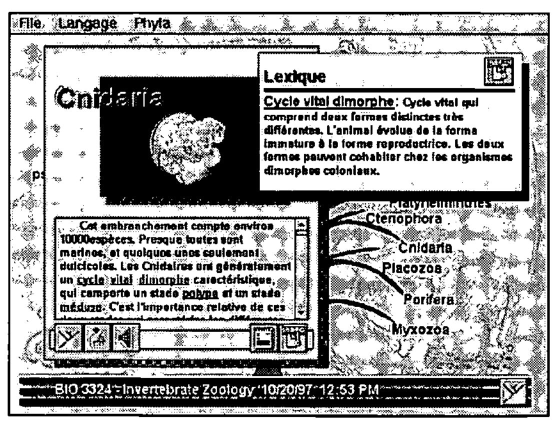

Figure 2. Taxon information box showing interactive glossary.

In addition to the drawings that were required for the course, digital photography was used for the specimens, microscope slides, and dissections that the students would be seeing in the lab. The material in the image bank was also utilised in the lectures using PowerPoint presentations. This created a link between the lecture and lab components of the course. The BIODIDAC image bank now contains close to 3000 images, and five Canadian Universities have contributed images to this on-line pedagogic resource in Biology.

Digital Zoology / Zoology Numérique

A major part of DigiZoo, as our student's call it, are the components designed to support the laboratory sessions with the use of annotated diagrams and photographs of the specimens that the students work with (fig 1). In addition to laboratory support, DigiZoo contains a hyperlinked glossary of zoological terms in both French and English along with information on the biology of the various taxa being studied (fig 2) and their evolution through the use of interactive cladograms (trees) (fig 3). DigiZoo currently consists of 29 modules including more than 40 organisms that are commonly used in traditional Zoology laboratory exercises. It is used in the French and English versions of Animal Form and Function (introductory zoology), and the third year courses Invertebrate Zoology and French and English versions of Vertebrate Zoology.

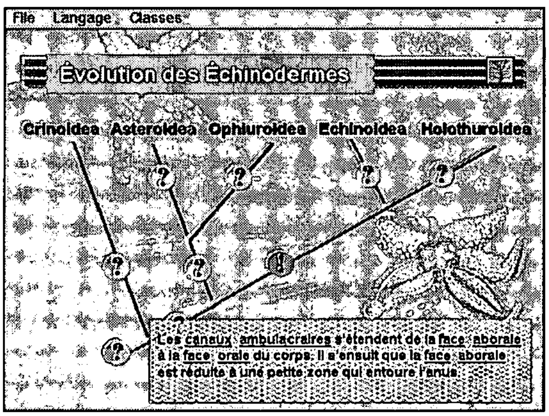

Figure 4. Interactive cladogram.

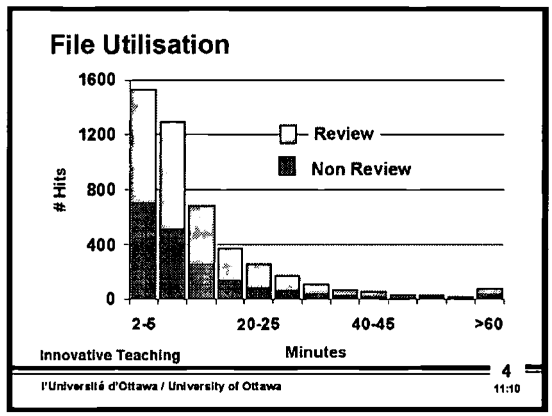

Figure 3. Module utilization on each day of the week by students in the Thursday and Friday laboratory sessions.

In this paper we report on the use of DigiZoo by students in the Animal Form and Function course (95 students in the English section and 68 in the French section). Although only twelve modules relate directly to that course, students are not prevented from looking at others in the application. If they choose something that they are not responsible for they are advised of that before that particular module opens. Students have access to DigiZoo on the 60 computers in the Undergraduate Science Computer Room which is open from 8:30 am – 5:30 PM Monday-Friday and during the laboratory sessions where a computer is shared between 7-8 students. The graphically intense nature of the materials does not lend itself to web based delivery, although samples of individual modules, without navigational links between them can be found at http://www.edteched.uottawa.ca/reports/digizoo.

Students in the course are not required to use DigiZoo. For those who do, the application's design allows us to log their activity and movement between the different modules in the program. Students are advised that the program does monitor activity but that the log files are not analyzed until after the final grade of the course has been given. The associated lab sessions were on Thursday and Friday mornings.

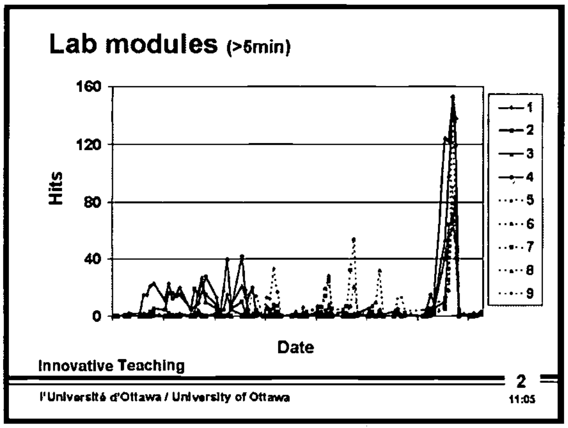

Figure 5. Number of hits, modules opened and closed, during the semester for each of the lab sessions.

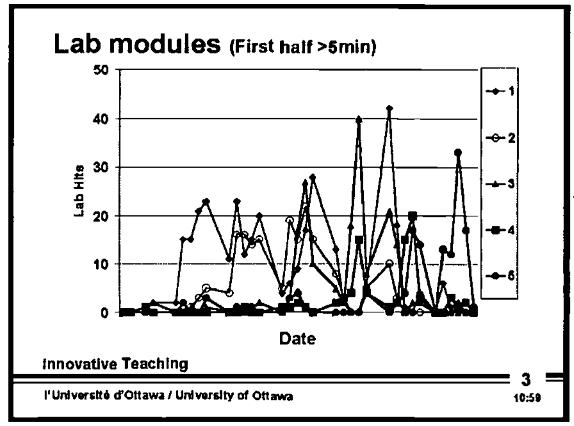

Figure 6. Number of hits, modules opened and closed, for each of the labs during the first half of the semester.

Student usage

Evidence of the effective use of the modules for preparation and review of the lab materials can be found from the data log for student's use of the modules. The number of hits, when a module's file is opened and closed, indicates that most of the students in Thursday's lab visit DigiZoo on either the Wednesday before or the Friday following their lab. The majority of students in the Friday lab make the heaviest use of DigiZoo on the Thursday prior to their lab session (fig 4) indicating that DigiZoo is being used to prepare for that current week's lab. The second part of our objective was to allow the students to review lab material prior to the lab exam. If we look at the number of hits that had a duration greater than 5 minutes (the module was in use for more than 5 minutes) in the week prior to the lab exam, we see the modules being opened from 120 to 150 times each day (fig 5) compared to the lower levels during the remainder of the semester. Clearly the students were using DigiZoo to review for their final exam.

When the data is plotted for either the first or second half of the semester, without the week prior to the exam (first part of the semester is shown in fig 6), we observe an interesting echo with respect to how the modules for any particular lab are used. There was a peak of activity during the week when the lab was offered and a second peak, or echo of usage, the following week (Fig 6). This is explained by the observation that, on average, a student

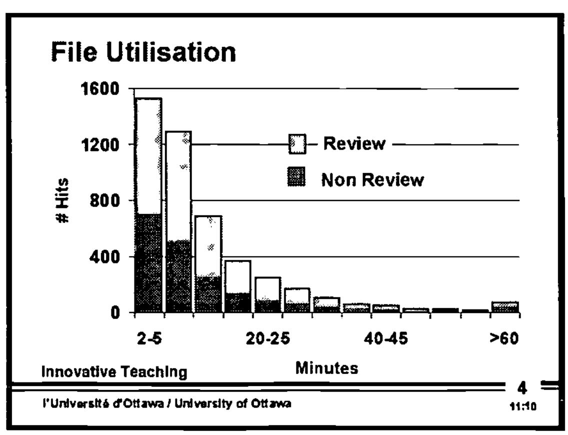

Figure 7. Number of time that modules were being used for different lengths of time.

logged into DigiZoo 5.9 times during the 11 weeks of the labs. Over that period the average student used the application every other week to look at the materials for the next day's lab (initial peak) and review material from the previous week (echo peak from previous week). On average, students used 12 modules, the minimum number that are directly related to the course. We felt that any module that was open for less than two minutes was being used only for navigation or quick reference and we did not include those in the analysis of how long individual modules were used for study (fig 7). Approximately 700 times the students worked in a module for between 2 and 5 minutes; 500 times for between 5 and 10 minutes.

We have not quantified the effect of DigiZoo on the effective use of the lab specimens but one observation that we do have is that student activity in the lab sessions was affected by the presence of the computers in the lab. Where previously students would attempt their dissection and then ask for an explanation of the result from the Graduate Teaching Assistant they were now asking each other for explanations and referring to the materials available on DigiZoo which was available in the lab. This effectively freed the Teaching Assistants to do other things during the lab which allowed us to add small group discussions to the sessions.

Evidence for the effectiveness of DigiZoo in preparing the demonstrators for the labs is only anecdotal. Graduate TA's reported that their ability to access the materials across the network allowed them to better prepare and become familiar with the materials at a time that was more convenient to them than the traditional weekly demonstrator's meeting. They could get their own specimens, take them back to their labs and work on them at a time convenient to them.

Conclusions

Although preliminary in nature, we feel that these results confirm the importance of combining technology and pedagogy to effectively meet the needs of students and the objectives of the curriculum. The student's use, either by its frequency or duration, supports our contention that they feel that DigiZoo is an important and valuable addition to the course. This is further supported in a less quantitative manner by student's comments in the course evaluation itself.

Sir John Daniels (1997) describes the success of the mega-universities as being due, in part, to technology and that "They owe it to the new application of technology rather than to applications of new technology". We feel that this very subtle semantic distinction applies to our own DigiZoo project which does not depend on the most recent advances in the use of multimedia. Instead it relies on the use of digital imagery distributed using networked resources that are common to many University campuses and commercially available multimedia software (Authorware). We also feel that beyond the technical issues that the blend of technological solutions with the pedagogic challenges of course and curriculum revision have allowed the creation of a tool that is completely integrated into the course's lecture and laboratory components.

The success of our attempt at achieving this is supported by the students own voluntary use of DigiZoo, demonstrating that if a multimedia application meets the type of criteria outlined by Laurillard (1993) then we do not need to use any form of academic coercion to demonstrate its validity.

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Using an Open Architecture to Build Social Learning System on World Wide Web

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Abstract: This paper discusses a separate, rearrangeable and open architecture of Social Learning System on World Wide Web. Rearrangeability means that such systems are built by several independent modules, called *software components* (*Soft-ICs*), and a suitable recombination of these modules can create a new SL system. From this viewpoint, all SL learning models can be analyzed into several basic learning components stored in different places. This brings the charm of separateness. Openness means that every module communicates through standard protocols, therefore other people are able to develop their own components if necessary.

1. Introduction

Late in the 1980s, the research of SL (Social Learning) system became mature. [Blo84][Chan88][Chan95] An SL system describes learners' behavior and their relationship in a learning group. The participants of an SL system include users and their learning partners, which could be real human beings or computer- simulated agents.

For SL systems, it is hard to develop a ready-made system, which can fit different new requirements. As WWW (World-Wide Web) becomes a universal networking platform, it is possible to connect Web-based SL systems across the world. [OCL97][OCHH97] However, the flexibility of such systems is still a problem.

If any system's subsystems can be decided in advance, then it is possible to create such system with specific proposition. This is an idea similar to the layout of a circuit with different kinds of IC (Integrated Circuit).[CDK94][Orf96] Such Soft-IC and soft circuit concept can be applied to set up our SL systems. To facilitate this approach, this paper analyzes SL systems based on Soft-IC concept.

Using these ideas as the core, we develop the rest sections. Section 2 is focused on the model of SL systems, the cooperation among learners [Chan95a] and the basic elements of Web-based SL systems. In section 3, these basic components and their interfacing format, interactive flow and packet formats are analyzed in details. Section 4 uses Petri net to analyze the above basic learning components. Two realistic learning models of SL systems: *asynchronous cooperative learning model* [TSH97] and *composite learning system* are implemented on WWW to prove the open architecture of SL systems in section 5. Section 6 is a conclusion.

2. Learning Models of Social Learning Systems

Social Learning systems are often divided into two kinds: *Centralized SL systems* and *Distributed SL systems*. The former means that all learners and teachers have access to the same computer; whereas, learners and teachers in the latter systems are located in different places and communicate through network. As Internet emerges, distributed SL systems become more popular today. No matter whether centralized or distributed, social learning systems are usually composed of several independent modules, called *components* or *Soft IC*. Each component communicates with other modules through standard protocols and forms an open architecture, as Figure 1 shown.

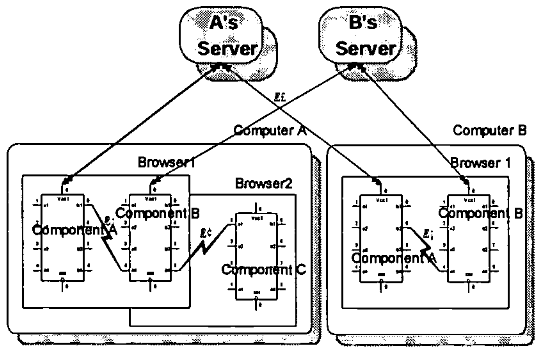


Figure 1 Open architecture formed by components

The interactions of distributed SL systems can be *collaboration* and *competition*. In addition, they both have two kinds of spatial temporal relationship: *synchronous* and *asynchronous*. With these taxonomy, Web-based SL systems can be classified into seven models:

- **Single Learning Model:** In this learning mode, there are many limits when studying. Since a learner does not keep any connection with server, the learning progress could not be recorded. However, he/she can download necessary learning systems to his/her browser.
- **Single Learning On-Line Model:** The user must login a server and after get authentication, he/she can obtain many resources from server. This system can record all the learning process. In this mode, the courseware can always be kept at the latest version and the user can often obtain the latest knowledge and teaching resources.
- **Asynchronous Collaboration Learning Model:** Users also login servers, but need not go with other users at the same time. Users logining at different time may exchange messages through BBS (Bulletin Board System) or mailbox. Any user can post his/her problems to message board or BBS to wait for answers of other. Therefore, users help others asynchronously.
- **Asynchronous Competition Learning Model:** Users must login a server but need not have any connection with others users. However, all learning data, such as users' learning rate, their scores and learning states, are collected in the server and can be acquired by every user. This forms one kind of competition among users.
- **Synchronous Collaboration Learning Model:** Users login some servers and then their learning states are recorded accordingly. Moreover, since there are communication links among users, such as white board and talk, they can solve problems through questioning or opinion exchange. This makes users learn faster and more efficient.
- **Synchronous Competition Learn- ing Model:** In this model, every user logins one server and connect to other users. These users' learning states are recorded and broadcasted. Thus, the progress of one user will incur others' emulousness and competition is formed.
- **Mixed Learning Model:** Each of Models 1 to 6 provides one special *character* of some ideas. This model combines more than one of above learning models and forms a kind of multiple characters.

After these seven learning models are analyzed, some general concepts embedded in these models can be caught. It is possible to find several *BL (basic learning) modules*, which can be used repeatedly. These basic learning modules include *system control panel, learning panel, identification module, recorder, bulletin board system (BBS), learning status display, real-time communication module, SC (synchronous controller)* and *GC (group controller),* whose relationship with the above seven learning models are listed in Table 1.

3. Analysis of Basic Learning Modules

In order to implement SL systems on WWW, we first have to analyze BL modules to understand their basic functionality and communication requirements. With these modules, any kind of SL systems on WWW can be assembled easily. This makes an open architecture of social learning systems.

- *Functions of System Control Panel*

(1). System flow control (includes scene change control): This component sends open/close-window messages to browser to change homepages (scenes). It also receives messages from browser and parses it to do some relevant process.

(2). Learning model control: by what users assign.

(3).User identity Recording: calls *identification module* to execute user authentication process whenever user logins or other modules inquire.

□ necessary ×□unnecessary ▥ at least one

Basic learning modules Learning models	M1	M2	M3	M4	M5	M6	M7	M8	M9
Single Learning Model	□	□	×	×	×	×	×	×	×
Single Learning on Line Model	□	□	□	□	×	×	×	×	×
Asynchronous Collaboration Learning Model	□	□	□	□	□	×	×	×	□
Asynchronous Competition Learning Model	□	□	□	□	×	□	×	×	□
Synchronous Collaboration Learning Model	□	□	□	□	×	×	□	□	□
Synchronous Competition Learning Model	□	□	□	□	×	□	×	□	□
Mixed Learning Model	□	□	□	□	□	□	□	□	□

M1: *system control panel*
M2: *learning panel*
M3: *identification module*
M4: *recorder*
M5: *bulletin board system*
M6: *learning status display*
M7: *real-time communication module*
M8: *synchronous controller*
M9: *group controller*

Table 1 Relationships between Social Learning Models and Basic Learning Modules

- *Functions of Learning Panel*

(1). Textbook browsing: for users' reading or doing do some exercises.

(2). Measurement of learning outcomes: It could be an instructional questionnaire, a preview test, a score rating or a general exercise. After processed, its results will be shown on *learning status display*. This panel is the most important interface between users and system kernel.

- *Functions of Identification Module*

(1). User authentication: When getting user's identity from *system control panel*, this module will check user's registration data, such as username and password, and then other modules can request user information directly.

(2). User information management: This includes password change, user account creation/deletion and group creation/deletion. These kinds of information are so important that only administers can get access to them.

- *Functions of Recorder*

(1). Data recording: processes and records any data sent by other modules.

(2). **Data restoration:** Other modules may ask for recorded data.

- *Functions of BBS (Bulletin Board System)*

(1). **Post/read/reply/delete message:** according to users' instructions.

(2). **Change board and discussion forum:** ditto.

- *Functions of Learning Status Display*

(1). **Display learning status sent by other modules:** The display styles are also controlled by other modules through some control instructions, such as data type, data value, user's name, group name, and so on. This module also handles some error exceptions.

- *Functions of Real-time Communication Module*

(1). **Transmit message inputed by user:** Then users can send messages to server in real time.

(2). **Show messages dispatched from server:** If there is any status change on server, this module will display the present situation instantly.

- *Functions of SC (Synchronous Controller)*

(1). **Get control token:** An *SC client* will send a *login* message to its *SC server,* then this server will deliver *control token* to the first user and announce to other modules or users.

(2). **Transfer token:** When another user asks for token, the *SC server* will decide the next token-owner.

- *Functions of Group Controller*

(1). **Create/Delete a group:** When a *GC client* sends a creation/deletion request including users' number and group identification to *GC server, GC server* will add/delete relevant information to/from group database.

After analyzing social learning models and the corresponding basic learning modules, we can get some understanding of their relationships. Now, a few examples can be given to get indepth understanding.

First, we take a look at *Single Learning Model.* In this model, both *System control panel* and *Learning panel* are needed. However, *Identification module* is optional since a user can just read textbook, without logining any server. On the other hand, *Asynchronous Collaboration Learning Model* implies that *Identification module, Recorder, Bulletin board system* and *Group controller* should be added. But other modules are not necessary.

Up to now, we have introduced basic functions of social learning components. By distributed object principle, every component is an independent object, which can be treated as a piece of software IC. The following will use these Soft-ICs to propose an open architecture of social learning systems on WWW.

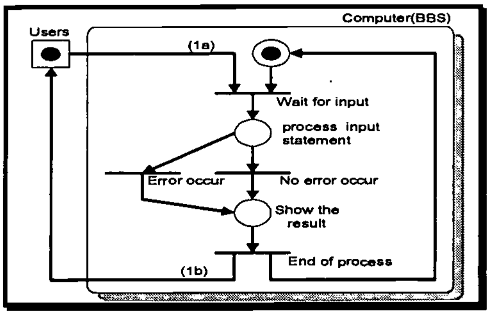
4. Open Social Learning System

In order to analyze the key status of basic learning components and their relationships, Petri Net is chosen. A *Petri Net* is a quintuple $\mathbf{P} = \{\mathbf{p_1}, \mathbf{p_2}, \ldots, \mathbf{p_m}\}$ is a set of finite place, marked by "□". $\mathbf{T} = \{\mathbf{t_1}, \mathbf{t_2}, \ldots, \mathbf{t_n}\}$ is a set of finite transition, marked by "□". $\mathbf{A} : (\mathbf{P} \times \mathbf{T}) \cup (\mathbf{T} \times \mathbf{P})$ $\quad \mathbf{I}, \mathbf{I} = \{\mathbf{1}, \mathbf{2}, \mathbf{3}, \ldots\}$ is a group of directed arrows, marked by "□ . These arrows represent the status that transmission from **P** to **T**, or **T** to **P**. **M:** the place which owned token, marked by"⦿". $\mathbf{P} \cap \mathbf{T} = \varnothing$ and $\mathbf{P} \cup \mathbf{T} \neq \varnothing$.

Under this basic definition, we can define a set of symbols in our analysis model:

1. ▭ represents a computer.
2. □ is one process in the computer.
3. ⦿ is the present process.
4. □ represents an event on trigger.
5. □ is a user before computer.
6. ⊡ is the user with some token.
7. ⬭ is a memory buffer receiving event from another user.

With these definitions, many properties in multi-user multi-processing systems, such as multi-process branching, time-out procedure and multithreading, can be easily indicated, as Figures 2 shown.



	Function	Parameter
1a:	1 (open window)	Window name, URL, window status
	0 (close window)	Window name
1b:	1 (succeed)	(none)
	0 (error)	error message

Figure 2 System control panel and its procedure

By a distributed multi-server system. If any server crashed or got some trouble, the other servers still work normally. This means multi-server system provides more reliable environment. However, there still exist some potential problems:

Problem of Incomplete Components Loading

Because of the multi-processing architecture, more than one component may load data and do some processes at same time. This makes the whole system more efficient, but also brings some trouble. The system may be stuck in an unstable status, waiting for the coming all needed resources. When on WWW, this problem can be solved by the *media tracker method* provided by Java.

Problem of Chain-Calling between Components

This is a hidden problem in multi-tasking system. When one component called by another one wants to call a third component, this brings *deadlock* problem. On WWW, the function *setTimeout()* offered by *JavaScript* gives one solution. When a component is called, the system sets a timer. As the timer overflows, the system creates a new process/thread to go on. Thus, the blocking can be untied.

5. Experiment System on WWW

To prove the feasibility of our open architecture of social learning systems, a homepage named *Social Learning System on WWW* is made. This experimental homepage includes *Asynchronous Collaboration Learning Model* and *Mixed Learning Model*, each with courses being Chinese and mathematics.

As mentioned, the *Asynchronous Collaboration Learning subsystem* uses *Learning panel* and *Bulletin board system* in Chinese course, as Figure 3 indicated. As the snapshot shown in Figure 4, students can review lessons and post questions to message board at their free time. With such design, students can share learning experiences with friends from all the world.

Besides asynchronous message board, the *Mixed Learning subsystem* in Figure 5 possesses *TextPhone* to exchange opinions, *Learning status display* to show users' learning status and *Synchronous controller* to assign corresponding exercise. Moreover, a synchronous computer game embedded with some lessons is added to make students happy to learn, as shown in Figure 6.

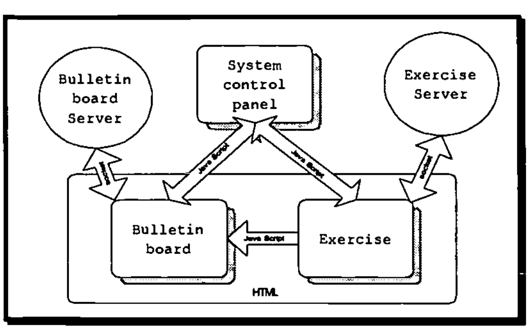


Figure 3 Architecture of asynchronous social learning subsystem

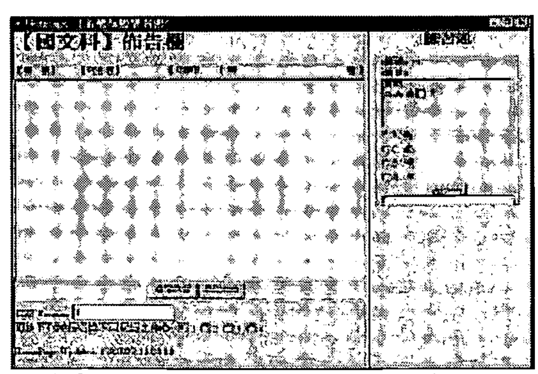


Figure 4 Snapshot of asynchronous social learning

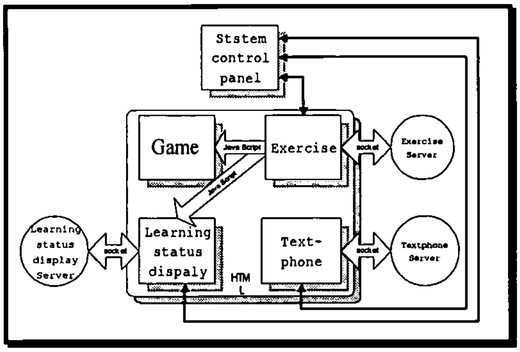


Figure 5 Architecture of mixed learning subsystem

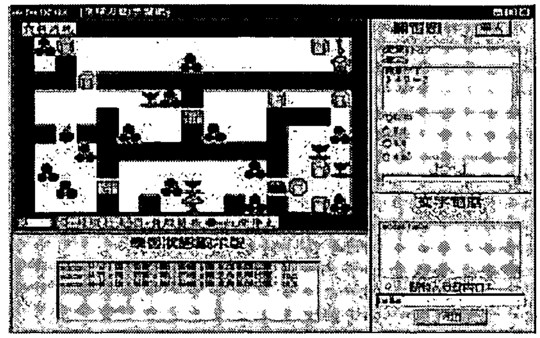


Figure 6 Snapshot of mixed learning subsystem

6. Conclusion

In this paper, we propose an open architecture of social learning systems on WWW. This architecture possesses a set of independent learning components, a set of open interface protocols and one construction method. One example is actually implemented on WWW to demonstrate the feasibility and flexibility. Such structure can be applied not only to society learning system, but also to other similar systems.

Up to now, we only study the prototype and demonstration of this open architecture. More experts with professional knowledge and domain teaching knowledge should be invited in the future. Furthermore, such architecture should be invested through strict educational evaluation to prove its learning effectiveness.

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Designing Instruction for the Web: Incorporating New Conceptions of the Learning Process

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Abstract: New technologies such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) have led to recent discoveries about how the brain works, indeed how we learn. The interactive capabilities of WWW-based instructional strategies can be employed to better match how we teach with how we know students learn. This paper provides a summary of new conceptions of how learning occurs, an overview of instructional strategies which are known to promote learning, and an argument for taking advantage of the interactive capabilities of the WWW to create an optimal setting for learning. It concludes with a description of a staff and media development project which successfully integrates these ideas to enhance undergraduate education.

Learning is the process by which we acquire new information. Memory is the process by which that knowledge is stored and recalled when required.

The typical tertiary education classroom, can better be described as a theatre of transcription than an optimal setting for learning. To walk into most undergraduate classes, one would likely see students frantically taking notes while their professor stands at the front engaging in a 50-minute monologue of factual information, stopping only to scribble a few words or a diagram on the chalkboard. There is often little interaction among the learners or between the teacher and learner.

How congruent is this description with what is known about how students learn? Not very.

The Learning Process

Previous conceptions of learning envisaged filling empty spaces with information, which became "bins" or neatly organised "filing cabinets" of knowledge from which the mind retrieved what it required. Today we know that learning is not a process of filling an empty bin with knowledge for later retrieval. There are no bins of knowledge that we look for when we learn or remember. A memory does not exist in a specific location in the brain. As early as 1949, it was known that long term memory is developed through the establishment of repeated connections, or pathways, among masses of neurones [Hebb, 1949]. It is the activation of the mental pathways, rather than the arrival at a specific destination, which enables us to learn and remember.

The brain works through "an electrochemical process, which distributes both chemicals and electric charges through an incredible network of tubes extending throughout the brain and body. It appears that *learning consists of the growth of additional neural connections* stimulated by the passage of electrical current along nerve cells (neurones) and enhanced by chemicals (neurotransmitters) discharged into the gaps (synapses) between neighboring cells" [Valiant, 1996]. Mental effort actually changes the physical structure of the brain, as additional neural connections are created, the density of the brain's mass is increased. (Note: To be called "dense" or "think-headed" is a compliment!)

People learn differently and know things differently because they take different pathways on different occasions; dependent on the context, their previous experiences, and their current physical and emotional state. Not all pathways are accessed in the same way. The nature of the learning or memory task will prompt different access routes.

However, as a particular pathway is re-used, additional connections are built which strengthen the linkages. Undoubtedly some of these mental pathways, like tracks in a forest, become so worn that the mind seeks to use these easy routes to arrive at an understanding -- the path of least resistance. Other paths are more difficult, are never discovered, or are overgrown for a variety of reasons. As pathways are lost with non-use, we "forget." In many cases learning means adjusting existing pathways or removing pathways among memories that become "known" as incorrect.

Assumptions on the Nature of Learning

From the argument that learning occurs through building and traversing neuronal pathways, we can assume that:

- Learning occurs through making connections.

  It is doubtful that any idea is ever truly new; for a new idea would have to be constructed by the mind without any links to anything already known. Even a new word in a different language will be processed by the mind through links to existing words in the vocabulary. Those links may be words with similar meanings or simply similar sounds.

  For example, one person seeing the word "togafiti" for the first time may associate it with the word "graffiti" or a Roman toga. Another person, who recognised the word as Samoan and knew that that the "g" is pronounced "ng" would follow entirely different pathways that lead to a connection with something to do with "Tonga."

- The best predictor of what students learn is what they already know.

  New learning is more easily achieved if there is an existing pathway or framework waiting for it. These existing pathways can facilitate or hinder new learning. Sometimes existing pathways divert new ideas into what the learner wants to believe and thus affirms existing beliefs, even when the incoming idea is contrary. If what is "coming in" happens to be diverted into an existing pathway, the learner may feel more comfortable than if the new information challenges an existing concept. Any biology teacher can tell of students who achieve pass examinations on the principles of biological evolution, but not believe the basic tenets of the theory. The new pathways were not embedded or placed in contradiction with deeper held beliefs.

- Nothing is learned until it is internalised into long term memory, ready for later retrieval along well-worn pathways.

  Learners can create a new pathway easily, but that path will not be available in a month's time unless it is very strongly connected with a specific context, something already known, or frequently rehearsed. Memory consists of all the bits and pieces of an experience -- the sights, sounds, smells, and emotions. Each fragment is stored in areas of the brain responsible for handling that particular sensation. Sounds are stored in the auditory cortex, sights in the visual cortex, etc. Keeping track of what's where is a region of the brain called the "hippocampus," which functions as a sort of memory index. Recalling an event requires re-assembling all those fragments, it is literally a process of re-membering.

- Students learn in different ways.

Students have different preferences for the way in which they learn and these preferences vary within individuals, across time and contexts. Each student's mental pathways are idiosyncratic. The specific bits of knowledge and links among them will differ because of life experience and preferred methods of receiving and processing information.

Instructional Strategies which Promote Learning

Perkins proposes that there are three dimensions of intelligence: neural, experiential, and reflective. He posits that in-born, neural intelligence can be influenced through nutrition and maturation, though very little can be changed through instruction or practice. Educators do, however, have great opportunity to influence the other two. New neural connections are developed as students experience their environment; and additional connections are created as they reflect on their experiences and seek alternate pathways to understanding. [Perkins, 1997].

Assisting students learn involves creating opportunities which facilitate the building and activation of these mental pathways. This is best done by gaining an understanding of what students already know; followed by designing activities which require them to reflect upon the new information, affirm correct conceptions, and alter any previous misconceptions.

The Three R's -- Information is not knowledge. Information is not connected; it is "out there" waiting for students to bring it into their knowing. To do that, they need to do more than say it, print it, hear it, read it, sing it, dance it or spell it. Teachers have to encourage connecting information to something already known and that process is best achieved with *Reflection.* Reflection is thinking about something, examining any linkages or any connections anew; indeed thinking about one's thinking. Reflection is encouraged through asking questions which require analysing similarities and differences, applying the information to new situations, and assimilating, or synthesising, the new information with what was previously known. Lev Vygotsky discovered that the brain learns and remembers more information during socially interactive vs. isolated learning situations; the physical characteristics of the brain change as we engage with others [Caine & Caine, 1997]. Therefore, students may most benefit from presenting these questions as items for discussion in small groups or in the larger classroom setting.

Sometimes this reflective process will reveal misconceptions in previous understandings and prompt the *Reconstruction* of old pathways. Jean Piaget, a noted Swiss educational psychologist, developed a theory of intellectual development which recognised that increasingly complex levels of thinking and understandings of the world are developed in a number of stages brought on by life experience and maturation. For example, infants understand the world through their senses. If they can see Mommy, they know Mommy exists. However, if Mommy disappears from their sight, then Mommy no longer exists for them. This is why infants will become frightened when Mommy leaves the room. It also explains the fascination with "peek-a-boo" type games, in which the adult disappears and instantly re-appears. It is through these experiences, and natural maturation of the brain, that infants come to understand object permanence -- "Mommy still exists even if I can't see her." Infants reconstruct their mental pathways to accomodate this new understanding.

To prevent the loss of a useful pathway or script, teachers need to encourage *Rehearsal* through repetition and revisitation. Running the script again and again, along varied routes strengthens the pathway. Storytellers remember stories by telling them. Comedians remember jokes better than others because they tell them. Some teachers remember faces or names better than others because they repeat them or recall them more often. Teachers lose the names of last year's class through non-use, though they remember the complex taxonomies in their own disciplines through frequent recall.

This repetition should come from presenting the information in a variety of ways; for rote rehearsing is not as effective as rehearsing with a variety of stimuli and in a variety of contexts. For example, to assist students understand the concept of "virus," the term could be presented in computing, biological, and medical contexts. Similarly, increasing the number of senses involved in the learning experience contributes to the amount of information received and retained.

Students enjoy variety and will learn more when the instructional methods change than when they are boringly similar. Some will prefer information to come to them on a screen or in a book or from a friend or from a teacher. Much is known about the benefits of varying the approach to meet the different needs and preferences of students. Researchers have identified eighteen factors (elements of the emotional, sociological, and physical environments) which affect learning styles [Dunn, Dunn, & Price, 1987]. Effective teaching methods recognise and allow for this variety in the learning style preferences of students.

Supporting Learning with Modern Technologies

Interactive multimedia (known as "hypermedia") learning materials offer many pedagogical advantages which address the needs identified above. First, the combination of text, graphics, video, and sound enable the creation of multi-sensory experiences which are more likely to be remembered. Their interactivity precludes the necessity for presenting the information in a linear form. Indeed, Bill Atkinson, the creator of HyperCard, the first widely available hypermedia authoring tool, refers to it as an electronic construction set which creates new possibilities for teaching and learning. Each learner can experience a different presentation based upon the paths they choose.

Learners do not have to sit passively watching a presentation someone else has prepared. They are allowed to interact with the media themselves. They can access the presentation in the order of their choice and they can use many resources to create their own study materials, thus guiding their own learning. Marchionini [cited in Azarmsa, 1991] refers to this as a "fluid environment (which) requires learners to constantly make decisions and evaluate progress, thus forcing students to apply higher order thinking skills" [p. 170].

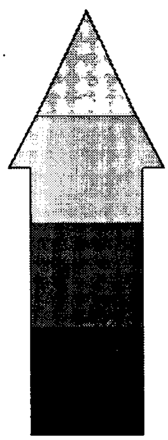
For example, an author might create a hypermedia resource on Napoleon Bonaparte and, at key points, link passages of text, graphics, video, and sound. These links to additional information would be signalled to the learner by means of a font change or graphic icon. Learners might have the option to see a picture of Napoleon, review a map of Napoleon's campaigns, skip to a passage about his exile on Elba, get biographical data on Josephine, or obtain a definition of an unfamiliar word. In other words, each time the material is read it could be accessed in any sequence and to any degree of detail. Students could explore these links to construct their own pathways regarding Napoleon's decision making skills, his driving personal characteristics, etc.

Teachers and students learn from each other [Angelo, 1993]. Hypermedia offers a tremendous potential for enhancing these teacher-student and learner-learner relationships. Students can develop their own tours through the knowledge base and share their experiences with their teachers and other learners. Further, the creation of multimedia and hypermedia materials fosters cooperative relationships among learners as they work together to share the creativity and responsibility needed to produce such a project.

The rapid advancement of the Internet, particularly the development and prolific expansion of the World Wide Web, enable educators to create multimedia teaching resources and interactive instructional strategies which can be delivered to any student without regard to time, place, or computing platform. Educators must recognise, however, that the medium of delivery is not the most important condition for learning. It is no better to distribute large amounts of static information via the WWW than it is to engage in a 50-minute monologue. Nothing happens until the learner is actively engaged; and at a level beyond passively responding by copying a lecturer's words or pressing an <ENTER> key.

WWW-based instructional strategies vary in terms of the degree of interactivity between the learner and the teacher, the learner and the learners, and the learner and the material. Figure 1 illustrates the range between passive to active instructional strategies.

Educators must adopt teaching strategies which marry the new conceptions of learning with the benefits of WWW interactivity. However, academic staff tend to teach as they have been taught. For teachers to adopt new instructional strategies (technology based or not) involves raising the teachers' awareness of how they and their students learn and supporting their moves to teach differently. It involves an awareness of new methods, developing new skills with the methods and knowing when to apply those methods to optimise student learning [Joyce and Showers, 1998]. The process is further complicated when staff are expected to use technologies, such as WWW, with which they are unfamiliar.



5 The materials require that students work collaboratively to respond to assignments or create new learning resources to be shared with other peers.

4 The materials require that students seek additional information and write their own materials which link to the existing ones.

3 The materials contain questions that students are asked to reflect on or respond to, either off-line or online. Answers are provided through successive screens or through teacher marks or comments.

2 The posted materials have "hot point" links to other related or supportive information.

1 The teacher's written lecture notes, tests, diagrams, questions, exams, etc. are placed on the web without alteration.

Figure 1: Continuum of Interactivity Available via the WWW

Linking New Conceptions of Learning with Teaching via the WWW

Personnel within the Education Centre at Lincoln University (New Zealand) have designed a new staff development project, PROJECT LEARN, which recognises the new conceptions of learning, the interactive potential of the World Wide Web, and the challenge of assisting academic staff adopt these new technologies into their instructional repertoire.

Many tertiary institutions are moving into distance delivery of their educational programmes by adopting Internet-based methods. At Lincoln, we are encouraging academic staff to use these same technologies to first support and enhance our on-campus learning. Beginning by supplementing on-campus instruction gives us more control over the pace and assessment of our innovations and gives us face-to-face connection with students. We believe that combining teaching methodologies which focus on how learners learn with WWW-based delivery methods will give us a model that works equally well for on-campus and off-campus students; for the WWW allows for the best of both worlds: independent pathways through the material and interaction with teacher and peers.

PROJECT LEARN, initiated in June, 1997, is primarily an in-depth media and staff development activity. It is structured to respond to earlier feedback from academic staff (survey data obtained in April, 1997) on what resources they needed to incorporate more technology-based instructional methods in their classrooms: knowledge of how to re-design their subjects and the technical support necessary for developing new curriculum resources. Paramount features of the project are the incorporation of two principles found to be important when supporting teachers: providing different strategies for different stages in the change process, and offering continued monitoring and support as the new strategies are implemented [Scott, 1996 and Joyce & Showers, 1988].

PROJECT LEARN is currently focused on first-year compulsory subjects taught within the University. In subsequent years, second and third year compulsory subjects will be brought into the project. By concentrating on compulsory subjects, we are able to direct our efforts toward creating materials which will be used by the greatest number of students--thereby increasing the impact of our efforts for change.

Project personnel recognise that developing a deeper understanding of content requires more than passively absorbing a body of facts and regurgitating it in an examination. Students learn best by being engaged with the content, actively processing the new information in new ways [Bonwell & Eison, 1991]. A key premise to PROJECT LEARN is that the instructional resources developed will engage students in exercises which promote an active learning experience, where active learning is defined as "instructional activities involving students in doing things and thinking about what they are doing" [Bonwell & Eison, 1991]. It takes advantage of the WWW's interactive capabilities to design learning experiences which allow students to interact with (not just read) subject-specific material, interact with related resources which peak their personal interests, and interact with other students and teachers to enrich and embed their learning.

The PROJECT LEARN team is made up of content specialists (the academics teaching the subjects), instructional design specialists, graphic artists, HTML programmers, and some managerial and clerical support. Currently, no attempt is made to fully convert an on-campus course to distance delivery. Rather, the team begins by having an instructional designer meet individually with each academic to gain an overview of his or her instructional goals. These two then identify one element of the subject -- perhaps a teaching strategy, assessment activity, or content module -- which can be better accomplished by taking advantage of WWW capabilities. The nstructional designer then discusses the issues with the technical support staff for the creation of the materials. The academic is brought in periodically to review the work in progress.

During the development process the academic's involvement is two-fold: providing the content and the instructional objectives. When the subject is taught the following semester, the academic is given additional assistance with implementing the Web-based resources. The academic will later be expected to maintain and further enhance the resource.

Features of the project which have thus far indicated success include: the acceptance of the client academic staff (12 of the 15 academics approached eagerly agreed to participate); the creation of a template to facilitate efficient web development; and the diverse, yet complimentary, skills of the project staff involved. February, 1998 saw the first PROJECT LEARN materials being used by approximately 2500 students. An evaluation of the materials--in terms of their content validity, instructional design, and impact on student learning-- will be conducted. Those results should be ready for presentation and discussion during the Ed-Media/Ed-Telecom '98 conference.

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Supporting Component-Based Courseware Development using Virtual Apparatus Framework Script

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Abstract

This paper reports on the latest development of the "Virtual Apparatus Framework", a contribution to efforts at the University of Melbourne to mainstream the digital transformation of curricula. We discuss the integration of the educational content and pedagogical functions of learning components using an XML compatible script. Our approach facilitates component re-usability and administration and is based on a database model matched with an authoring system that hides the technical details while preserving the contribution of content experts to the courseware development. In particular, this paper is to be the reference point of version 1.1 of the VA framework.

Introduction

The concept of "Virtual Apparatus" (VA), software components written to a specification and providing interactivity on a web page, was discussed and demonstrated at ASCILITE 1996 [Ip and Canale,1996]. We have since brought the implementation forward so that virtual apparatus built using different technologies (such as Java Applet, Active X controls & Macromedia Shockwave movies) can now communicate via scripting on the enclosing web page [Ip et. el.1997]. As we put the framework to real use, we recognize that there may be three different types of virtual apparatus, differentiated by the way instructional content is related to the functions provided:

- Some virtual apparatus are generic and content-free, for example a data logger. A data logger may continuously monitor the performance of a learner and store or pass on information for immediate feedback, assessment or evaluation purposes.
- Some virtual apparatus are content-rich, for example a simulation of a particular scenario. The virtual apparatus itself in this case contains the educational content. It may however, still be usefully operated with other apparatus, such as the data logger.
- Other virtual apparatus may be generic but content-dependent, such as a question shell object [See Fritze and Ip (this volume)]. These virtual apparatus are loaded with instructional content in order to operate.

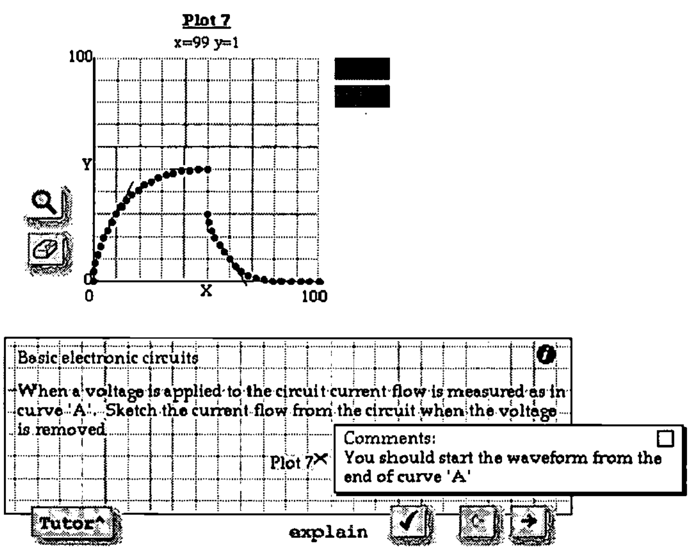
While the first two types can be implemented as Version 1.0virtual apparatus, additional support is necessary for the third type [see our online resource for the details of the Version 1.0 specification, located at http://www2.meu.unimelb.edu.au/virtualapparatusframework/]. Version 1.1 is an extension to the virtual apparatus specification1.0 that defines a standard mechanism to support the generic but content-dependent virtual apparatus. Virtual apparatus developed in accordance to version 1.0 and version 1.1 are inter-operable. The content is expressed in a tagged format and is referred here as VAScript.

Typical use scenarios

Learning Engine object model (with a master object)

The Learning Engines Project [Fritze and McTigue, 1997] outlines particular model of interactive object that can be independently produced and combined into useful learning activities. These objects correspond to visualisations, simulations, dialogue shells and interface extension components. The dialogue shell object takes the more important role, acting as a controlling agent that shapes the dialogue between the learner and other objects. The shell derives its content from a VAScript.

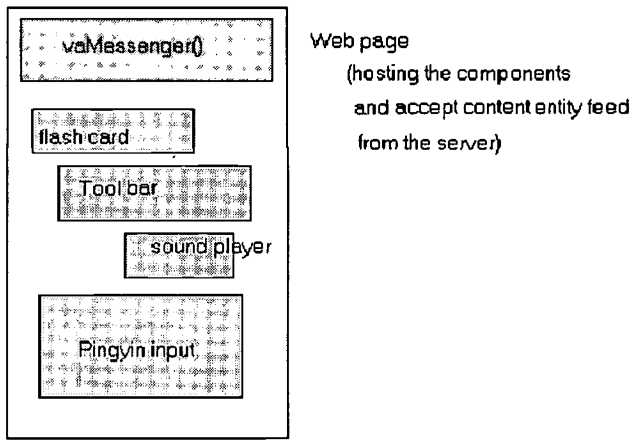
In the illustration below, we show two such components on a page. The bottom component is a particular dialogue shell, the Tutorial Item Set, which embodies a series of questions items specified by its current VAScript. The upper object is an interactive graphing object which can both plot curves and interpret those sketched by the student. The graph object has plotted an initial curve as specified by a <command> tag in the VAScript of the Item Set and relayed by the VAmessenger. The VAmessenger is the agent controlling inter-object communication within the VA Framework[Ip et. el. 1997]. A curve entered by the student has been reported back to the ItemSet which has judged it against the specified criteria and shown a corresponding feedback message. It is possible, if the author deems appropriate, to send a drawing command to the graph using the `<command>` tag in the ItemSet script to display the correct answer.



NALSAS model (using peer-to-peer relationship)

Another project being undertaken for NALSAS (National Asian Languages and Studies in Australian Schools Taskforce) to teach Mandarin to teachers, assumes a different content model. All the components of a learning activity on the Web page communicate via the VAmessenger. No component is in a master position. The Flash Card, Sound Player and Pinyin Input software objects have been constructed as version 1.1 virtual apparatus and have their respective scripts. When the page is requested by a student, the server generates these three scripts. When the student clicks on a "start" button on the tool bar, a message is sent by the tool bar apparatus to the VAmessenger. Logic written within the VAmessenger generates a command received by the three objects to use the first item in their respective scripts. The Flash Card displays a Chinese character briefly. The Sound Player plays the sound corresponding to the character and the Pinyin input is receives typed input from the student corresponding to the pinyin of the flashed character. After a correct input, the Pinyin Input sends a message to this effect and VAmessenger asks the other components to advance to the next element in their scripts. The synchronization is established by the index attribute in the second layer tags of the respective scripts.

An interesting point about the NALSAS project is that, while the flash card and sound player are shockwave movies, the tool bar and the pinyin input are Java applets. The VA framework provides the mechanism that enables them to inter-operate on the same page.



Flexibility in adding data-logging functions as needed

A data-logger is an invisible apparatus. When activated by a line in the VAmessenger, a copy of all messages passing through the messenger can be relayed to it. In an online environment, the data-logger can establish a direct database connection to the server(e.g. via JDBC using a data logger written as a Java Applet). In an offline situation, another data-logger (e.g. written as an Active X control) writes the data to local storage. As long as both data-loggers have the same registered methods and properties, changing from online to offline delivery requires a change to just one line of code. In some situations, this can be automatically generated by the server side component.

Adaptive content delivery using a back-end database server

The functionality provided by the virtual apparatus on the page can be easily customized by a content author or an instructional designer, for example in the flash card example above, by setting the umber of times the Chinese character is to be flashed. Content sent to the virtual apparatus as VAScript by the back-end database can be adapted according to the performance and/or background of the student. This flexibility is make practical by the principle of separating software function from content description.

Technical Specification of VAScript

The Virtual Apparatus specification 1.1 concerns three parts:

- format of the educational content (i.e. VAScript).
- the compulsory parser behaviours to handle the VAScript. In different circumstances, a parser may exist within a virtual apparatus or externally as a generic parser apparatus.
- the support on the browser (using browser scripts) for VAScript.

VAScript is based on XML (Extended Markup Language). XML is a document specification offering significant advantages over HTML, particularly with its extensibility and DTD (Document Type Description) metadata descriptions and will soon replace HTML as the major Web document standard. The following is the technical specification of VAScript which relies on an understanding of XML.

VAScript Syntax

A VAScript is a tagged document in the form of an XML document with the following notable features:

- every virtual apparatus supporting specification version 1.1 can have its own set of recognized tags. The definition of the tags, known as the DTD part of the VAScript, is also part of the specification.
- the DTD definition is now a part of the `VAinfo` and hence the function `getVAinfo` will return the DTD as well. `Vainfo` is a mechanism defined in Specification version 1.0 to enable content author to read the methods and properties of a virtual apparatus.
- the DTD defines the legal tags within the VAScript supported by the associated virtual apparatus. The meaning and/or the functions of the tags are specified as comments in accordance with the syntax requirement of XML document.
- In order to enable future compatibility with metadata, all the tags will begin with "VA:". Note the colon ":" is included. Effectively, all VAScript will operate within our own namespace.
- The DTD of the top element of a VAScript is:
  ```
  <!ELEMENT VAScriptName - - (SecondLevelTagName+) >
  <!ATTLIST VAScriptName
  LoadState (auto|preload|incremental) auto >
  ```
  (Note: If `LoadState=auto`, the VAScript will be loaded using the default behaviour of the virtual apparatus. If `LoadState=preload`, all the `SecondLevelTagName` will be loaded and made available at the same time. If `LoadState=incremental`, each `SecondLevelTagName` is treated as an element in a set. The virtual apparatus should provide mechanism to handle the `SecondLevelTagName` one by one.)
  See an explanation of the syntax of the DTD grammar at Appendix 1.
- The second level tag must be in the following form:
  ```
  <!ELEMENT SecondLevelTagName - - (OtherElements+)>
  <!ATTLIST SecondLevelTagName
  Index ID #IMPLIED>
  ```
  (Note: `Index` is necessary for all second level tags because on a web page, there may have several virtual apparatus interacting in order to provide a rich experience to the learner, these virtual apparatus rely on `index` to synchronize the content. As such, a server-side component should ensure that all `Index` on different VAScript on the

same page are mapped correctly. If Index is not supplied, it will be generated internally by the virtual apparatus, however it will not be available for use by the other virtual apparatus.)

- <EXTERNAL> </EXTERNAL>is always implicitly defined and is supported by the build-in parser. The <EXTERNAL> tag is defined as follows:
```
<!ELEMENT External - - (*)+>
<!ATTLIST External
target NAME #IMPLIED
TargetLoadState (discard|append) append
ExportIndex (UseSource|UseTarget|Increment|$ID)
UseSource>
```
  (Note: Any VAScript which are enclosed by the <EXTERNAL> </EXTERNAL> tags is called embedded VAScript. Embedded VAScript is not understood by the current parser and should be forwarded to the target virtual apparatus as specified in the target attribute. The embedded VAScript is a full VAScript with its own Top level element.
  Upon arrival at the target virtual apparatus, the embedded VAScript will replace the previously loaded VAScript at the target virtual apparatus if the TargetLoadState=discard. It will append to the previously loaded VAScript if the TargetLoadState=append.
  The Index in the second level element of the embedded VAScript will take the parent VAScript's current Index if ExportIndex=UseSource. The Index will be that specified in the embedded VAScript if ExportIndex=UseTarget. The index will be the numeric additive sum of the parent VAScript's current Index and the embedded VAScript Index if the ExportIndex=Increment. Finally, the index of the embedded VAScript will be ID if ExportIndex=$ID)
- <command> </command> is always implicitly defined and is supported by the build-in parser. The <command> tag is defined as follows:
```
<!ELEMENT command - - (*)+>
<!ATTLIST command
target NAME #IMPLIED>
```
  This is used to send command to the target virtual apparatus.

Compulsory parameters supported by Version 1.1 virtual apparatus

Virtual apparatus conforming to virtual apparatus specification1.1 must also support the VAScriptURL parameter. This parameter provides the URL of the VAScript which maybe loaded during initialization. On successful loading, the virtual apparatus will send the message "VASLoadOK". Then the VAScript will be parsed. On successful parsing, the message "VASParseOK" is sent.

Compulsory behaviours supported by Version 1.1 virtual apparatus

Virtual apparatus conforming to virtual apparatus specification1.1 must implement the following methods:

- SetVAScript(VAScript, LoadState, IndexState, InitIndex) where InitIndex is the first index in a set, replacing the index in the incoming

VAScript. `InitIndex` will be ignored if `IndexState=UseTarget`. If the `LoadState=Append`, the treatment of the index will depend on the `IndexState`.
This method will load the VAScript and parse accordingly. On successful parsing, send message "`ExtVASParseOK`"

- `SetVAScriptURL(VAScriptURL, TargetLoadState, ExportIndex, _ CurrentIndex)`
This method is similar to the previous method except it will initiate a loading of VAScript using the `VAScriptURL`. On successful loading, send message "`EXTVASLoadOK`". Then the VAScript will be parsed. On successful parsing, send message "`ExtVASParseOK`"

The built-in parser must support the following:

- When the `<external>` tag is encountered, the content of this tag is passed to `VASforward()` method in the browser environment.
- When the `<command>` tag is encountered, the content of this tag is passed to `VAScommandSwitch()` method in the browser environment.

Browser Script support for Version 1.1
When a page contains one or more virtual apparatus meeting this specification, it must implement:

- `VASforward(target, VAScript, TargetLoadState, ExportIndex, CurrentIndex)`
Where target is the name of the virtual apparatus to get the VAScript with the specified `TargetLoadState`, `ExportIndex` and `currentIndex`.
- `VAScommandSwitch(target, commandstring)`
Where target is the name of the virtual apparatus to receive the command specified in command string.

Concluding remarks

The VAScript provides a way of applying XML, as a powerful document description language, to educational content in the form of modular software objects. While the Chinese flash card described may fall into the category of practice and drill, more sophisticated uses are also supported by the framework, such as with the Learning Engine components. The time and effort invested in creating the interactive graphing object, for example, can be better justified with its re-use in different subject areas by redesigning the scripts, rather than the object itself. At the same time, the object, as a virtual apparatus, can inter-operate with others through a communication standard offered by the VA framework.

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Architecture in the Digital Domain: A Collaborative Design Studio

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Abstract: This paper describes an interdisciplinary design studio that utilizes concepts and methodologies intended to create a comprehensive approach to the organization of building design through the merger of several techniques. These techniques include 1) collaborative learning and design, 2) using multi-tasking workstations, 3) hypertext learning modules and courseware, and 4) interdisciplinary team teaching. The studio merges the preceding teaching paradigms, building on current research and the experience of the faculty. The studio also establishes the premise that architectural design studio and engineering laboratories (structural and mechanical) will need to be organized across departmental boundaries as team oriented activities. The paper discusses the issues of ease of interface (both person to person and person to machine), the continual shift between synthetic and analytic processes in the context of problem solving, methods of representation, design assignments which increase the domain of possible useable forms, and design methods and process.

The Problem

Architects and engineers, who need to interact during their professional career in order to build any kind of complex building, are educated entirely separately. "Over the past century, increased movement toward concentration with an academic discipline has taken charge of the curriculum, as well as serving to compartmentalize the professoriate and the institution." [Landry 94] The vertical separation of disciplines occurs in most universities. This suggests a need for modification of the curriculum, the delivery of course material and teaching methods. Fortunately, this comes at a period of reflection in schools of architecture when, as Mitgang suggests, there are "growing doubts over whether the traditional educational environment is preparing students for a rapidly changing world outside." While "schools remain wedded to shopworn traditions" there seems to be a growing malaise about the role of design as the centerpiece of architectural education. [Mitgang 97] Recognition of the problem also comes at a time when new teaching methods are emerging.

The major effort in trying to reform elements in the curriculum (particularly in different departments) depends upon what might be termed "changing the culture" of the curriculum. To create these changes architectural design studio and engineering laboratories will need to be organized comprehensively, across departmental boundaries. In the course of these revisions they will also need to be changed from independently organized activities to team oriented activities.

The problem with the vertical separation between disciplines is that students from each discipline learn to solve their part of the problem independently. This separation discourages them from understanding the relationship among the problem components. The students can complete their projects without having the opportunity to gain insight to the trade-offs required for an optimal solution. While courses in each department include information about the other disciplines, each is taught in a manner which tends to diminish the importance of integration. Moreover, the ultimate professional relationship among the disciplines, which in the building industry consists of teams, is downplayed by the students working as individuals in their classroom experience. Research outside of the architectural and engineering professions suggest that "future work situations are likely to use a complex mixture of different information channels, including video conferencing, e-mail, small group work, and on-line searches. The design parameters of (these) information systems (will) rely on an awareness of how the social and technological aspects of human interaction intertwine." [Kilker & Gay 94] These are the conceptual underpinnings of the development of a new approach.

Designing the Solution

The hypothesis of the faculty is that a concurrent and collaborative design environment will add to the problem-recognition and problem-solving abilities of the engineering and architecture students. In most workplaces in the building industry, problems solving and design require collaboration among members of a group. These activities require that people share information and coordinate their activities in a setting that allows for immediate interaction [Kilker & Gay 94]. Traditionally, in the professions, although the design and production of buildings requires collaboration, the work is done serially, with drawings passing among the professions and each adding their skills and recycling through the process until the project is completed. No methods of optimization are applied because of the way the design process is structured. Optimal solution spaces are closed off by the time each new part of the process is introduced. Therefore, the focus of the studio is around the activities in which the students can engage to help construct a comprehensive knowledge base necessary to design, optimize and build complex structures.

The potential impact of the studio is to improve the education, professional behavior and attitude of students as they prepare for various aspects of the building industry. The students will have the opportunity to see how the separate courses they have taken in architecture, structural engineering, and building performance are integrated. They will see that contemporary construction is not a simple separate, sequential process, but rather a system characterized by integration and a search for optimal solutions. When design is objectively considered as an iterative, multifaceted process, and a series of problem solving sequences, a significant paradigm shift can occur. Thinking this way, we discovered, was imperative because the way engineering and architecture students learn is different.

Ultimately, the intention is to create a completely computer mediated environment, where students will work on their designs and problems, communicate with each other and others more distant, and receive courseware and criticism at the workstation. The innovative aspect of Total Studio is that it is interdisciplinary, and has been designed from the beginning to provide the format for the perpetuation, replication and dissemination of the studio in a continually upgradeable hypertext format. This focus is away from the traditional piecemeal architectural methodology.

Implementing the Solution

The Underlying Pedagogy

The study of building design must be rooted in a general theory of building science in which architectural space and form, structure, and the effects of the bounding envelope for moderating the environment are considered inseparably. Optimization is a complex problems to solve. "In architecture, aesthetics deals with the way buildings look: the skin, form, site, and overall image within the culture to which they belong. In engineering, technology is informed by modern science and is systems and process oriented. Controlling building environments (both actively and passively) can produce more insightful architecture when an understanding of the aesthetics of the building envelope (static) is paired with an appreciation of the technology of the building systems (dynamic)." [Greenwood et al 97] The studio focuses on the development of structural, energy and spatial intuitions and the relationship among them. Study of highly indeterminate structures is crucial for understanding building frame design. For energy analysis and building performance, it is preferable to analyze a skin-dominated building so that relationship of form to energy flow can be considered. The goal of the faculty is to identify projects at the appropriate scale to study these relationships.

Collaboration and the matrix of studio organization

Collaborative design—thus collaborative learning about a project—is a new concept for students in the studio. A very serious introduction is required to get the students working collaboratively. "By collaborative learning is meant a learning process that emphasizes group or cooperative efforts among faculty and students, active participation and interaction on the part of both students and instructors, and new knowledge that emerges from an active dialog among those who are sharing ideas and information." [Turoff 95] While group criticism and group research is a normal activity in the design studio, designing together is not. Turoff, is his years of development of computer-mediated environments at NJIT concludes that "in many learning situations it has been observed that two people working together at a computer learn more working together than either one separately. It is this ability to share the actual interactive process of "creating the painting" that this approach entails." [Turoff 95] This suggests, as Feisel points out, that "we need to design an educational process that involves students in one another's learning and rewards mutual accomplishment." [Feisel 94]

To facilitate the collaborative idea of teaching and learning, the studio is organized around a matrix of teams and groups. Teams are defined as a number of students assembled to apply techniques and complete a design task. Groups are defined as a number of students organized to develop techniques and learn a particular set of the task. Each student is a member of one team and one group. The sets of teams and groups act as support clusters for each student. In the spring semester of 1997, the four by four matrix of teams and groups worked as theorized. The teams and groups for the first part of the semester were four member each. When the major design project began the teams of four were divided into teams of two. This afforded the opportunity to modify teams to improve interpersonal relationships among the members.

The Learning Groups

In theory, the learning groups should be divided among the three disciplines involved in the project: architectural design, structural design, and mechanical design. Each learning group will be led by an instructor who will develop the educational modules associated with that discipline. The members of each learning group will be responsible for learning the software packages associated with specific segments of the problem and also be encouraged to share their knowledge. To test the learning group concept last spring, project research assignments were made by the learning groups.

The Design Teams

The design teams develop the building design as a whole. During their sessions with the design instructor they work together on the development of the project, each member looking at, and engaging, the design from the perspective of their learning group. Understanding the concept means having access to various forms of representation, selecting ones that are most appropriate for particular uses, and using them accordingly.

The Laboratory

The studio is held in an advanced graphics computer lab with video equipment available for both local viewing, editing and broadcasting. Last year the laboratory had its equipment augmented through funding from the National Science Foundation (NSF) for the project titled *Development of Interdisciplinary Courses and Laboratory Facilities* [see the Appendix]. The primary computer workstations available are Silicon Graphics (SGI) Indy models. The full complement of equipment is eleven workstations, the fastest of which is an Indigo Impact, with 128 MB of RAM. The UNIX based workstations are extremely flexible and able to multitask flawlessly. Students can be logged into multiple computers anywhere on the network and run several software packages simultaneously. The terminals are linked together through a hardware and software system called Comweb which allows faculty to control of all workstations for the purpose of software instructions, group critiques, and other demonstrations. The computers are networked with adjacent laboratory facilities and the Internet.

The Four Modes of Representation

One important idea in the studio is to dampen the use of the computer as the central tool. The computer needs to be on equal footing with all the tools in the toolbox. This is accomplished directly through the assignments which emphasize the four modes of representing architecture. The notion of multiple representations of information is central to the course and is discussed thoroughly with the students at the beginning of the semester. Narrative descriptions of initial and final concepts are required, as are short written reports on field trips and research issues. Building class site models and chipboard study models in the traditional way—especially as a comparison to the 3D computer models—is emphasized. Students learn to study their work simultaneously via the computer models and via physical models and sketches to augment their visual perception and other cognitive skills. Research suggests that students relate to what they see on the screen better if they can relate it to previous experiences. [Roberts, et al] Final projects are presented on traditional "boards" which allows computer work to be communicated as others (especially clients) perceive it, and gives the students the opportunity to mix their media, drawing on strengths and skills they may have previously acquired. My own experience as a designer indicates a multimodal design process is most useful. Project are also represented on the Internet.

Preliminary Results

The present manifestation of the studio has been offered in the academic year of 1996 and the spring of 1997. The following items have been implemented: 1) collaborative learning and design, 2) computer mediated environment, and 3) preliminary interdisciplinary work. Deep within this seemingly complex learning environment are elements of the traditional studio. The semester is divided into an analysis phase and the design phase with a few short research assignments interspersed. The two semester sequence is designed to emphasize structural issues in the fall semester and building performance issues in the spring. Development of a preliminary syllabi quickly dispatched the idea that such a holistic approach could be accomplished in one semester.

Collaborative learning

From the faculty point of view dividing the class into teams has two major effects: 1) it increases management time to continually monitor the interpersonal problems which occur as people adjust to working together; 2) it reduces the number of critiques and increases the time available for each critique. In addition, it increases the students' effective working time because they need to manage each other and spend time in the studio discussing the problem and working together.

The computer-mediated environment

The computer-mediated environment works as follows: Course material created on the word processor is converted to HTML, stored on the server, accessed, displayed and disseminated through Netscape. This provides the student and others continual access to all of the course material as it is posted and modified. The NJIT library catalog is also available through the workstation so that references to books and articles can be located immediately by the student.[1]

We have found that it is imperative that faculty take a hands on approach to imparting computer skills. Comments from the students indicate they are more confident in the instructors who are hands on and display their skills directly rather than those who are more aloof and directive in their approach. The experience of the last two semesters suggests that teaching small groups of students detailed methods of access to the computer systems diffuse information among the students more rapidly than imparting the information to the whole class in a formal setting. The students learn more quickly in informal settings in which they are able to communicate directly with their peers. Research by Roberts et al also suggest that of the critical variables for productive learning, "the most important is the faculty's pedagogical style in their direct teaching and the student interest in the subject. The faculty must be sensitive to both the need to empower students exploration by providing them with the skills they need to explore... through direct teaching as well as allowing and encouraging students to do their own exploring." [Roberts et al]

Problems

The development of TOTAL Studio is an evolving effort. A review of the three semesters of experience have yielded the following findings: 1) students are slow to conceptualize the multitasking potential of their workstations, and therefore under utilize the potential of the UNIX environment, 2) there are only a finite number of teaching hours in a studio and having to spend time teaching software subtracts from the time used for teaching principles of design, and giving individual design criticism, and 3) creating the studio as designed requires outside support as leverage against the internal politics in the various departments.

While working on teams is generally not part of the studio culture, last spring all but one of the teams operated successfully—an improvement from the fall semester. The reason for lack of success in teamwork seems to be based on the conflict in personality, differences in work ethic and habits, the lack of experience in working on teams, and a mismatch in skill levels between team members. In anonymous evaluations, the students commented that "I liked the team thing as an idea. It didn't work out for me though because I had a hard time with my partners. I do think in the future, team design is a good idea." Or "Groups of peopled helped but caused many disagreements which slowed down progress. Although the thought of putting people together was a good one." The history of the studio as a collaborative one aids in the development of teamwork because it generally excludes students who are determined to undermine the concept.

The engineering component of the course has not been fully implemented. This has occurred for a variety of reasons. Without funding there is no leverage in the other departments and therefore no way to influence faculty teaching assignments, There has been no publicity in the other departments for the course. What was substituted was lectures on building performance and structural design without getting involved with trying to teach additional computer systems in the classroom. Funding for the project is expected for the Fall semester of 1998 in which the full compliment of activities will be pursued.

Conclusion

The metaphor, changing the culture of the curriculum, may seem slightly pedantic; however, methods of teaching have been passed from generation to generation in the most unquestioning manner. New technologies, as precursors of changing methods, are often resisted. The efforts to change, sometimes abetted by the layers of accrediting organizations, are held back by the 'viscosity' in the organization. Creating a change that evolves, rather than changes abruptly, gives the results an opportunity to become integral to the culture and reaffirmed by tradition. Our team of faculty expect criticism from our colleagues, from professional organizations with long standing paradigms and vocabularies holding antithetical views, and even from the students. We are abetted by the support of outside funding, which adds an imprimatur to our efforts. At the core of our activity is the goal of helping to "lead the professional to a future of greater relevance and responsibility." [Mitgang 97]

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Endnotes

[1] The website can be observed athttp://www-ec.njit.edu/ec_info/image1/text_files/hp_2.html.It is a dynamic place, continually changing as courseware and student workis added and modified.

Lessons Learned and Lessons to Be Learned: An Overview of Innovative Network Learning Environments

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Abstract: This paper provides an overview of five innovative projects involving network learning technologies in the United States: (a) MicroObservatory Project, (b) Teaching Teleapprenticships, (c) Learning through Collaborative Visualization (CoVis), (d) Knowledge Integration Environment, and (e) GLOBE. Each of these projects has an explicit research orientation that allows for principled ways to consider the successes and failures of the respective projects. After a brief overview of each project, features common to these projects are discussed, followed by a consideration of challenges to be faced as innovative pedagogues and network technologies are used to support educational improvement and reform.

The purpose of this paper is to provide an overview of selected innovative projects that use electronic computer networks in the United States. It should be stated at the outset that such a paper can only be a snapshot of what might be described as one of the largest educational experiments in history. Beginning in the early 1980s, many in the United States became concerned about declining educational achievement (The National Commission on Excellence in Education, 1983). Since that time, numerous initiatives have been implemented to improve the quality of K-12 education in the U.S. A common aspect of many of these initiatives has been the utilization of computational and communication technologies to support systemic and curricular reform [Honey and McMillan 1994; Hunter 1992; President's Panel on Educational Technology 1997]. However, there have also been cautions against assuming that technologies in and of themselves will substantively enhance educational outcomes and effect reforms [Educational Testing Service 1997].

Yet there is no denying the fascination in the U.S. with computer and network technologies, in particular the World Wide Web. Nearly all universities and businesses now are "on the Internet" and have Internet "addresses" (i.e., URLs, universal resource locators). As of 1997, sixty four percent of the schools in the U.S. have a connection to the Internet [Educational Testing Service 1997]. Also, there have been national initiatives, such as the *Goals 2000: Educate America Act* (signed into law in 1994), that have promoted the applications of technology, including networking, at the pre-college level. Other national programs have aimed to form cooperative partnerships between the U.S. federal government, states, local communities, individual schools and school districts, and private companies to help foster the use of technologies at the K-12 educational levels.

Yet what do we know about the ways educational technologies mediated by electronic networks may be used to achieve substantive educational outcomes? What are the lessons that have been learned? And what are the lessons still be learned? This paper will provide an overview of what is know about these questions based on selected projects involving schools and electronic networks in the U.S. The first portion of the paper provides a survey of exemplary educational networking research projects. The second section of the paper considers these projects more generally in terms of their underlying learning and theoretical frameworks, research issues, and general lessons learned.

EDUCATIONAL ELECTRONIC NETWORKS: SELECTED INNOVATIVE CASES AND PROJECTS

There are quite literally thousands of schools in the United States which are now using network resources in a variety of interesting and creative ways--far too many to be systematically considered. Five projects are discussed in this paper which utilized computational and communication technologies in educationally innovative ways: (a) MicroObservatory Project, (b) Teaching Teleapprenticships, (c) CoVis, (d) Knowledge Integration Environment, and (e) GLOBE. Also, each of these projects has a research orientation that allows for principled ways to consider the successes and failures--the lessons learned and to be learned--of the respective projects. Given the limitations of space, these projects will be generally discussed in terms of their goals and major findings. For more detailed information, the reader should consult the references and Web sites for these projects.

MicroObservatory Internet Telescope

Astronomy is a popular science among the nations' youth and adults. However, the opportunity for learning astronomy by doing original research with professional grade instruments has been extremely limited for most students. In 1992, the MicroObservatory telescope network became the first generation of remote astronomical scientific instruments available on the Internet [Sadler, Gould, and Brecher in press]. The MicroObservatory is a collection of small, high-quality, and low-maintenance telescopes operated by the Harvard Smithsonian Center for Astrophysics. A Macintosh computer through an Ethernet communications protocol controls each telescope. The MicroObservatory Web site allows the user to control one of these special telescopes from his or her desktop. This makes the experience of high quality astronomical observations available in real classrooms rather than just from relatively inaccessible mountain observatories. The MicroObservatory user can schedule real-time use or program delayed observations and network delivered digital photographs.

The MicroObservatory has been used remotely in ten high school classrooms throughout the US. Experimental use has also been extended to introductory astronomy courses at the college level. Participating teachers use the MicroObservatory to demonstrate daytime observations during class periods, or download images taken by MicroObservatory telescopes. Students often work collaboratively to initiate their own astronomy investigations using the MicroObservatory telescopes over the Internet. For example, students found Comet Hale-Bopp to be an exciting object to observe during the spring of 1997. Students recorded the comet's shape and brightness over time and, some downloaded images from other students to make short movie of the comet. Similar to professional astronomers, students must write proposals to obtain time on the telescope for observations, and work with other users to analyze the images collected. Overall, student use of the MicroObservatory network of telescopes has indicated students can in fact conduct interesting scientific activities in a manner similar to research scientists.

Teaching Teleapprenticeships

The *Teaching Teleapprenticeships Project* at the University of Illinois has been exploring frameworks for learning that use electronic networks to create apprenticeship-like, asynchronous or synchronous learning environments for teacher education [Levin and Waugh in press]. A variety of frameworks for *Teaching Teleapprenticeships* (TTa) have been integrated into learning activities in many different preservice and inservice education courses. These frameworks include question answering and asking, collaborations, student publishing, utilization of Web resources, and project generation and coordination. For example, in the "question answering and asking" framework, undergraduate biology students were engaged in extra-credit course assignments as mediators to answer pre-college students' science questions. A suite of telecommunication software (e.g., Eudora, Gopher, Newswatcher, and Netscape) and a laptop computer were provided for each participating preservice education student.

The main features of the TTa approach include: (a) preservice or inservice students receive a "tele-field experience" for participation in a K-12 classroom as a "teaching teleapprentice," (b) students practice answering the kinds of questions they will be faced with when they are teaching K-12, (c) pre-college students interact with a diverse set of advanced learners (i.e., the teaching teleapprenctices in the project) in a manner that was found to be scaleable, and (d) undergraduates receive support in their mediator roles from their university instructor and graduate assistants. Network technologies allow novice teachers to start as "legitimate peripheral participants" [Lave and Wenger 1991], and then to gradually take on more central roles in networked-based projects. Students in the TTa Project were able to learn in meaningful and contextualized ways (i.e., school related) supported by multiple mediators (e.g., practicing teachers, fellow students, scientists, education faculty), while serving as valued mediators themselves to pre-college students. Other aspects of the TTa Project have investigated the nature of the mediator roles for learners and teachers as important factors for the successful use of new distributed learning environments and ways to integrate teaching teleapprenticeship frameworks into supportive and sustainable institutional structures.

Learning Through Collaborative Visualization (CoVis)

The Learning through Collaborative Visualization (CoVis) Project at Northwestern University and SRI International was one of the four initial NSF-funded National Networking Testbeds for Education [Pea 1994; Pea, Edelson, and Gomez 1994]. The CoVis Project has investigated how students can acquire scientific understanding mediated by scientific visualization software in collaborative environments, and how to support project-enhanced learning of science in a community that extends beyond the classroom. The central goal of the CoVis Project is to utilize advanced technologies and innovative pedagogical approaches to help make the teaching and learning of science more like the practices of scientists. The CoVis Project provides students with collaboration and communication tools that include: desktop video teleconferencing, shared software environments for remote, real-time collaboration access to the resources of the Internet, a multimedia scientist's notebook, and scientific visualization software.

The initial classroom uses of the CoVis Project started in 1992 with 296 grade 9-12 students in Chicago area. Students in the CoVis Project primarily study atmospheric sciences with some environmental science emphasis. For example, they may use tools such as *Weather Visualizer* and *Climate Visualizer* to investigate the progress and changes of major hurricanes through animations based on visible and infrared satellite data. Student activity logs are recorded in the *Collaboratory Notebook* and may be shared among a group of collaborators. Through a diverse suite of communication technologies, students engage in dialogs with practicing scientists in "teleapprenticing" relationships (Levin et al., 1987; Riel, 1992). The ongoing assessments of the CoVis Project investigate issues such as scaling, culture diversity, equity of access, sustainability, attitudes toward science and technology, and pedagogical improvement related to the use of networking technologies for remote collaboration.

Knowledge Integration Environment (KIE) Project

The World Wide Web is a complex resource that presents significant challenges to teachers to use in educationally powerful ways. In contrast to the focus of the CoVis project on network-mediated, collaborative data visualization, Dr. Marcia Linn and her colleague at University of California at Berkeley have developed a different model to foster Web-mediated learning. In the Knowledge Integration Environment (KIE), middle and high school students not only look for information on the Web, but also analyze evidence and provide scientific explanations about real world phenomena and problems. Research involving KIE has investigated the use of on-line scaffolding and guidance, student search strategies on the Internet, individual and collaborative sense-making of science evidence, on-line discussion tools, and reflection for science learning. KIE research findings suggest that students' performance in searching relevant sites improved through collaborative search activity and using the design library that contained pre-selected sites related to student project areas. Given that information found on the Web is often very complex and ill-organized, an "advanced organizer" approach was developed for KIE to provide key ideas about the Web content and sources with the intent of helping students become more critical in interpreting evidence and more successful in applying evidence to their projects. Overall, the KIE research to date has demonstrated that providing specific types of scaffolding and support to students as they utilize Web resources for inquiry projects can enhance student learning of scientific knowledge.

The GLOBE Program

The *Global Learning and Observation to Benefit the Environment* (GLOBE) program is a major Internet-based international science education program that was enunciated by Vice President Al Gore on the Earth Day April 22, 1994 [Means & Coleman in press]. GLOBE aims to enhance student's understanding of earth systems as well as to promote science and mathematics learning and environmental awareness. Through the GLOBE program, K-12 students around the world use the Internet to collect environmental data, perform measurements, exchange data, and interact with scientists and with other students. Students also use software developed by NASA to visualize the data they have collected from ongoing research investigations being conducted by practicing scientists. GLOBE participants come from more than 3,500 schools in 50 countries.

Empirical results of GLOBE activities for the past three years are being collected largely through electronic surveys. On-site observations and interviews at selected sites conducted by SRI, International researchers are also being used to supplement the survey data. Students are asked to reflect on their involvement in GLOBE activities and their attitudes and beliefs about technology, science, and measurement issues. Teachers are surveyed concerning the ways in which GLOBE activities are implemented in their classrooms, the challenges posed by setting up the program, and their strategies for dealing with problems. Participating scientists provide comments on the quality of various types of student-collected data and the ways in which the data support the scientists' investigations. Recent evaluations of this large scale, ongoing project suggest students are quite motivated by the authenticity of their participation in GLOBE research and the use of state-of-the-art technology [Means & Coleman in press]. Significant learning outcomes have also been found related to student performance on taking measurements, sampling principles, and data interpretation. Overall, the GLOBE program is a very interesting and important project in terms of the large implementation scale, the use of innovative learning approaches and activities, and the significant learning outcomes being documented.

LESSONS LEARNED

The previous sections have primarily described the features and learning activities associated with selective exemplary educational network learning projects. In this section, we consider general issues related to the use of educational networks that have emerged from these projects.

The projects described above reflect a wide range of ways that electronic educational networks may be used. The MicroObservatory, CoVis, and GLOBE projects scaffold students to be involved with scientific projects in ways that are qualitatively similar to professional scientists. The KIE project also involves students in projects, but provides ways to support students' critical and thoughtful use of Web-based resources as part of project activities. And the Teaching Teleapprenticeship project focuses on teacher education, and utilizes various network resources to support collaboration and apprenticeship learning mediated by the network.

There are also other general features shared by these projects in a "family resemblance" manner. These include:

- employ a constructivist framework for learning and teaching;
- involving students in authentic activities and tasks;
- involving students in "tele-apprenticeship" collaborations with peers and adult practitioners and experts;
- promoting intrinsic motivation;

- enhancing student generated inquiry questions and interest in independent learning;
- changing the teacher's role from information provider to facilitator and mentor;
- scaffolding higher order student engagement in problem-solving and inquiry activities;
- providing technological support for teachers and students to facilitate productive learning activities;
- developing scientific software to be integrated into curriculum for advanced activities;
- providing asynchronous and synchronous activities in different places and time (removing physical constraints); and
- providing equitable access to network learning technologies.

There are many nuances in terms of how these features are instantiated in the different projects discussed in this paper. For example, the ideas of "teleapprenticeship" are implemented differently in the Teaching Teleapprenticeships Project and the CoVis Project. Overall, these various projects should be regarded as model cases of innovative and generally successful approaches to using the technological affordances of nationally and globally interconnected electronic networks in educational contexts. However, the full value of these projects is not just in detailing their successes, but in learning from the difficulties and problems they encountered, which we consider next.

Lessons to Be Learned

Internet technologies provide ways to interconnect people around the world in ways and on a scale that has never before been possible. Combining these technologies with innovative ways to improve and reform education thus represent significant challenges to teachers, students, schools, school systems, and national educational systems. In this section, we discuss some of these challenges and issues.

Based on the projects discussed in this paper, there are several areas that need further research in applied contexts (i.e., real classrooms) to address. For example, many of the projects were mainly science oriented due to funding priorities for research in the United States. How may these technologies and learning approaches be adapted and used in liberal arts and social science domains? Also, most of these projects were assessed using innovative learning outcome measures or qualitative methodologies. How will it be possible for traditional large-scale quantitative standardized assessment methodologies to measure that types of learning outcomes associated network learning projects? If so, how? If not, what are the implications for large-scale assessment methods? These projects primarily employed open-ended student directed learning activities involving electronic networks (e.g., CoVis, MicroObservatory). How can teachers meet curriculum content requirements and national standards, particularly at the high school level, with primarily student directed learning activities? These projects involved tens to hundreds to thousands of schools, yet there are over 100,000 schools in the U.S. alone. Will it possible to "scale-up" to hundreds of thousands of globally distributed schools? Finally, the successes reported in these projects were associated with a constructivist learning framework and educational epistemology. How can constructivist based network learning approaches be implemented in school situations which may be employ an "instructivist" approach teaching, learning, and assessment?

Given the relatively short period of time these technologies have been available in the schools, it is certainly understandable that there are not "definitive" answers to these and other questions related to how emerging network technologies can be infused into the educational activities of our children. However, it should be stressed that there are many who feel that the research and experiences to date concerning the educational efficacy of network learning environment technologies warrants continued implementation concurrent with continued research investigating questions of learning efficacy and implementation [President's Panel on Educational Technology 1997].

Conclusion: Learning New Lessons

Clearly there is much that has been learned in the research oriented U.S. educational network projects to date. This continues to be a time of rapid development with respect to the cluster of computational and communications technologies that comprise the Internet. Higher connection speed with the Internet II, faster and less expensive computers, new programming paradigms with network-based languages (e.g., Java), desktop video conferencing, Web-based digital video and audio, virtual reality (VRML) simulations--the list is seemingly endless and ever changing. The pace of technological change at this point in history is certainly a challenging issue to be confronted by those who are interested in exploring the emerging possibilities of network learning environments.

One major lesson of these projects, though, is that technology per se is *not* the most important issue. Of course, each of these projects has had to grapple with the complexities and the frustrations of implementing their respective models of learning mediated by technology. But the main lessons to be learned from these projects relate to the constructivist pedagogical and curriculum innovations they employ, and how the computational and communication technologies may be used to help facilitative those innovations. More research and practical experience is certainly necessary as the task of educational improvement and reform mediated by technology continues. The true challenge is to continue learning new lessons.

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Adoption Patterns of Faculty Who Integrate Computer Technology for Teaching and Learning in Higher Education

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Abstract: Why is the integration of technology for teaching and learning so appealing to some faculty, and not to others? The present investigation builds and extends upon Rogers' (1995) diffusion of innovations framework and adopter categories in an attempt to accurately reflect and describe faculty innovativeness with technology for teaching and learning. Information collected from faculty across disciplines at two major North American universities is analyzed for the differences between early adopters and mainstream faculty, the rate of adoption of educational technology by faculty, resulting changes to the teaching and learning environment, the incentives and barriers to integrating technology, preferred methods for learning about technology, and methods for evaluating the outcomes of integration.

Introduction

Recent estimates indicate that colleges and universities invest billions of dollars per year for the acquisition of computer technology [Geoghegan, 1994]. Instructional technology [IT] may support and increase the efficiency of the teaching-learning transaction or even modify educational processes, especially with regards to distance education and "anytime, anywhere" access [Daniel, 1997]. Formal evidence linking this investment to higher productivity [Schwalbe, 1996] and changes and improvements in the teaching and learning process is accumulating [Kulik & Kulik, 1980, 1987] [Ehrmann, 1995], and new research approaches and methodologies are being developed to adequately study the unique issues involved in educational technology [Bull, et al, 1994] [Clark, 1989] [Reigeluth, 1989]. In some cases, integrating technology into the teaching-learning transaction has been found to transform the teacher's role from being the traditional "sage on the stage" to *also* being a "guide on the side", and student roles also change from being passive receivers of content to being more active participants and partners in the learning process [Alley, 1996] [Repp, 1996] [Roblyer, Edwards, & Havriluk, 1997]. IT is currently being used effectively in higher education for information access and delivery in libraries, research and development, as a communication medium, and for teaching and learning. Increased access to and use of the Internet is making a unique contribution to the teaching and learning process [Shaw, 1994] and will be an important part of future strategies to provide services to increased number of students in very diverse locations [Daniel, 1997].

Despite research and testimony that technology is being used by more faculty, the diffusion of technological innovations for teaching and learning has not been widespread, nor has IT become deeply integrated into the curriculum [Geoghegan, 1994]. Estimates suggest no more than five to ten percent of faculty utilize technology in their teaching as anything more than a "high tech" substitute for blackboard and chalk, overhead projectors, and photocopied handouts [Reeves, 1991]. Although there is a growing number of faculty who are very enthusiastic about adopting technology because of the potential of newer tools for their students, there is still a large number of faculty who seem hesitant or reluctant to adopt technology for their teaching tasks. Explanations for limited adoption may be found in the many barriers that still constrain use by enthusiastic beginners; *user friendliness* is a seductive term which misrepresents current technological reality. While acknowledging improvements in current design, computers and peripherals are still not well-designed, fault-free, and easy to use. As such, the evaluation of the success of educational technology still seems to depend largely on how well "early adopters" make it work. Given the size of investment in instructional technology in higher education, the increased demand for distance education in the future, and the demonstrated effectiveness with some educational outcomes, it seems reasonable to investigate why the integration of technology for teaching and learning is so appealing to some faculty, and not to others.

Diffusion of Innovations

A conceptual framework for analyzing faculty adoption of technology patterns is provided by Everett Rogers' [1995] theory of the diffusion of innovations, which defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system". The four main elements are the innovation, communication channels, time, and the social system. [Rogers, 1995] defines an innovation as an idea, practice or object that is perceived as new by the individual, and diffusion as the process by which an innovation makes its way through a social system. For our purposes, the innovation is instructional technology for teaching and learning, and diffusion is the extent to which all faculty have adopted this innovation. Because individuals in a social system do not adopt an innovation at the same time, *innovativeness* is the degree to which an individual is relatively earlier in adopting new ideas than other members of a system. Based upon empirical investigations and market research, [Rogers, 1995] describes five adopter categories along the continuum of innovativeness [Figure 1] which are *ideal types* designed to make comparisons possible based on characteristics of the normal distribution and partitioned by the mean and standard deviation.

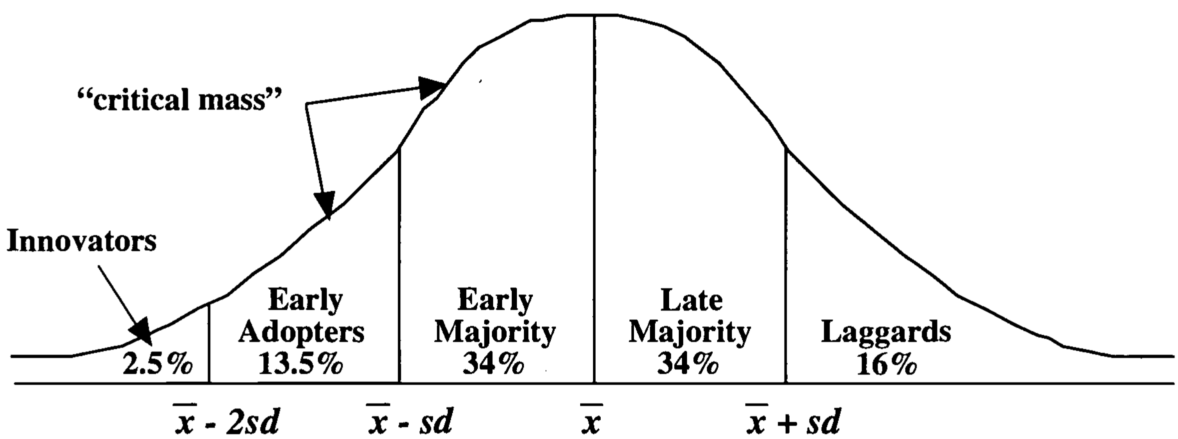

Figure 1: Adopter Categorization on the Basis of Innovativeness [Rogers, 1995]

When an innovation has been adopted by most or all of the members in a social system or adopter category, diffusion has reached the saturation point. [Geoghegan, 1994] suggests that this saturation point has been reached with early adopters of instructional technology, but that "critical mass" alone, the segment of the diffusion curve between 10 to 20 percent adoption or the "heart of the diffusion process" [Rogers, 1995], is not enough to stimulate adoption by the mainstream [i.e., 84% of the population]. Geoghegan [and Wertheimer & Zinga, 1997] contrast early adopters, who are risk takers, more willing to experiment, generally self-sufficient, and interested in the technology itself, with early majority faculty who are more concerned about the teaching and learning problems being addressed than the technology used to address them, view ease of use as critical, and want proven applications with a low risk of failure. Early adopters make an innovation visible to the mainstream, decrease uncertainty about an innovation, are more experienced with technology and have higher *use innovativeness* [Ram & Jung, 1994], thus capitalizing on technology's many features and options. They seek different uses of technology to solve novel problems and contribute to new and better uses of technology. However, by making adoption look relatively easy, early adopters may disguise the extensive knowledge and skills that mainstream faculty will need in order to adopt. Universities are in a situation where there is widespread adoption of instructional technology by innovators and early adopters, but limited adoption by mainstream faculty. It is apparent from various descriptions of early adopters and the mainstream [Geoghegan, 1994] [see Jacobson & Weller, 1988], that these two groups have different characteristics, motivations, and needs. Therefore, campus-wide integration plans cannot be developed on the assumption that mainstream faculty will naturally use computers as readily and easily as the early adopter. Research into the adoption patterns of various technologies by higher education faculty will give insight into strategies for encouraging more widespread adoption.

Methodology

The present investigation surveyed faculty members from across disciplines at two major North American universities. Items gathered information about technology use patterns, computer experience and use of technology for teaching, general self-efficacy [Schwarzer & Jerusalem, 1995], changes to teaching and learning, incentives, and barriers, using a web-based survey instrument [http://www.acs.ucalgary.ca/~dmjacobs/phd]. Invitations to participate were distributed using paper-based mail, e-mail, and a campus newspaper. To solicit a representative sample, paper-based versions of the survey were also made available to potential participants. Complete data was obtained from 76 subjects (38.2% female, 61.8% male), 55 of whom completed the web-based survey and 21 the paper-based version. Subjects were on average 45.5 years old, had an average of 12.5 years experience as faculty member, and hold various academic ranks within their institution [i.e., 19.7% assistant professor, 35.5% associate professor, 26.3% professor, 18.4% lecturers and sessionals]. Over 65% of participants hold appointments that are tenured or leading to tenure. The majority of respondents teach 100 or less students per semester, and represent a range of academic disciplines: Agriculture, Continuing Education, Education, Engineering, Environmental Design, Fine Arts, General Studies, Humanities, Kinesiology, Management, Medicine, Nursing, Science, Social Science, and Social Work.

Computer Use in Classrooms and Faculty Expertise

According to the Annual Campus Computing Survey [Green, 1996], adoption of technology for classroom use has risen between 1994 and 1995; e-mail use has almost doubled to 20%, presentation software use is over 25%, and the use of multimedia and CD-ROM-based materials is just under 10%. The present study indicates that the adoption of technology for classroom use is even greater in 1997. Faculty were asked to indicate whether they had ever used any of 44 types of computer software and tools in a course they taught. Word processing is used by 60% of faculty, spreadsheets by 38%, charting & graphing by 36%, databases by 34%, presentation software by 34%, and 18% have used CD-ROM-based materials. A number of faculty use instructional courseware for teaching: tutorials 18%, drill & practice 14%, simulations 17%, and games 6%. E-mail is used by 67% of faculty in their teaching, on-line databases or library catalogues by 46%, newsgroups by 21%, listservs by 29%, and FTP by 23%. Newer technologies, like the World Wide Web, have been adopted for searching & browsing by 56% of faculty, and by 36% for web page creation and editing. It seems fair to suggest that communication technologies are the proverbial carrot that entices mainstream faculty to adopt technology for teaching and learning [Foa, 1993]. Once faculty are intrigued by e-mail and the Web, they may start asking questions about other technologies [Gilbert, 1995]. Faculty rated their level of expertise [i.e., 0.none, 1.a little, 2.fair, 3.substantial, 4.extensive] with 44 types of computer software. Findings indicate that faculty tend to develop a level of personal expertise with a particular computer technology before attempting to integrate it into their teaching [i.e., these technologies have been personally adopted by late majority].

Software/tool	A little(1) - Fair(2)	Substantial(3) - Extensive(4)	Total Adoption	Mean	SD
Word processing	14.5 %	81.6 %	96.1 %	3.20	1.07
Spreadsheets	39.5 %	30.3 %	69.8 %	1.60	1.36
Charting & graphing	42.2 %	25.5%	67.7 %	1.50	1.38
Databases	52.7 %	22.4 %	75.1 %	1.50	1.22
Presentation software	36.9 %	21.0 %	57.9 %	1.30	1.37
CD-ROM materials	47.4 %	18.5 %	65.9 %	1.30	1.23
E-mail	19.7 %	75 %	94.7 %	3.00	1.10
On-line databases or library catalogues	50 %	36.8 %	86.8 %	2.10	1.28
Newsgroups	39.5 %	19.7 %	59.2 %	1.20	1.32
Listservs	39.5 %	25 %	64.5 %	1.50	1.44
FTP	46.1 %	26.3 %	72.4 %	1.60	1.35
WWW searching and browsing	36.8 %	55.2 %	92.0 %	2.60	1.25
Web page creation	30.2 %	22.4 %	52.6 %	1.20	1.48

Changes to Teaching and Learning

[Hadley & Sheingold, 1993] indicated that significant changes can take place as teachers integrate computers into instruction. Faculty were asked to use a five-point scale (1.strongly agree, 2.agree, 3.neutral, 4.disagree, 5.strongly disagree) to indicate their level of agreement with statements about how the integration of technology may change the teaching and learning environment. Faculty most strongly agreed with the following five statements:

Statements - Changes to Post-Secondary Teaching and Learning	Mean	SD
Faculty will spend more time preparing materials and resources for instruction.	1.77	1.00
Faculty can expect more from students in terms of their pursuing and editing their work.	2.05	0.84
Faculty will spend more time acting as a guide and facilitator with individual students.	2.44	1.19
Faculty are better able to tailor students' work to their individual needs.	2.48	0.95
Faculty can be more comfortable with students working independently.	2.59	1.21

While four of these statements describe benefits to student learning, it is also clear that faculty can expect to invest additional time preparing materials and resources when they integrate technology into teaching and learning. When asked to elaborate on the nature of changes they have observed as a result of using technology in teaching, one person confirmed that "*it increases preparation time in the short run [first year or two], but allows for rapid changes/updates in web materials in the long run*". So, the investment of time can yield returns. Technology can also appeal to some students, and not to others: "*Some of my graduate students are frustrated when I ask them to try to use new technological tools...those who have an open mind and flexible learning style like using technology enhanced instruction; others do not and resent the demand on their time to change. Some of the more shy and quiet students blossom in terms of their learning when technology is introduced*". The next comment touches on the fundamental changes that technology integration seems to require of teachers and learners: "*I still struggle with students who are conditioned to a system of grades and dependency ...who are reluctant to take responsibility for their own learning. However...a small number of students do seem to be catching on to the idea that they are in charge of their learning and willingly take risks*". New tools both provide and require a new approach to teaching and learning.

Incentives to Integrate Technology

Given the time and effort required to integrate technology into teaching, different reasons tend to motivate and keep faculty engaged with this task. Some incentives are more important for encouraging faculty members to integrate technology in their teaching [Hadley & Sheingold, 1993]. Using a five-point scale (1. strongly agree, a major incentive, 2.agree, 3.neutral, 4.disagree, 5.strongly disagree, not an incentive), faculty indicated the extent of their agreement with twelve incentive statements. The following five reasons emerged as the most important incentives:

Incentive Statement	Mean	SD
I get personal gratification from learning new computer knowledge and skills	1.80	0.84
Computers are a tool that help students with learning tasks, such as writing, analyzing data, or solving problems.	1.82	0.98
By integrating technology, I am helping students to acquire the basic computer education they will need for future careers.	1.92	1.01
Technology tools enable students to help each other and cooperate on projects.	2.22	0.97
Computers enable me to make a subject more interesting.	2.28	0.97

While four of the highest rated incentives have to do with providing enriched learning opportunities for students, the number one incentive for integrating technology is the personal gratification one gets from learning new computer knowledge and skills. When asked to elaborate on the incentives for using technology, one person wrote, "*I am convinced that I can provide a better introduction to complex subject matter using interactive, computer-based technology than I can using either the traditional classroom or any paper-based medium*".

Barriers to Integrating Technology

Many faculty are highly motivated to integrate computers for teaching and learning. Although many have developed impressive expertise in using computers in their classrooms, to a greater or lesser extent, all faculty experience barriers when they attempt to integrate computers in their teaching. Faculty used a five-point scale (1.strongly agree, a major barrier, 2.agree, 3.neutral, 4.disagree, 5.strongly disagree, not a barrier) to rate the significance of twenty barriers, adapted from [Hadley & Sheingold, 1993], to the use of computers for teaching and learning in the campus environment. The following six statements describe barriers that most faculty agreed were impediments to integrating technology on campus:

Statements - Barriers to Integration	Mean	SD
Faculty members lack enough time to develop instruction that uses computers.	1.50	0.82
There are problems scheduling enough computer time and/or resources for different faculties' classes.	1.78	0.89
Financial support for computer integration fróm administration is inadequate.	1.80	0.86
There are too few computers for the number of students.	1.86	0.94
There is inadequate financial support for the development of instructional uses of computers.	1.88	0.93
The reward structure does not recognize faculty for integrating computers for teaching and learning.	2.06	1.26

In response to a request to elaborate upon barriers that may prevent or discourage faculty from using technology in their teaching tasks, 58 faculty submitted responses. The most common explanation for non-adoption was the perceived lack of time to learn how to use technological tools as well as learning new methods for teaching. Several faculty identified "faculty complacency" as a reason for non-adoption, and suggestions were made that many faculty will not adopt unless they are forced to by formal administrative expectations. Some faculty pointed to the importance of research over teaching in annual merit reviews, and the absence of recognition for the use of technology for effective teaching and learning. A faculty comment confirms that "*the barriers are not specific to computers but are the general lack of any reward whatsoever for effort put into teaching excellence*". Among many faculty, there is the perception that technology is still an unproved instructional intervention: "*Due to the fact that there is insufficient data to support the efficacy of computerized teaching, only the risk takers in academics are prepared to spend the time developing courses for this medium*". Hence, early adopters integrate despite risk.

Learning About Technology

Individuals tend to have preferred methods for learning more about technology. Faculty were asked three questions for which they were asked to rank the importance of different methods for learning about technology, getting help and support, and accessing information about innovations. In terms of media and methods for acquiring NEW computer application skills and knowledge, faculty ranked the following from *most* to *least* important in descending order: [1] hands-on experimenting and trouble shooting, [2] mixture of manuals and hands-on, [3] hardcopy materials, books, etc., [4] on-line manuals, [5] workshops and presentations, and last, [6] structured courses and guidance. A good number of Technology Integration Plans suggest that faculty need more workshops and courses in order to acquire the knowledge and skills they need to adopt technology. However, future plans for professional development should be informed by faculty member's expressed preferences for more hands-on experimentation and trouble shooting.

In terms of HELP or ASSISTANCE with using computers, faculty ranked the following sources of support from *most* to *least* important in descending order: [1] colleagues on campus, [2] one-on-one assistance, [3] experienced graduate students, [4] media center support staff, [5] hot-line, or telephone assistance, [6] outside professionals trained in technology use, and last, [7] colleagues at another institution. Faculty prefer to get help from colleagues and graduate students, and want one-one-one assistance, rather than relying on outside professionals or colleagues at another institution. Combined with the preferences expressed in the first part, it appears that the most successful professional development would be to have just-in-time, one-on-one access to colleagues and experienced graduate students when one runs run into trouble experimenting and playing around with new technologies.

Faculty were asked to rate the importance of various sources of information for keeping abreast of changes and innovations in the area of computers. From *most* to *least* important in descending order, are: [1] colleagues on campus, [2] an informal network of friends and family, [3] innovative graduate students, [4] on-line computer newsgroups & websites, [5] conferences, demonstrations and workshops, [6] colleagues at another institution, [7 tie] popular computer magazines, [7 tie] popular newspapers and television, [8] hardware and software stores, vendors, suppliers, and also [9] hardware and software catalogues and brochures. The highest ranked source of information is a colleague, followed closely by friends, family, and innovative graduate students. Faculty prefer to learn about changes and innovation from people they know and to which they have immediate access. Five sources of information that were ranked "not important" or "neutral" sources of information about changes and innovations in the area of computers, from least important: [1] department chair, [2] university administration, [3] refereed computer journals, [4] publications from major computer vendors, and [5] on-line computer journals. Faculty apparently do not look "up" for information about technology innovations, nor do they rely on vendors or refereed journals.

Discussion

Previous explanations for why the majority of faculty did not adopt technology for teaching and learning focused on blame. Faculty were blamed for being stuck in traditional methods of course delivery, were labeled as resistors and charged with negative attitudes towards technology [Gordon, 1983]. These explanations were based on a poor understanding of the difference between faculty who readily adopt technology for teaching, and those who do not. The challenge for researchers interested in the adoption of technology is not to assign blame nor to attempt to fix faculty attitudes. The challenge instead is to draft technology integration plans and design new educational systems within the logic and meaning of the emerging paradigms that are informed by our growing understanding of the complexity and interconnectedness of faculty social systems, communication channels, and patterns of diffusion. A different support infrastructure is clearly needed for mainstream faculty than that which sufficed for early adopters of technology. A number of system-wide initiatives have been implemented at various higher education institutions which provide models for encouraging wider diffusion of technology for teaching and learning, and bridging the gap between early adopter success and more mainstream adoption.

The present research provides additional support for three trends identified by [Jacobson & Weller, 1988] to describe faculty adoption patterns: [1] the use of computers for one purpose may encourage enthusiasm for further computer use, [2] that mainstream faculty may be limited adopters because of the lack of technical support and training, and [3] that colleague supported training is a viable way to encourage diffusion of computer technologies. Administration has to be convinced to let go of the infrastructure-driven "if you build it, they will come" approach to technology integration if they want to address the gap between early adopters and mainstream faculty. Critical mass alone is insufficient to drive further adoption. Faculty and administration have a deep mutual dependency; the top-down program advocate needs convincing exemplars to justify large investments in technology at a moment when funds are scarce, and the bottom-up project advocate and enthusiastic beginner needs a well-conceived and reliable working environment for successful implementation of innovative concepts [Noblitt, 1997]. To make the efforts of early adopters more widespread and their results used more comprehensively, incentives, training, support and reward structures "from above" are needed to build a strong human infrastructure [Foa, 1993] as well as providing the technological infrastructure [i.e., networks, hardware and software] to drive integration. IT investments for teaching have to be ahead of what is the state of the art in the world of work, as higher education prepares for the future. These ever-new investments cannot be left to uncoordinated departmental or individual initiatives, as they often exceed respective budgets [Bull, et al., 1994]. If the integration of technology for teaching and learning is a valued institutional goal, administration must recognize that in order to drive change they will have to address the reward system and commit to system-wide investment in IT. The key to diffusion will be training and support. Without investment in the human infrastructure nothing of sustainable value will be achieved [Foa, 1993]. One final thought: it may not be the case that *early adoption* and *excellent teaching* qualities exist in the same person. Universities must include an emphasis on excellent teaching in their technology integration plans. Early adopters of technology who are also excellent teachers have much to contribute to this planning process. [Kearsley, 1996] suggests that excellent teaching should be our first priority, because adopting technology will not improve poor teaching. He argues that without excellent teachers, technology will not enhance learning to any degree. If cases are found where early adoption and excellent teaching exist in the same individual, then it is worth profiling this expertise for the benefit of other faculty members who wish to develop both their technology and teaching knowledge and skills.

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JUGEND AM NETZ (JAN - http://www.jugend-am-netz.de) is a project to bring youths in the age of 11-25 together using modern communication media. Participating youngsters built a network to exchange their opinions on various topics and help each other by providing information. JAN runs an intranet of different widespread dial-in nodes in the project area. Determining their contributions the young people practice their ability to present certain issues using internet technology. JAN already shows synergetic effects:

• Project members offer regular lessons on computer and internet providing interested youths with needed information.
• In special lessons female project members teach girls interested in computer-related topics.
• JAN cooperates with enterprises by educating their apprentices in the new communication media and offering the possibility of presenting the enterprises in the World-Wide-Web.
• Regular meetings let the project members meet each other personally initiating further activities.

JAN's friendship-network grows...

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A Model for Supporting Subject-Matter Expert Faculty in Developing Quality Computer Assisted Learning Software

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Abstract: Developing effective multimedia learning packages requires expensive equipment, is labour intensive, and requires expertise in a number of areas which teaching staff who are experts in particular subject matter areas are not likely to possess. This paper describes a grant-funded project which is using a team approach to cost effectively bring together human and machine resources necessary to developing high-quality interactive multimedia learning tools. Participants are expected to produce small prototype learning modules. In pursuit of this goal they attend workshops, have access to hardware needed in development, are provided with the authoring software of their choice, and receive individualized assistance.

1. Introduction

Methods of encouraging interactive learning that are self-paced yet can evaluate and document learners' understanding of key concepts are highly desirable. In most subject matter areas there are key concepts and principles that must be taught over and over again to large numbers of students or which are difficult for students to grasp without the use of sound, graphics, or moving images. In these situations, lecturer time could be saved and students would be more likely to comprehend difficult concepts if they were given a well-designed learning resource that they could access in their own time and use at their own pace. Computer-driven interactive multimedia has the potential to address these needs in education.

Technology enthusiasts claim that computer-assisted learning tools and, in particular, interactive multimedia, have definite advantages over other media of instruction- they can provide a multisensory learning environment, promote a more active form of learning, offer more independent learning, and provide simulations of complex scientific or social processes that are difficult or even impossible to demonstrate in classroom situations.

Clark (1991) argued that effective computer-based instruction depends not on the technology itself, but on the conscious and creative application of knowledge about learning and instruction in designing the multimedia programs. Gilbert (1995) suggested that effective implementation of interactive multimedia technology in universities requires the commitment of the institution to the infrastructure, the commitment of the staff members to the approach, and the availability of information, help, and support from various campus organisations (for example, computing services, educational/instructional development services, the library, etc.). On the other hand, domination by the technologists in the development of materials may be detrimental to implementing interactive multimedia instruction. Hansen and Perry (1993) argued that a lot of technology-based instruction failed because of the technologists' tendency to create their products *for* rather than *with* the users. It follows that the design of tertiary education CAL (computer assisted learning) materials needs to be influenced by input from educational specialists as well as subject specialists.

Potentially, subject specialists (content experts) who are familiar with the stages of interactive multimedia software development, can contribute to more efficient and effective production. They would (1) understand the preliminary steps needed in software design, (2) appreciate the precision needed when filling out storyboards, and (3) understand the logical structures which need to be programmed in order to implement question-and-answer routines. Since they have the best understanding of both the content of the software and the intended users, content experts taking a leading role in CAL production can help to ensure both subject and educational validity of the product.

This paper will describe a project funded by the Hong Kong University Grants Committee through The Hong Kong Polytechnic University (PolyU) which is intended to develop university subject specialists' knowledge about and skills in interactive multimedia production. An overall model of the project will be explained, progress to date will be given, and modifications based upon what has been learned in the first cycle of the program will be discussed. It is hoped that this information may help other universities undertake similar activities.

2. The Project

The project, *Multidisciplinary Applications of Computer Assisted/Multimedia Learning Resources* was funded with HK$600,000 (US$77,000) obtained through a Learning and Teaching Development Grant from the Hong Kong University Grants Commission through PolyU.

The aim of the project was to assist over 25 academic staff members to develop working prototypes of interactive multimedia software useful to the learning processes of their students. In doing so, it was expected that these subject specialists would gain knowledge and skills in development of educationally-sound modern technology software which would make them better informed about aspects of this complex and time-consuming activity. Past experience of the team leaders has proved that many subject experts become involved with CAL materials development without having adequate knowledge of the commitments and skills involved and some become overwhelmed with the workload. Unacceptable results include projects that are never finished, or are of questionable educational value. The present project hopes to prevent this by encouraging small-scale prototype development in which each participant is able to test the concept and design of their idea before they embark upon a large-scale commitment.

The time frame of the project spans eighteen months; this includes six months of meetings and workshops, ten months of development activity, and two months for CD production.

[Fig. 1] graphically depicts the people and other resources contributing to the project. Input to the project comes from workshop leaders (L), a research assistant (A), and software/hardware resources (R). Subject specialists (S), benefiting from the aid of the workshops and collaborative work with the other personnel, produce small but working prototypes of programs which have the potential to be expanded later into full CAL tools. The "deliverable" from the project is one (or more) CD-ROM "Prototype Sampler(s)".

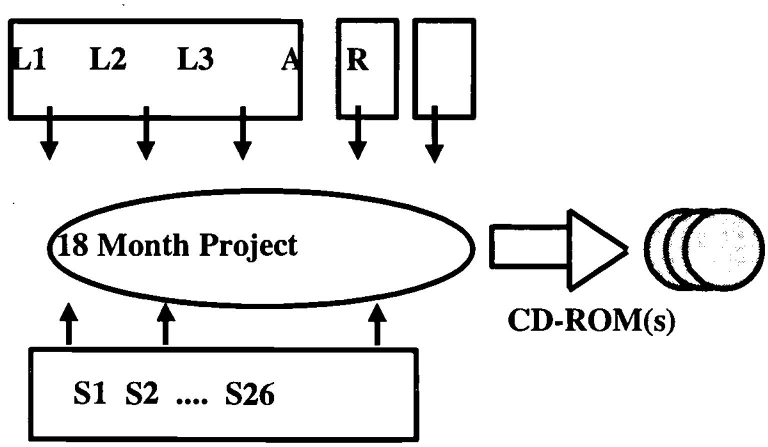


Figure 1: Project model

Subject specialists participating in the project come from eight university departments. CAL topics range from *A computerised construction planning game* from The Department of Building and Real Estate to *Therapeutic art in healing (pain expressed through art)* from The Department of Applied Social Studies. A complete list of participants and projects is available from the project's web site:

(http://etu618.edu.polyu.edu.hk/Umbrella/Calmenu/Calmenu.html).

"Leaders" of the project were three staff members from The Educational Development Unit and one Research Assistant. Combined expertise of this group includes curriculum development, learning theory, educational environments, CAL development, user-interface design, computer programming, and miscellaneous technical skills such as filming and digitising video segments.

As microcomputer use at PolyU includes both PC and Macintosh platforms (in approximately 90% to 10% respective percentages), resources purchased for the project were intended to cater for both platforms. The Research Assistant has been given both a Pentium-based PC which includes full video and audio facilities, and a PowerMac (9500), along with a full complement of drawing and authoring tools. The project also funded each participant an authoring tool; Authorware Professional was the overwhelming choice, with some members choosing ToolBook. One obvious efficiency of this project was the saving in costs by bulk-purchasing software.

3. The Blueprint

All project participants were given a "blueprint" which helped them to organise the information and ideas necessary to create an educationally sound tool. The blueprint is the template overlying each participant's sub-project. It is a fill-in form which prompts subject specialists to consider a wide range of areas from both educational theory and technical development perspectives, in planning their prototype. The blueprint incorporates the following categories:

1. concept map
2. learning objectives
3. target students
4. description of software required
5. media components
6. interactions intended
7. interface design
8. screen design
9. storyboard format

The blueprints were to be filled out over the course of the workshops. The intention was that when the blueprints were completed, the process of storyboarding could be conducted which would then lead to the programming phase of development.

The experience of the authors is that many academic staff who want to develop interactive multimedia materials lack both the requisite knowledge of educational theory alluded to by Clark(1991) and skills in the technical procedures involved; these procedures range from storyboarding and screen design to authoring, digitising, etc. Workshops were specifically designed to inform participants of the sequences of steps involved in the whole CAL software development process. Five two-hour workshops were conducted. Each workshop covered specific areas that subject specialists who were relative novices in multimedia/CAL development needed to know. These workshops were intentionally associated with the blueprint and included information and activities designed to help the participants complete portions of their own blueprints.

The first workshop demonstrated examples of CAL programs. These programs ranged from simple text-based computer-directed styles to more current multimedia with highly interactive structures.

The second session was titled "Design Issues" and introduced concept maps which are intended to be used to structure and organise a program's components. These maps can take the form of diagrams, drawings, flowcharts, tables, or outlines. There was also discussion concerning the understanding of target students and setting learning objectives.

The third workshop gave an overview of authoring languages. Three example programs, each written from the same sample concept map were demonstrated. The three authoring languages used were Authorware Professional, Director, and ToolBook. A follow-up of this session was a one-to-one session for each participant with the Research Assistant; these sessions lasted approximately two hours each and gave the subject specialists a closer "feel" for one or more languages. Following these sessions, project members were expected to choose which authoring languages they would ultimately use for their prototypes.

The fourth workshop dealt with interactive multimedia user-interface design. Included in this workshop were topics such as the design of the amount of interaction which was incorporated in a program, screen design, and navigation issues.

The final whole-group workshop dealt with storyboarding. Example storyboards, both blank and filled-out, formed the basis of this session. Following this workshop, smaller more specialised sessions were planned and presented on an "as-needed" basis. Examples of these include Digitising Videos and Incorporating Sound. Works-in-Progress sessions are also underway.

During the present programming phase of development, one-to-one consultation sessions are occurring. These are meetings with the Research Assistant for assistance with programming problems, clip-art libraries, etc. as well as meetings with project leaders regarding such issues as screen design and reinforcement feedback.

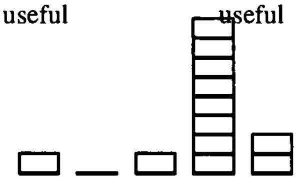
4. Present State and Predicted Results

At the time of this writing, the project is fourteen months old. Already, the progress of participants covers a wide range- there are five working prototypes. Other project members have been hindered by the inevitable demands of lecturing commitments, vowing to make progress during the summer "holidays". However, a wide variety of progress, results, and even the dropout of a few members was anticipated.

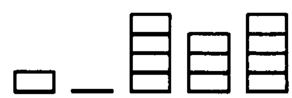
An anonymous project evaluation questionnaire has recently been distributed to project members. So far, returns have been received from half of the participants. These results expressed overwhelming satisfaction with the basic understanding and skills gained for creating CAL resources. Members also expressed satisfaction with the software and personnel resources available to them. Furthermore, they were in agreement with the high amount of time commitment required to produce computer programs. The authors concede that the half who have not yet returned questionnaires are likely to agree with the demands of software development, but also would be expected to have more negative attitudes to various components of the project than those who did make returns. Following are results of selected items:

1. Please rate the <u>usefulness</u> of the following aspects of the project: Not useful — Very useful

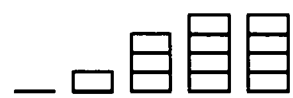
• Providing you with a basic understanding of the various knowledge and skills required to create computer-assisted/multimedia learning resources.



• Helping you recognize the potential benefits of CAL packages.

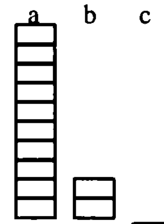


• Helping you understand the commitments required (time, effort, and cost) for developing CAL packages.



2. Which of the following statements best represents your view towards developing computer-assisted/multimedia learning resources for your own teaching?
a. I think that it is a challenging and rewarding task, and I am definitely interested in getting involved in CAL/MM development in future.
b. I think that it is useful and interesting, but I do not plan to be involved in such development in future.
c. I don't find it particularly interesting and rewarding, and I will not be interested in getting involved in these developments in future.

a b c



From item 2. above it is clear that respondents have found the development of resources a challenging and rewarding task, and that they are definitely interested in continued involvement in future. The benefits of the project, from the participants' perspective, are evident in the evaluation results which were succinctly summarized in the written comments from one of the members:

1. mastering the techniques of developing a CAL program,

2. sharing experiences with colleagues having the same interest in developing CAL programs,
3. self satisfaction from work done with recognition from colleagues and students,
4. developing a deeper interest in the hardware and software for producing CAL programs.

However, participants also reported that they have encountered problems and difficulties. Heavy workload and inadequate technical support are the two things that most participants identified as the major obstacles to their progress and continued involvement.

It is predicted that three groups of participants will emerge from this project. One group will find that interactive multimedia development is vastly different from what they expected. It is hoped that many of this group will at least be better-informed consumers of this modern technology. A second group may want to be involved in multimedia production, but as participants rather than as leaders of projects. They should have the experience to be better-informed for the job of directing others to perform tasks such as screen design and programming. Finally, it is anticipated that some enthusiasts will emerge from this project; this group will be those who enjoy a deep involvement in the design and technical aspects of development. At the completion of the project, an analysis will be made to determine if these (or indeed, other) groups form.

One surprise facet of this project which was not anticipated is the integral part the World Wide Web has taken. It was decided to build a web page on which project information would be placed. This page has evolved into many folders of files which comprehensively document the following:

1. project data such as aims and rationale,
2. references including scanned articles, relevant web sites, and conferences,
3. a discussion channel for notices and participants' communication,
4. participants' information,
5. prototype descriptions (projected to include prototype delivery).

With increased world wide web delivery capabilities, it is anticipated that the prototypes will also be installed on the project's web pages.

Based upon demands from PolyU staff members, a second project is currently underway. There are seventeen participants, inclusive of workshop leaders. Two significant changes arising from the questionnaire are (1) the workshops were "telescoped" to be conducted within two months, leaving longer production time, and (2) the second project will involve the exclusive use of Authorware Professional.

5. Summary

The potential of interactive multimedia technology in education is recognised by many. Because of the specialised and local nature of many university subjects, the development of these teaching aids often needs to be performed "in-house". However, CAL software development is a complex, labour-, and time-intensive activity. This paper described an efficient model for training academic staff to become knowledgeable and experienced in software production. Regardless of whether staff who participate in these activities become enthusiastic, "hands-on" developers, participants in larger software-development projects, or never partake in software development again (but are intelligent consumers of available packages), all should benefit from their involvement in the production of prototypes.

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Note: copies of blueprint, survey, and survey results are available from the authors upon request

Practical Issues in Interactive Multimedia Design

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Abstract: CAL (Computer Assisted Learning) software can be designed using the same principles of teaching which apply to the design of traditional teacher delivery. Software can be a simple page-flipping delivery system, or can incorporate components associated with active learning. Likewise, CAL software can vary according to the amount of control and "advice" given to the learner. Compromises can be made concerning the complexity of the educational environment produced with corresponding differences in the complexity of the programming used to produced the software. A program intended to teach principles of molecular biology is an example of software which attempts to incorporate components of both receptive and constructivist learning. It is designed to incorporate a certain amount of intelligence but in doing so, also introduces the question of fairness to different users.

1. Introduction

While computers continue to increase in memory capacity, speed, and multimedia delivery, the most critical factors in educational software design are concerned with the incorporation of *interactivity* into the CAL environment. Just as university teaching can vary from uni-directional, didactic lecture presentations to student-centred environments in which the learners inquire, discuss, discover, and generally contribute to their own learning, educational software can be designed which to follow a similar range of models.

This paper describes a range of CAL software models and issues such as control, interactivity, and ease-of-programming. It also introduces a "compromise model", used for a package currently under development, which is intended to teach students principles of molecular biology, incorporating three activities- Concepts, Practice, and Assessment. The paper will also consider the difficulties involved in attempting to build some "intelligence" into the Practice sectors, particularly the irony of designing software which can actually disadvantage the "good" students.

2. A Linear Approach to Software Design

The lecture style has a long-standing tradition in university settings. This one-way didactic teaching method is based on a model where a subject expert *presents* information to students. This information can be relayed verbally or in text form, with the result of this information being transcripted into students' notes. Advantages of this expository teaching style include efficiency (often with a teacher-to-student ratio of one-to-hundreds) and the relative ease of preparation and delivery. However, it can be argued that a good text could replace this teaching method with the favourable end result of less errors in the students' resultant written material (lecture notes would rarely be edited to the accuracy of a textbook).

The simplest and by far the easiest-to-program CAL software model has a linear, sequential structure. It follows a book metaphor where typically, the reader begins on page one and reads pages in order until the end of the book is reached. A computerised book may have the advantage of incorporating multimedia objects on each page, but the essential structure of this model as shown in [Fig. 1] is the electronic equivalent of a lecture. Control is determined by the order of the content, the user simply clicking a "next page" button. Presentation software such as PowerPoint could be used for creating and delivering such a book. James et al (1998) describe how beginning educational software programmers tended to design linear systems.

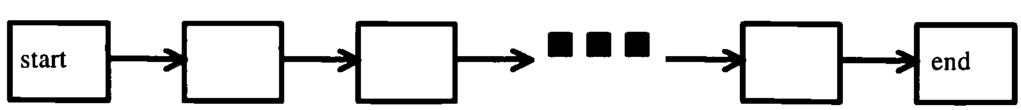


Figure 1: An electronic "book".

3. An Unstructured Model

The opposite approach to learning from the one mentioned above is one which gives students complete control of their information acquisition. Handing a student an encyclopedia or giving access to the World Wide Web are two examples of placing unrestricted learner-control tools in the hands of the student for a potentially rich, active, investigative environment.

[Fig. 2] shows graphically a typical hypermedia software model which, like the electronic book, is a simple point-and-click environment, but which allows complete user-control. The user can traverse any part of the structure, limited only by the buttons available at each node. A structure like this is still relatively easy to program using any authoring tool (such as HyperCard or ToolBook) which allows node (card or page) creation and linking between nodes.

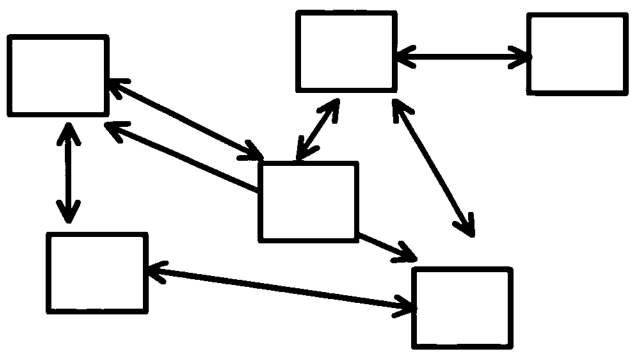


Figure 2: Unstructured hypermedia software

While the amount of control may be different for each of these teaching methods, the commonality is the *lack* of interaction between computer and user.

4. The Ideal Model

An idealistic teaching model would be based on a "tutoring" concept; the program would ask the user a question, accept *any* answer and give expert feedback, ask another question, etc. Unfortunately, this all-wise, infinitely-patient, intelligent tutor [Fig. 3] would require a level of artificial intelligence which would increase the programming complexity immeasurably.

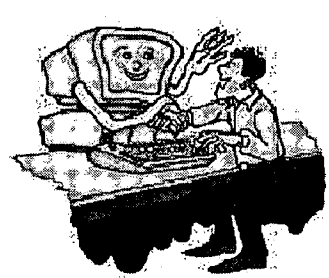


Figure 3: The Intelligent Tutor

It has long been recognised that there is more value in a "deeper" learning approach to education than that which is represented by the "expository" model. Laurillard (1993), in her comprehensive analysis of teaching in higher education, suggests that an active-engagement approach as advocated by educational psychologists Piaget and Bruner, is as relevant to university students as it is to younger learners. In practical terms, an environment such as this contains more learner-directed investigations (from the "hypermedia model"), combined with a significant amount of interaction (from the "tutor model").

In designing computer assisted learning tools, it is reasonable to attempt to design software which involves learners in the most powerful educational environment possible. Latchem et. al. (1993) advocate basing software design on sound pedagogical principles such as constructivism where students work in a knowledge-construction environment designed to be interesting, challenging, problem-oriented, and sometimes experimental.

The issue of control is fundamental to constructivist learning. In discussing the amount of control in CAL software, Schwier and Misanchuk (1993) caution that different learners have different amounts of control requirements. High-achieving students apparently benefit from having higher degrees of control whereas less-able and sometimes more naive students require more direction and structure to be administered by the computer program. It follows that educational computer software will be more adaptable to a range of students if it is flexible enough to allow different amounts of control by the users, although from a practical programming perspective, this is difficult to achieve.

Current interactive multimedia software often contains hypermedia knowledge structures. These are nodes of information (for example, screens of information), connected together by links (often in the form of buttons pointing to other screens). According to Muffoletto and Knupfer (1993), hypermedia enables students to explore information resources and can provide them with the opportunity to actively use newly-discovered information in the production of new knowledge. Jonassen et al (1991, p237) agree that "hyper environments" are "among the best examples of constructivist learning environments".

Assuming that more powerful learning environments as discussed above can be programmed into CAL systems, Csete and James(1996) have proposed a conceptual framework for designing an instrument to encourage learner control and engagement. This framework is in the form of a template with three components: (1) a window for the presentation of basic (and new) information, (2) a menu of learning options, and (3) a "safe" learning workspace for experimentation and the application of new concepts, principles, and skills in a non-threatening environment. Within the third template component, it is expected that learners will be encouraged to try new things, repeat activities, and explore "what if" scenarios. Rather than a completely free, open, and 100% learner-controlled environment, the viewpoint was that there will be a "guided discovery" situation where the program shares control with the learner. Lowyck and Elen (1991, p214) label advocates of this compromised position "mild constructivists",

> "Mild constructivists argue that, though self-regulated learning might be the ideal, most learning involves the interaction between internal (cognitive) and external (e.g. instructional materials) monitoring and that learning processes can be initiated both internally and externally."

A CAL program which has a modified hypermedia design, consisting of nodes connected by links including components of guidance from and interaction with the program, is consistent with this compromise.

[Fig. 4] shows a conceptual model of a CAL program which has a general sequential structure of units, but within each unit there is (1) information delivered to the student, (2) an environment where the student can investigate, and (3) "intelligent" interaction between the student and the program. A model such as this attempts to incorporate constructivist opportunities and interaction within a guided-delivery system.

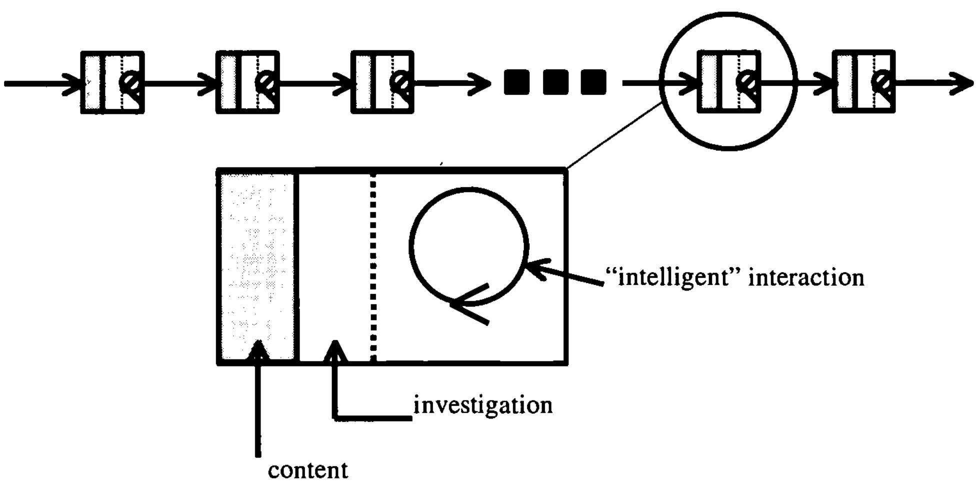


Figure 4: A "mild constructivist" model made up of three-part units.

The content component is similar to a sequence of one or more nodes in the "lecture" model, each node explaining a concept using text, diagrams, pictures, animations etc. The investigation component can vary, but typically will be an activity where the students make decisions based on what they understand of the content. It should be noted that activities such as these often require sophisticated design and programming skills.

The "intelligent" interaction consists of a "dialogue" which can be programmed using logical structures (e.g., if-then-else statements). This component addresses the concern expressed by Latchem et. al.(1993) that a majority of interactive multimedia systems are a "shallow" result of a simple menu-and-selection philosophy of interaction. They also see a potential for a more Socratic environment, posing questions and challenges. This view is supported by Larkin and Chabay (1992, p170) who propose, "Never tell when you can ask".

Larkin and Chabay caution, however, that designing interactive programs is a difficult task- the programming logic and possible pitfalls can be seen in the following example. The result of a well-designed comprehensive dialogue can be worth the effort, the alternative being what Bates(1995) describes as a lack of flexibility leading to student frustration when reasonable responses are not "recognised" by the computer.

5. Example Case

In early 1996, the Hong Kong Polytechnic University allocated Hong Kong University Grants Commission funds for projects which implemented interactive multimedia technology in teaching and learning situations at the University. A sub-project of one of the successful grant applications is called Molecular Biology which is intended to develop a teaching tool to aid third-year students to learn DNA technology. The philosophy behind the design of this project is to create CAL software which is consistent with the "mild constructivist" model given above. It incorporates high-resolution graphics and animation, and was authored using Micromedia Director. [Fig. 5] is a snapshot of a sub-menu of the program.

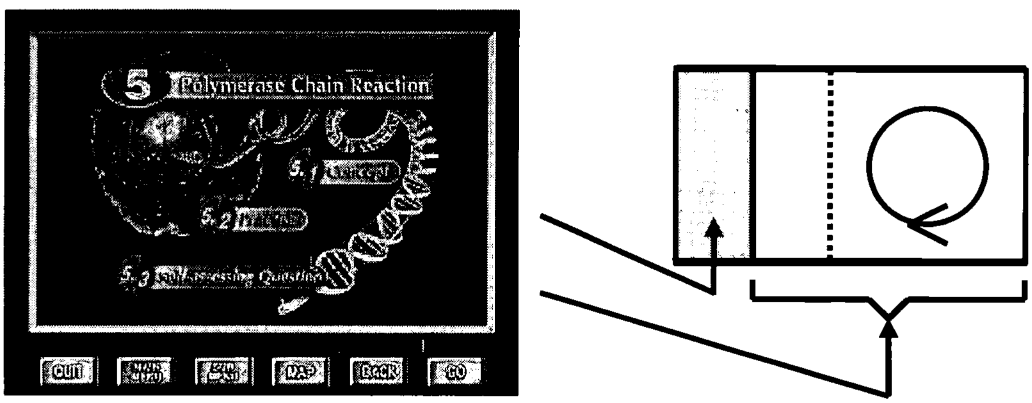
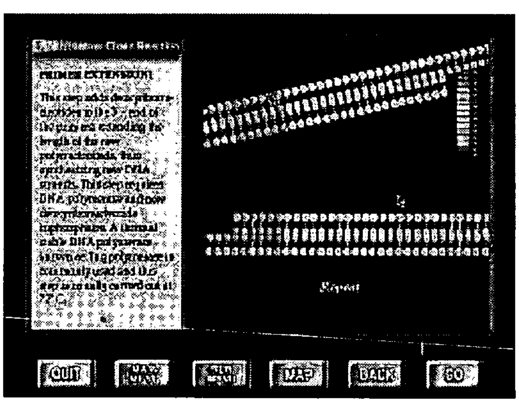


Figure 5: A Sub-Menu of the Molecular Biology Project.

The Concept part delivers subject content to the student; an example page is shown in [Fig. 6a]. This particular page gives an animation demonstrating how temperature affects DNA strand separation.



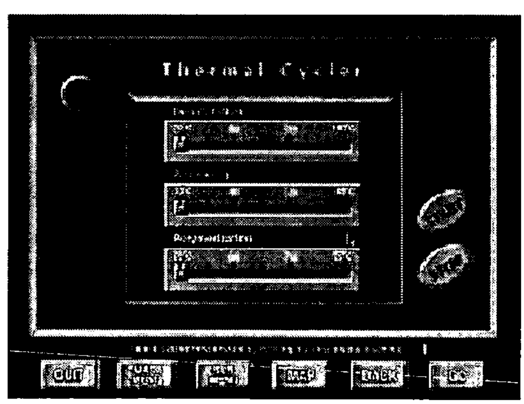


Figure 6a: Example Content Page. **Figure 6b:** Example Activity

The Practice option provides a problem-solving environment with appropriate user-computer interaction. [Fig. 6b] displays an activity where the student is expected to specify three temperatures using temperature slides. When the temperatures are set and the Start button pushed, the computer will report appropriate feedback to the student. This feedback is in the form of a written report. [Fig. 7] is a diagram displaying the logic the computer program will follow in determining feedback to the student's temperature settings (D, A, and P). Each of the seven possible reports will be a unique "intelligent" response to the temperatures which the student specified (note that in the actual package there are sixteen reports available, rather than seven). If the user sets all three temperatures correctly (D = 95, A is between 40 and 50, and P is between 70 and 75 degrees), Report 5 is given and control then leaves this routine, progressing to the next step in the program. If incorrect combinations of temperatures are specified, an appropriate report is given and the user has the opportunity to specify a new set of temperatures.

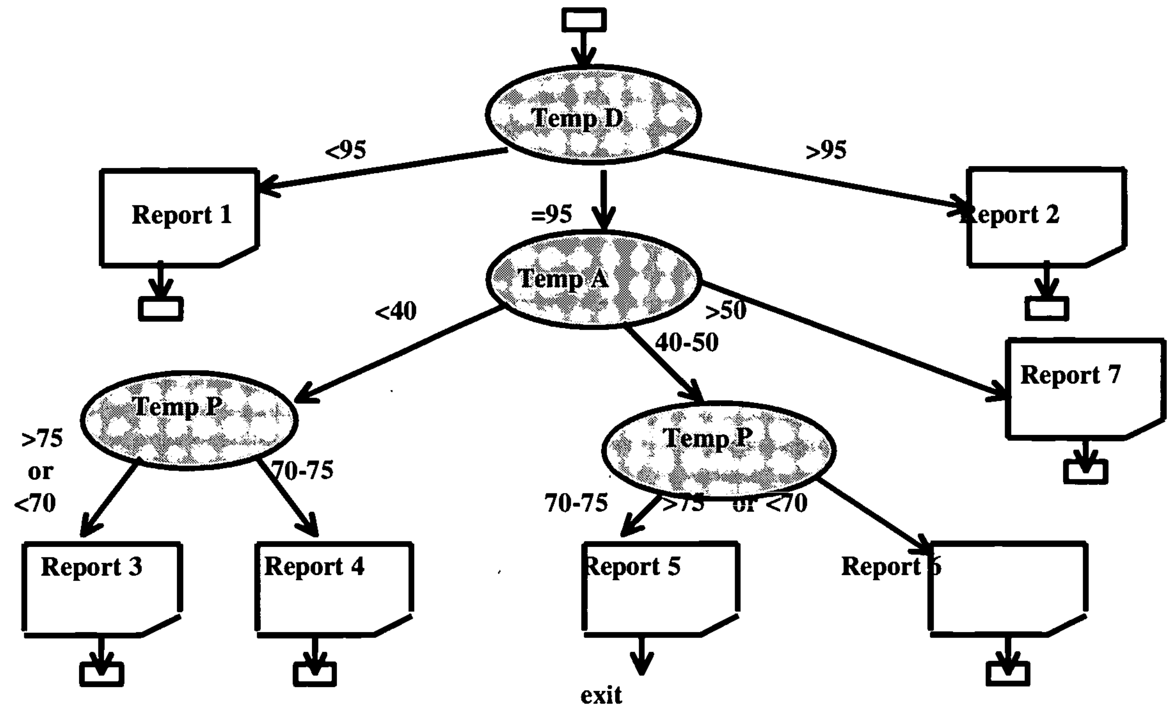


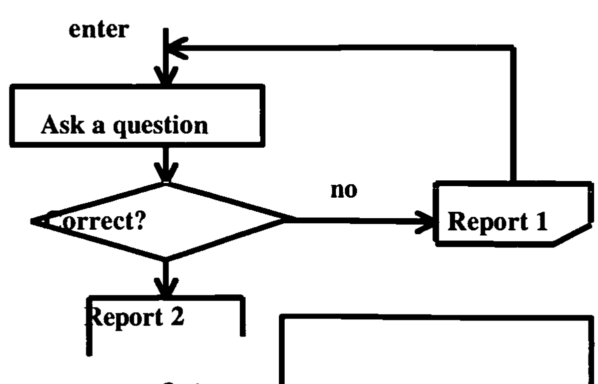
Figure 7: Logic Depicting Possible Feedback.

While the logic described above appears to be reasonable, the designers have a dilemma: assuming that the six "incorrect" reports are information-rich for each respective combination of temperatures, it could follow that the "good" student who gets the correct temperatures upon the first (or even second) attempt would have learned something else from some of the incorrect reports. If this is so, then the student was *disadvantaged* by leaving the routine following their correct input. Designers are cautioned therefore, that perhaps a more "fair" routine would look like that shown in [Fig. 8] where all students have the opportunity to gain from a variety of situations, in this particular case, from investigations arising from different incorrect temperature settings.

Example questions which would generate reports could be:

Report 1: What would you expect to happen if the Denaturation temperature was set to less than 95?

Report 2: Good! Did you also know that "de-oxy" means "removing oxygen"?



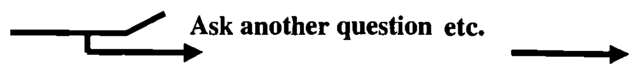


Figure 8: A More Incremental and Fair Routine.

The inevitable tradeoff with this structure however, is that all students must go through all possible settings, increasing the time of sitting by most students and more importantly, minimising the individuality of program runs.

In the spirit of the active learning approach however, guidance could be given in a more open-ended manner; for example "Investigate a wide range of temperature settings" could result in a variety of reported results as in effect, the student would be instructed to traverse the whole structure of [Fig. 7]. However, this would favour Schwier and Misanchuk's (1993) "high-achiever" students. A designer wanting to incorporate an "all things for all people" philosophy could cater for both types of students by adding another selection page with two buttons, one labelled "Sequential path approach" and the other "Open-ended approach".

6. Conclusion

Just as there are different teaching methods and styles, CAL software can be designed to reflect different teaching philosophies. Active learning approaches can be incorporated into computer programs to promote more effective learning, but there will be a tradeoff between more powerful learning tools and programming practicalities. Furthermore, it is not possible to build the "perfect" CAL program because of the differences between learners and hence, their learning styles. Perhaps the most serviceable educational software designs are accomplished by incorporating both guided and self-discovery components. In all cases however, interactive software designs must include components of intelligence and fairness to all learners.

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Self-Directed Learning of University Students Using a Hypermedia on English: Spectral Analysis of Their Performances

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Abstract: Today we are witnessing an explosion of the learning resources on the one hand and on the other hand a need of continuous learning [Leclercq & Denis 95]. In this context autonomous learning will take an increasing part of the educational process and people will turn more and more towards computerised products. As educationists, we study how and what people learn by exploring these resources... to be able afterwards to offer them helps to improve their learning strategies… and outcomes.

For one year, we have been conducting a research on learning strategies with a CD-Rom on English. Our research has been attempting to study the benefit of a punctual self-directed learning experience with a hypermedia in the appropriation of a foreign language. Our two main research questions are : (1) What is the evolution of each student's "spectrum of performances" between the pretest and the post-test ? (2) Which learning strategy does he/she use and what is his/her efficiency ?

Context

In the current context of self-directed learning, people turn more and more towards computerised products... The Task force's report on Multimedia Educational Software edited by the European Commission (1996) shows for example the predicted evolution of CD-Rom drives in families between 1994 and 1998 (for Europe, 2.74 millions in 1994 and 35.96 millions in 1998).

We start from the idea that a lot of commercial tools do exist on the market and are actually used. As educationists we have no control on their diffusion but we can turn the situation to best account and formulate recommendations concerning their use. That is why we study how and what people learn by exploring these computerised informational resources… to be able afterwards to offer them helps to improve their learning strategies… and outcomes.

Research Object and Questions

For one year, we have been conducting a research on learning strategies exhibited by students using a hypermedia on English (as a Foreign Language). Our main research question is : " What is the benefit of a *punctual self-directed learning experience* with a hypermedia in the appropriation of a foreign language ? ". More precisely, we attempt to answer the two following questions : (1) What is the evolution of each student's " spectrum of performances " (see [Concept of " Spectrum of Performances "]) between the pretest and the post-test ? (2) Which learning strategy does he/she use and what is his/her efficiency ?

Progress of the Experiment

Pretest

Our main objective is to measure the impact of self-directed learning by exploring three English lessons in the CD-Rom " L'anglais d'aujourd'hui en 90 leçons " (a " Studio Multimédia " product). Therefore, last year, 28 students registered in the first year of the licence in Educational Sciences received a pretest containing 55 items (short open-ended questions) on English notions. These notions represent 55 " opportunities to learn " (OTL) precisely located in the hypermedia lessons. Students had to complete the test and accompany each of their answers with one of the six following " confidence degrees ".

Interval of the probability axis	*0-25*	*25-50*	*50-70*	*70-85*	*85-95*	*95-100*
Codes for confidence degrees	0	1	2	3	4	5

Figure 1: confidence degrees

The reasons for this (asymmetric) segmentation of the probability axis have been explained elsewhere [Leclercq 83 & 93] and are related to what is currently known of the human capacity in discriminating different levels of doubt (or partial knowledge).

Self-Directed Learning Session

At the beginning of the self-directed learning session, students received directions for navigation and got familiar with the possibilities of the hypermedia. Later, students explored individually three lessons of the hypermedia (n° 25, 35 and 40) during one hour as a maximum. Half of the students received back their pretest during the self-directed learning session with a short feed-back on their answers (correct answer/incorrect answer) ; the other half did not receive anything. This experimental design aims to compare learning strategies of students with " objective learning needs " and learning strategies of students with " subjective learning needs ". The first situation is similar to school situation ; the second one to everyday life.

After the self-directed learning session, students were given a self-assessment questionnaire on their degree of appreciation of the self-directed learning session ; on their initial objectives ; on their learning strategies ; on their feeling to have learned something ; on their computer literacy ; on their practical experience in self-directed learning ...
All the learner's actions in using the hypermediated lessons were video-taped with the help of a " Maxi Converter Pro " system, a hardware converter that allows to display the computer screen on a television screen and/or to record the tracks on a video cassette.

Post-test

Students received the same 55 questions as in the pretest. The post-test was not given immediately after learning, but postponed, since students have not had the learning session at the same time and because we prefer to measure long-term effects of self-directed learning.

Analysis of the Results

Concept of " Spectrum of Performances "

Too often the answer to a question is considered in a binary way : it is correct or incorrect without any concern for the learner's conviction [Gilles 96]. Nevertheless, pioneers like [De Finetti 65], [Van Naerssen 66], [Shuford *et al.* 66], followed by a lot of researchers [Bruno 93], [Dirkzwager 93], [Fabre 93], [Gilles 96], [Hunt, 93], [Jans 95], [Jans & Leclercq 97], Leclercq 83 & 93], [Plunus 96], [Van Lenthe 93] recommend that researchers deal with different states of partial knoweldge to study learning.

The expression of doubts with the system of confidence degrees enables to take account of these different states. [Plunus 96] and [Leclercq, Gilles & Jans 97] defined 6 of them, represented in a "spectrum of performances" :

	Incorrect answers ...						omit	Correct answers ...					
... with Confidence Degree ...	5	4	3	2	1	0		0	1	2	3	4	5
Central value of confidence zone	98	90	78	60	38	13		13	38	60	78	90	98
Unknown ignorance	X	X											
Simple ignorance			X	X									
Admitted ignorance					X	X							
Unknown knowledge								X	X				
Simple knowledge										X	X		
Perfect knowledge												X	X

Figure 2: 6 states of partial knowledge

The student's " spectrum of performances " can be defined as *the distribution of his answers according to their type* : from incorrect answers with a high confidence degree (the worst or leftmost part of the spectrum) to correct answers with a high confidence degree (the best or rightmost part of the spectrum), passing through errors with doubt and correct answers with doubt (intermediate states).

Notion of " Ideal Spectral Evolution "

A spectral analysis for a test will be called " static spectral analysis " when it concerns a fixed state. A " bi-static spectral analysis " compares two states (two spectra), for example a pretest and a post-test, i.e. the global evolution of the performance, but not question after question (that is the object of the dynamic analysis).
In our experiment, two spectra for each student are drawn : the first is related to his/her pretest performances ; the second one concerns his/her post-test performances, so that bi-static spectral analysis will be possible.
[Fig. 3] illustrates the kind of " couple of spectra " (pretest and post-test) ideally expected :

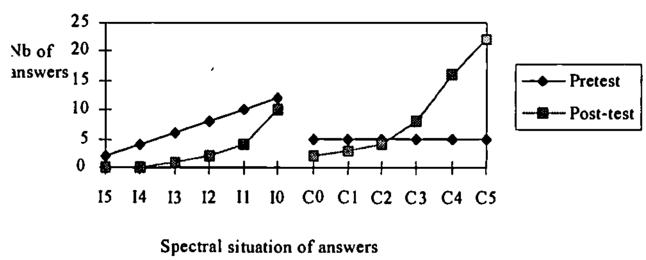


Figure 3: example of "ideal spectral evolution"

The following observations are expected :

	Incorrect Answers	Correct answers
PRE	No matter what the content is, they should always be accompanied by a low confidence degree (CD)	No special expectation. According to the test content (easy or difficult for the student), he/she will know a bit or more partially, with CD between 0 and 5. In our example, they are distributed uniformly.
POST (similar to the pretest)	Their number should decrease, mainly answers with a high CD. The curve should present an escarpment more pronounced on the right (J-shaped curve).	They should be more numerous and more confident. They should also present a J-shaped curve.

	The escarpment increase is mainly due to a *realism* increase.	The escarpment increase is mainly due to a *competence* increase.

Table 4: expected spectral evolution

Quantification of the Four Hemispectrum Shapes

The escarpment or steepness of the two " curves " (strictly, histograms should replace the curves ; we decided to join the tops of histograms in order to facilitate the comparison between pretest and post-test) can be quantified [Laveault & Grégoire 97] with the asymmetry coefficient (*skewness*). This mathematical function characterizes the asymmetrical degree of a distribution according to the mean. A *positive* asymmetry means a distribution with its "tail" moved forward the right side of the graph (i-shaped curve). A *negative* asymmetry means a distribution with its "tail" moved forward the left side of the graph (j-shaped curve).

The *skewness* index equation is : $$\frac{n}{(n-1)(n-2)} \sum \left(\frac{x_i - \bar{x}}{s} \right)^3$$

Here are the skewness coefficients computed for the four curves of our example. If the series of intervals of our six confidence degrees were symetrical, the skewness of the right side pretest curve would have been 0.

	Incorrect answers (left side)	Correct answers (right side)
Prétest	*-0.49*	*-0.14*
Post-test	*-2.03*	*-1.15*

Table 5: skewness coefficients

Categorization of Individual Cases

Our first experimentation led us to distinguish 6 types of students according to their "spectrum of performances" and their "performances card", i.e. their pre- and post-test results, their (absolute and relative) gains, their indices and graphs of realism, their skewness indices : (1) *outnorming students* (overcompetent or undercompetent) ; (2) *ideal students, aware of their (important) progresses* ; (3) *stationary students* ; (4) *radicalized students (at post-test)* ; (5) *weak students, aware of their progresses* ; (6) *students unaware of their progresses.*

Different clues can help to explain the evolution of the "spectrum of performances". They are related to : (1) the subject's learning strategy (duration of the exploration ; lessons really explored ; consulted screens ; number of "seized" opportunities of learning ...) ; (2) the learner him/herself (his/her initial competency ; his/her objectives ; his/her motivation to explore the hypermedia ; his/her computer and hypermedia literacy ; his/her satisfaction after the learning phase ...) ; (3) the learner's knowledge of pretest performance (objective feedback or subjective impression ?).
Detailed results are analysed in a previous article [Jans 97]. This paper presents only one example, Student 11, an "ideal" student, with his realism indices and his realism graphs.

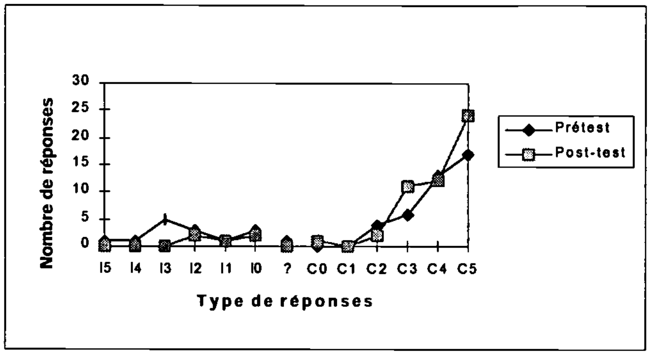
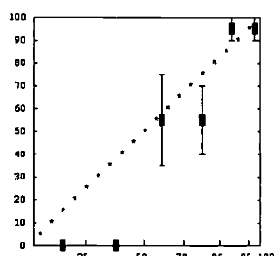


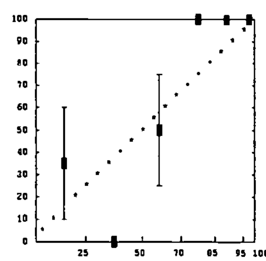
Figure 6: Student 11's "spectrum of performances"

Score (PRE) : 38,61 %	Realism (PRE) : 0.9 (very good)
Score (POST) : 60,32 %	Realism (POST) : 0.88 (very good)
Absolute gain : 21,71 %	Skewn. (PRE) : Incorr. A. : 0,73 Corr. A. : -1,42
Relative gain : 36,87 %	Skewn. (POST) : Incorr. A. : 0,05 Corr. A. : -3,1

Table 7: Student 11's "performances card"



Realism (pretest)



Realism (post-test)

Figure 8: Student 11's "realism graphs"

We defined an « ideal student » as *a student who makes progress in the two expected levels* :

(1) *in his knowledge of English* : The curve of his post-test "goes up" towards the right (peak at C5). His relative gain is high (37%).

(2) *in realism* : In this case, St.11 does not increase his realism index at the post-test, but this index was already "very good" at the pretest, refering to [Gilles 96] norms.

Interviewed, St. 11 declared he appreciated the self-directed learning session. The English level suited him very well. He did not have the opportunity to consult his pretest before the learning session. Nevertheless, his process of navigation in the CD-Rom was efficient, seeing that the rate (55%) of his "seized opportunities to learn" is higher than the mean of the group's rate (45%).

Conclusions

There does not exist something such as "the only one good way to explore a hypermedia". Moreover, students are characterised by what [Denis & Leclercq 94] called " mathetical ambivalence ", i.e. the need to rapidly change from an autonomous learning situation (let me try, let me search, let me create) to a dependent situation (tell me, show me, correct me) and vice versa. The hypermedia "L'anglais d'aujourd'hui en 90 leçons " allows these reversible shifts.

One kind of problems encountered by a hypermedia user concerns the navigation in the great mass of information. In collaboration with the CNRS - IRPEACS of Lyon, we are developing and experiencing new tools to facilitate the navigation in a hypertext [Zeiliger *et al.* 96 & 97].

The analysis of the first results stressed interesting recommendations to carry on with the research into this field. The second part of our research project will aim to compare the impact of self-directed learning on the one hand and of collaborative learning in the other hand of university students navigating in hypermedia. That's why, this year, 30 students were asked to experiment the two situations in English learning. Different indices such as the evolution of their " spectrum of performances ", their (absolute and relative) gains on competencies, their satisfaction,... will be analysed and compared according to the two experimental conditions.

It is hoped that from this research recommendations could be drawn about learning with hypermedia to attain objectives that the learner (or the learners' group) has assigned to himself.

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"Netview" – a Qualitative Method in Networking Interviews

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Abstract: This paper identifies differences between the traditional face-to-face interview and the face-to-interface networking interview. It is based on results from the Danish project "Blaagaard ONLINE" (1989-93) and a casestudy of the project "Interkomm+" - a networked version of the Communication Studies at the University of Roskilde in Denmark (1995-). *"Netview"* and *"Reflection-in-Interaction"* are concepts introduced to qualify the development of new qualitative methods adapted to field research in networking. The invitation is to cooperate and to apply interdisciplinary approaches bridging the sciences of education and software design. A web design of netviews is outlined, and the need for teamwork in research and design is emphasized. The design is to be implemented in evaluation of ongoing projects within education and in-service training in Denmark.

Introduction

This paper will be a presentation of the new methodological problems, which we will have to deal with in the future development of networked education. The major claim is that we need an interdisciplinary approach to bridge software design and system development on the one hand and the reflective practices of learning and teaching on the other. An interdisciplinary approach is necessary to break through the walls between the "soft" and the "hard" sciences to focus on the human actors in learning. The crossing of these borders is vital if we are to meet the demands for networked and hypermedia learning environments of a high quality. To initiate the dialogue and the sharing of ideas this paper is focused on some of the problems in the development of qualitative research methods. They hopefully have such qualities as to exemplify the major claim and call for an interdisciplinary approach. Presently we are "short" of qualitative research methods to analyze and evaluate the specific qualities of hypermedia and networking environments and the learning cultures within these. *"Netviews" is the preliminary term chosen for the networked "equivalent" to the research interview and the development of a method of netviews is one of the ways in which to deal with the demands for quality*. To initiate a dialogue on this new method the paper presents:

- Results from carrying out networking interviews and the ensuing problems of method.
- "Netviews" - a tool and design for networked research interviews in hypermedia learning environments as seen from the "inside" and from the view of the participants.

Results from Early Networking Observations and Interviews

In BlaaLINE (Blaagaard ONLINE) – a Danish project within teacher education - research and observations were carried out on teaching and learning in computer-conferencing in the late eighties and early nineties after a period of evaluating different computer-conferencing systems. In the process of carrying out these observations it was realized that the new environment had a profound influence on educational, organizational and social roles in teaching and on the processes of teaching and learning. In the early observations research was concerned with issues such as: the amount of student responses in different computer-conferences; the amount of discussion threads within conferences; the amount and frequency of student activity compared to teacher instruction and among students, etc. In other words data were collected on a quantitative basis and methods applied along the quantitative line. But the sense of understanding the environment diminished the more the observable activities were studied and "counted". There was an increasing "transactional distance" separating observations from the observed environments. So the method of qualitative research interviews was introduced to be complementary to the counting of activities. Little by little the focus of the interviews was on the group of teachers in the early networking communities and their reflections on how this new environment had influenced their roles as teachers and the qualities and the barriers they had to meet with. *From 1989 until 1993 a series of networking interviews were carried out trying to identify the qualities of teaching and learning in computer conferencing and to "configure" the future demands on teachers competencies within networked learning environments.* Electronic discussion lists were chosen as the means of distribution and they were chosen within subject areas such as education and communication in computer conferencing (CC) and in computer-mediated communication (CMC). The respondents were pioneers in these areas. [Jensen & Jensen 1993a, Jensen 1993b]. In the process of carrying out the networking interviews it was gradually realized that the procedures and the concepts of the qualitative research interview also changed profoundly in this new environment. The reason for this is to be found in the following two related phenomena:

1) *Events of communication in networking seem to combine the qualities and the different styles we find in oral and written communication,*
2) *Interaction and the events of communication in networking are complex phenomena of double-layered transaction combining the interaction between the user and the interface (face-to-interface) with the events of communication between human actors.*

The differences between the oral and the written styles are reflected among other things in the distinction between the questionnaire and the interview. The questionnaire is used to collect quantitative data and short comments on a subject in question, and the research interview is a way of gaining insight into the interpretations and viewpoints of respondents and their reflections. The questionnaire is a tool for "outside" evaluations and it needs to be strongly standardized, as there is no common context among the researcher and the respondent. These "decontextualised" qualities of written communication in the questionnaire are in line with the common cultural understanding of traditional textual qualities. In contrast to this the interview stresses the qualities of oral traditions and the "events" and situations in face-to-face communication and it appreciates the cues in metacommunication. In the process of an interview the researcher and the respondent create a common context along with the continuous negotiations of meaning and interpretation. Each of the participants in the interview "reads" the common context and interprets the ongoing interview-situation. The cues in metacommunication such as tone of voice, intonation, gesture and facial expression are essential in the process of shaping these interpretations. The negotiation of communication in an interview is a double-layered process of transaction. In one layer the negotiated content and the related context are produced while the second layer is concerned with the interpretation of the way in which content and context are negotiated [Kvale 1996]. The interview is visualized in [Fig.1].

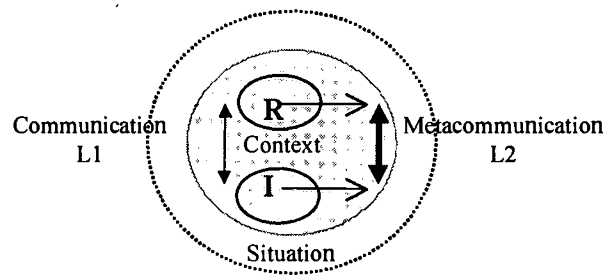

Figure 1: Interview. The interview is a face-to-face view in synchronous communication. The research interview is a mutual view of the interviewer and the respondent. In the traditional interview-situation the respondent and the interviewer create a common context *through* negotiation of content and in interpretation of the context - the communication layer (L1) - as well as simultaneously negotiated interpretations of the interview-situation as such - the metacommunication layer (L2).

The networking research interview is influenced by some of the procedures and qualities from the style of writing and the decontextualised features commonly associated with the questionnaire. But it is different from the questionnaire because it keeps the open and non-standardized format and the intention of gaining insight into the "inside" perceptions of the respondents and their viewpoints and interpretations. The content and the contexts of the interview are created in the process of the interview whereas the questionnaire is filled in according to the predefined and standardized categories and the foreseen way of working with the results.

It seems that the dynamics of the interview in networking environments is quite different from both the questionnaire and the traditional interview. It is open and unfolds itself during the process of negotiation of meaning very much as it is the case in an interview, although the events of communication take place in writing, which relies on asynchronous communication. Starting with an open and opening question the process might speed up and unfold in a day or it might develop within weeks or months and it could be "located" in a global environment.

In the networking interview there is also a double-layered process, but it is different from the traditional interview. As earlier mentioned the networking interview is characterized by the related interaction with the interface (face-to-interface) and the events of communication between human actors, be it teachers, writers or students. In software design, i.e. HCI, it is often emphasized that interaction with the interface is a kind of "transactional communication" between the user and the designer [Andersen 1990, Greenbaum & Kyng 1991, Suchmann 1991]. Thus the networking interview is very complex, because of the multiplicity of "participants" in the interview process. *In the construction of contextual situations and in the negotiation of meaning we have to deal with both the interviewer, the respondent, the designer and with the separate interview situations and their different but related contexts.* Some of these characteristics are visualized in [fig. 2].

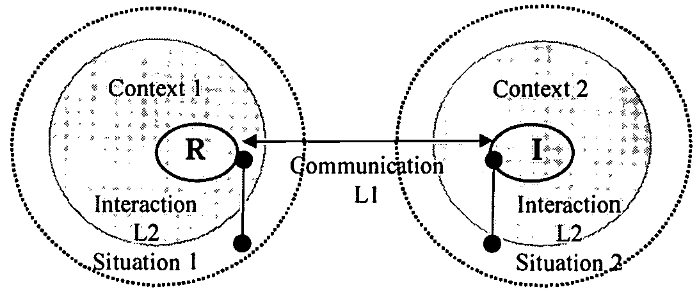

Figure 2: Networking Interview. The networking interview is a face-to-interface view in asynchronous communication. In the networking interview-situation the respondent and the interviewer negotiate and interpret the context *from* within different situations - the communication layer (L1) - as well as simultaneously from within different contexts - the interaction layer or the face-to-interface layer (L2).

The Problems of Version in Networking Interviews

When confronted with these differences the complexity of networking interviews became obvious and the need for new methods to deal with this complexity was realized. The perspective in the ongoing research and the "visual angle" were then changed from the global "birds eye view" in networking interviews to a "zoom-in" perspective on the use-in-practice situations. Focus was on related transactions of face-to-interface interaction and the events of communication between human actors in the networking environments. The idea was to get as close as possible to face-to-interface interaction and the method applied was the Video Interaction Analysis

(VIA) which is based on the use of video observation as an analytical tool [Jordan 1994].
One of the overall problems that occurred again and again during the analysis of the logged files with the interview dialogues was the question of "version". It was difficult to establish whether the responses in the dynamics of an interview were "first version" responses or to what extent they were reviewed and edited and as such "late versions" of the initial response. The interaction layer in the networking interview was "invisible" and the asynchronous nature of the interview opened up a "transactional distance" *within* the interview. The respondent had the opportunity to reflect on, edit and revise the responses in a way that is unknown in the traditional interview. While carrying out the networking interviews the dynamics of responses was "speeded" in a call for short answers closely linked to the subject in the subject-lines of the emails. The subject-lines were used as a key-feature in structuring the networking interview sessions. In the printed version of the interviews the overall style was categorized as either primarily oral or written based upon parameters such as length of comments and frequency and intervals. But even though the styles very often bore resemblance to the events of oral communication, it was not possible to prove the responses to be first versions such as it is the case in a conversation and in an interview.

The concern about problems of version in the interview dialogues was confirmed when the transactional processes were video analyzed [Jensen 1994]. During the video analysis it gradually became evident that reactions in the computer-mediated dialogues were heavily reviewed, edited, evaluated and very often shortened or otherwise changed before they were submitted. There were frequent changes of the "focus" in the dialogues: from networking dialogue to interface interactions and then again to a "traditional" dialogue with colleagues or workgroups in the physical environment with phones ringing, coffee breaks etc. In other words, it proved to be a quite different context of dialogue and situation in the networking interview.

In the traditional interview the layer of metacommunication serves to actively catalyze the focus and concentration "on and in" the interview situation and the ongoing process of negotiating meaning and interpretation. In comparison to this the layer of interaction between the user and the "system" environment (face-to-interface) in networking interviews seems to be distracting and the asynchronous nature of the events of communication creates different situations from within which the interview is to be carried out.

Design of "Netviews" and the Concept of "Reflection-in-Interaction"

The video observations dates back before the general development and diffusion of the web and hypermedia environments. They were carried out in the early years of the global spinning of the web (1993-1994) and not within hypermedia environments such as web-sites. But in the meantime the relevance of qualitative research methods of networking interviews has increased as the web has made networking cultures and their capacities visible for everyone. There is a shift from networking cultures as pioneering and experimental cultures within rather "closed" communities to the general integration of these cultures into society.

The underlying assumption in this paper is that the analysis of networked and hypermedia learning environments is to be carried out from the "inside" of the environment and with a focus on human actors. Networking cultures are coded with contexts created by the significant use of signs and symbols. They live by the actions and events of communication by human actors who are relying on a new set of values, conventions and rituals. The instrumental view on networking capacities as just a new technological infrastructure will leave us with no comprehension as to the new phenomena and the possibilities in relation to education and learning. To unfold their potentials and perspectives we need to understand the codes and contexts of these new cultures. In networking cultures as in any other culture we can learn a lot from asking and listening to the human actors and the way they interpret their own actions. The interview is one of the very important ways in which to gain this insight. So, in stead of "canceling" the interview as a rich and qualitative research method in networking cultures and environments, we need to develop the concepts and the way we think about interviews and the methods by which we carry them out. The "hybrid" and preliminary terms of "netviews" and of "reflection-in-interaction" are suggested as conceptual tools for the rethinking of networking interviews. The concepts of netviews and of reflection-in-interaction are visualized in [fig. 3], which is superimposed on the figure of the networking interview.

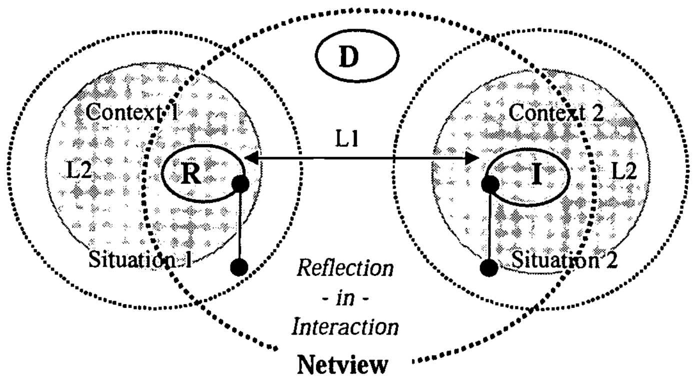

Figure 3: Netview. The netview is a multiplicity of face-to-interface views of the interviewer, the respondent and the designer. A common context is designed on the basis of reflexive strategies such as "reflection-in-interaction" in a hypermedia environment on the web.

The designer (D) is introduced as the "third part" in netview situations and the dotted line suggests the construction and design of a new and common context within the networked interview - "the netview". In netviews the design of face-to-interface interaction is in a hypermedia environment such as the web and it is designed to catalyze the focus of reflections in and on the interview situations. Hyperstructures and link facilities are important tools in the creation of interactive written dialogues and in the construction of a common context. Netviews are based on the asynchronous nature of networking, independent of time and place, and on the capacity of storing interaction and communication. The method prospers from the asynchronous communication as it opens up the possibilities of a process analytical approach [Borgnakke 1996] to interview situations.

In the present expansion of the web hypermedia environment are integrated into commercial and public affairs. In the wake of this there is a growing interest in surveys and inquiries into patterns of usage and the identification of segments and target groups of commercials and in marketing. The interests of commercial and marketing sectors have produced a new kind of software to "detect" the patterns of user movements within web-sites such as the program "WebTrends". The focus of interest in these programs is on the identification of "hit-lists" to decide on activities in which to invest. Tools for the logging of navigation patterns and different priorities within web activities are also of great interest to the analysis of learning situations especially if they are combined with the capacities to visualize priorities and patterns. In a Dutch hypermedia project, such tools for visualization have been developed although within a slightly different context [De Bra 1997]. The application of such software in hypermedia environments are important improvements of the methods to be applied in networking "field" studies, but only if it is combined with netviews as a tool and a method for interpretation and for the reflections of human actors.

Web environments support the integration of different representations and of face-to-interface interaction based on association and reflection. The web netview is designed in a hypermedia landscape as a "world" of digitized sources selected and organized by the interviewer and the designer. Together they create a common context framed by an interface supporting dialogue, exploration and interaction. The netview thus facilitates processes of reflection-in-interaction and of narratives as respondents travel through the hypermedia landscape of linked sources, following their impulses and associations. Patterns of respondent movements within the website are logged and so are the narratives and traces of interaction deposited as the traveler moves along. It is visualized in [Fig. 4]. The design and concept is heavily influenced by ethnographic approaches, methodological traditions of research into social history, theories on reflection and on human-computer interaction and methods in participatory design. In a netview the roles of the interviewer and the respondent are changed. The respondent leads the interview in creating a context to be jointly explored by the interviewer and the respondent or by a community of respondents. It develops in recursive patterns of dialogue and design.

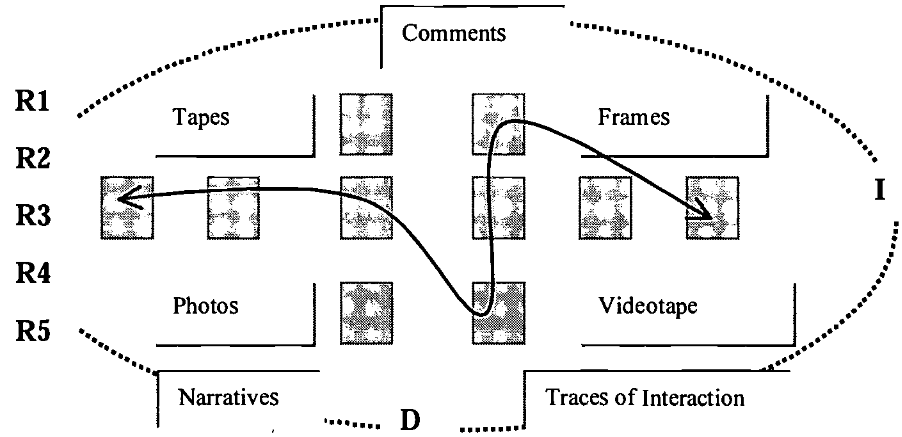

Figure 4: **Netview Design**. The web netview integrates different media in a hypertext format facilitating processes of "reflection-in-interaction". Respondents follow impulses and associations navigating through the hypermedia landscape of digitized sources. The netview interface is designed to support comments, narratives and traces of interaction produced by the respondents in the netview dialogue.

The conclusive concept in netview design, and in this outline, is "*reflection-in-interaction*". It necessitates an interdisciplinary approach as it integrates theories and knowledge areas from within educational and reflexive strategies [Schön 1987] and from HCI and theories on participatory design. It is an important precondition for the analysis of qualities in education and learning within hypermedia networking. *To qualify the development of methods and design in netviews based on the concept of reflection-in-interaction, we need to promote teamwork and to emphasize the need for cooperation between researchers from within the sciences of participatory and collaborative software design and from the educational sciences.* In current research activities the method of netviews are applied to the Danish project "Interkomm+" [www.komm.ruc.dk/interkomm] - a networked version of the Communication Studies at the University of Roskilde – in a casestudy. The web version of netviews is to be further developed in future evaluations and analysis of Danish projects within teacher education and in-service training on a national basis initiated by the Danish National Center for Technology Supported Learning.

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Learning Affordances of Collaborative Educational Multimedia Design by Children

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Abstract: We present and discuss the results of a project in which seven teams of elementary school students were involved in designing and implementing interactive multimedia resources in science for younger children. We found that students improved significantly in their science understanding and programming skills. We discuss the benefits and problems of integrating science content with multimedia design and discuss why the quality of dynamic and interactive components in students' multimedia production proved to be a better indicator of students' learning than the quantity of multimedia produced.

In recent years there has been a surge of interest in the use of multimedia in educational computer applications. Developers have added sound, graphics, photographs, and video to applications that were previously dominated by text. Various research efforts investigate ways in which multimedia features such as video [e.g., Cappo & Darling, 1996; Rubin, Bresnahan & Ducas, 1996], graphics [Rieber, 1994], or combinations of features [e.g., Jackson et al., in press] can contribute to students' learning. One underlying premise of most research is that providing students with multiple representational formats in a content domain helps to build their understanding and addresses the diversity found in students' learning and thinking approaches.

While these multimedia features potentially add value to applications, less attention has been given to approaches that provide learners with the opportunity to design and program their own multimedia software applications. To take a closer look at the potential of multimedia design for learning, we examined the cases of seven design teams that were involved in creating interactive multimedia resources about astronomy. We examine various program functions and the multimedia content of the final software products. Furthermore, we investigate how the team products themselves reflect the contributions of their individual authors. The purpose of these analyses was to illuminate some of the knowledge that young students have about multimedia design—as expressed in their products and in their interface design—and in which ways designing multimedia afforded learning opportunities for them.

Theoretical Background

Learning through designing multimedia applications is part of a larger effort to provide children with rich learning experiences [e.g., Brown, 1992]. It proposes software design as a new model of integrating programming with other learning that goes beyond learning programming for its own sake [Harel & Papert, 1991]. Software design requires students to consider interface design issues, deal with content aspects, and create, debug, and maintain their programs. In designing their own applications, students reformulate their knowledge by creating and implementing external representations in their software.

Multimedia features of software can facilitate this process, as they allow students to use and combine various representational formats in one medium.

While knowledge reformulation is an important feature of learning through software design, personal expression of one's ideas is another. With the increasing proliferation of commercial education and entertainment software, students have become accustomed to a software production level that makes extensive use of multimedia features. While students might have a wealth of experience in using multimedia applications, they have little knowledge about making multimedia software. Creating multimedia applications is a complicated and collaborative enterprise. In research and commercial contexts, groups of professional designers, programmers and content specialists work together for several months (Lammers, 1986]. Several studies have used this approach to study the thinking and learning of young software designers [Blumenfeld et al., 1991]. One series of projects focused on children designing instructional software for mathematics (e.g., Harel, 1991; Kafai & Harel, 1991] and instructional games in science and mathematics [e.g., Kafai, 1995; Kafai & Yarnall, 1996]. While these studies made special use of programming as a vehicle to foster children's learning of content, other studies used platforms such as hypermedia and authoring environments [e.g., Lehrer, 1991; Carver, 1991; Spoehr, 1995]. In this particular study, we decided to focus on the nature of the applications created by the students. We used the final computational artifacts as a starting point for investigating what kind of learning opportunities in science and programming was afforded by the design of an interactive multimedia resource and how this was related to individual students' contribution to the multimedia product.

Research Context and Participants

The project took place in an urban elementary school that functions as the laboratory school site for UCLA. The participating classroom was equipped with seven computers, one of each was set up as a workstation for the seven table clusters. An integrated class of 26 fifth and sixth grade students participated in this project (10 girls and 16 boys of mixed ethnic background) ranging between 10 and 12 years of age. Students were grouped in seven teams. One week before the start of the project, students were given an introduction to the main features of the Microworlds™ Logo programming environment. The assignment was to build an interactive multimedia resource about astronomy for younger students. Students worked 3-4 hours per week on the project for a period of 3 months, spending 46 hours in total of which 23 hours were dedicated to programming. Science instruction and programming time were combined. For this paper, we concentrate on the final software products which were analyzed in regard to the nature of their functions and the contributions of individual team members. The main data comes from a classroom activity conducted toward the end of the project in which each team met and determined which individuals should take credit for which parts of the final product (e.g., text, graphics, and animations).

Results

All seven teams finished a multimedia information resource at the end of the project. Our project observations documented that the completion process was not an easy one. For one, students had considerable problems in the beginning sharing work and computer resources, as each team consisted of 3-4 students each, but only one computer was available to all the team members. Furthermore, many students were learning Logo programming as they were designing their multimedia resource. While this provided an authentic context for students' learning, it also limited students' expression in the beginning to simple page designs. Later on, students started including animations of the life cycle of stars or the planet movements for lunar and solar eclipses. As for its science inquiries, each team posed several questions such as "Is there life on Mars?" or "What do we know about Black Holes?" which they intended to follow up in their science research. As the project progressed, these questions changed in focus and range. Some students reformulated their questions, while others added new ones which usually were more specific such as "What is the Big Bang?" In terms of the effectiveness of the overall intervention, we found that the design project was successful as a vehicle for both science learning and Logo programming development. To assess students' improvement in their knowledge of science content, we administered pre- and post-tests in astronomy. Our preliminary analysis showed significant differences for the pre- and post-tests in students' understanding of astronomy (Pre-Test: 31.5, Post-Test: 37.2, df 25, t: 5.65, $p<0.05$). Students' understanding of Logo also improved (Pre-Test: 13.3, Post-Test: 18.6, df 24, t: 4.38, $p<0.05$). In addition, in terms of programming skills, many students started out at ground zero, knowing no Logo at all.

Evaluation of Educational Multimedia Software: Team Contributions

Each interactive multimedia resource consisted of a set of interrelated screen pages that were linked together with the help of buttons or clickable objects that could be activated through a mouseclick. Some of the screens had combined media elements such as text and graphics while others worked only in one medium, text or graphics. The number of created screen pages differed considerably for each multimedia design team; yet this was not a good measure of production value because screens differed in their functionality. We defined three categories of screens: content screens, quiz/feedback screens, and information/ navigational screens. Table 1 provides an overview of the distribution of the different screen functions.

Content screens represent some piece of knowledge about the field of astronomy. They can take the form of text, pasted pictures, drawings, or any combination of those three design elements. The larger category of content screens was also broken down further to specify content animation screens. Content animation screens (CA) contain animations or simulations that exemplified dynamic aspects of the solar system such as the lunar eclipse, the life cycle of a star or effects of gravity. Only in one instance was the player given the possibility to set the parameters for a game-like animation (team3).

Many groups in the project decided to include *Quiz/feedback screens* to complement their multimedia resource. Quizzes usually asked questions about the content displayed elsewhere in the product but occasionally introduced new material. Most quiz screens contained one or two multiple-choice questions with buttons linking the user to feedback on his or her response. Feedback screens consisted primarily of simple pages exclaiming "right!" or "wrong!" in a very large font. Only in a few instances were users provided with additional information, as in the question "Can Martians Dance: Yes or No?" The answer page in either case replied "There is no right or wrong answer to this question, because we don't know if there are Martians on other planets" (team 6).

Another type of screen common to most group products was *Information/ navigational screens* that provided information about the designers themselves or displayed the title of the software and subtitles of topic areas, such as, "This is the Planets Section!" Other screens contained buttons or turtles which linked to different topic areas and provided information to the user on how to navigate the software, such as a table of contents. The graphical arrangements on these pages differed considerably. While in a few instances students took advantage of a graphical representation of the solar system as an entrance to different planets, many others just placed a variety of buttons on the page.

To summarize the design efforts by the teams, we see that students made extensive use of multimedia. A pervasive feature of all software applications is that students tried hard to emulate commercial software models. A comprehensive analysis of all seven final versions of the educational multimedia resource showed that all of them used "Point&Click" as their main mode of advancing through the program. They provided menu options, had navigational features such as title screens, introductions, content overviews and final screen and credit messages. In the instructional component, students (with the exception of one team) provided limited positive and negative feedback and sometimes explanations. But students' software did not provide the player with a "Quit" option, a feature that either many designers did not have time to implement or did not consider important. Furthermore, "Help" options were absent as well. Being beginning interface designers, the students were able only in a limited way to foresee their users' needs.

Evaluation of Educational Multimedia Software: Individual Contributions

While all students contributed to the final versions of their software, the levels of individual effort among the students in any group needed further examination. We decided to use the final artifacts themselves to not only document effort and equity, but also to examine the ways in which individual contributions to each group's final product have different affordances for product appearance, individual credit-taking, and learning benefits. To create a score commensurate with students' experience, we created a "design differentiated score" by looking at the types of screens created by individuals in the context of their total contribution. For that purpose, we used the three types of screens defined above, content screens, quiz/feedback screens, and information/navigational screens. Student differentiated scores for each type of screen were created using the same values as the raw scores. To create design differentiated screen type scores for each student we added up all their points for each category of screen. Thus, a student with a raw score of 8 screens might have 4 content, 3 quiz/feedback, and 1 information/ navigational screens.

Table 1: Distribution of Screen Page Functions

	CON	AN	IN	QU
Team 1	17	2	4	6
Team 2	15	3	3	11
Team 3	9	2	3	-
Team 4	12	1	6	13
Team 5	14	2	2	12
Team 6	23	1	6	18
Team 7	11	0	2	31

KEY: CON=content screens; AN=Animations; IN=Info/Navigation; QU=Quiz/Feedback

Table 2: Distribution of "Design Differentiated Scores"

Team 1	10	1	.75	2
	2.5	-	.25	-
	2.5	-	2.25	4
	2	1	.75	-
Team 2	1.25	1.5	1	5.5
	6.75	.5	-	1.5
	4.25	1	-	0
	2.75	0	2	4
Team 3	3	-	2	-
	1	1.5	1	-
	5	.5-	-	-
Team 4	3	1	6	-
	4	-	-	-
	3	-	-	-
	2	-	-	13
Team 5	3.33	1	.25	-
	3	1	.25	2
	4.83	-	1.25	10
	2.83	-	.25	-
Team 6	4.5	1	2.5	0
	13.5	-	1	10
	2.5	-	1.5	8
	2.5	-	1	0
Team 7	2	-	1.5	5
	8	-	.5	14
	2	-	-	12

KEY: CON=content screens; AN=Animations; IN=Info/Navigation; QU=Quiz/Feedback

	CON	AN	IN	QU

After examining the differentiated scores (see table 2), it appeared that they explained much of the deviation from expectations that showed up in the objective scores. Looking at screen types seemed to be a much more viable measure of participation than total screens. Students who created the most content screens and content animations were the same as those who displayed the most leadership, spent the most time at the computer, and showed the most developing astronomy knowledge. In the group products where the student with the most total screens was not the same as the most dominant and knowledgable student, we saw that the one with the highest raw score created mostly quiz/feedback and information/navigational screens. This finding is interesting not only because it lends support for measuring individual performance and contribution by some deeper means than merely counting the number of pages created, but it also provides a window into which types of screens are valuable for what purposes. In the following section, we discuss how the different screen types afforded different modes of thinking and learning benefits, and served different personal goals.

Discussion

Working on different multimedia functions served different goals for the designers, in both science content and multimedia learning. While informational/ navigational screens presenting tables of contents, title pages, or personal information about the designers may not necessarily contain science content, they have definite value in terms of technological fluency. Making tables of contents, main title pages, and topic area title pages requires taking the perspective of the user and considering what he or she would find most helpful in navigating the software. Navigational screens are not by nature devoid of content, as illustrated by the comparison of the solar system model title page and buttons title page shown earlier, but many of the information/navigation pages designed by students in this study had little or no content. The process of making such pages is relatively easy, since no animations are required, no astronomy research is required, and little programming is necessary other than linking buttons.

Quiz/feedback pages afford several benefits from a software design perspective. For one thing, the type of drill-and-practice quiz designed by most groups is a "quick and dirty" way to add interactivity to the software. In fact, when asked by researchers why they were making a quiz, the students often responded that it was because the users would want more interactive features. Making a quiz takes relatively little time, when all that is required is a series of questions with buttons leading to pages that say "right" or "wrong." Another benefit is thus that students who felt that their contribution was too small were able to increase the number of pages they created by adding a quiz on some topic at the last minute. From a science learning perspective, making quizzes does not allow the designer to experience the maximum benefits of the software creation process. Most quizzes in this project were a disjointed set of questions with little or no relation to one another, followed by feedback pages which gave no explanations of the correct answer. The process of designing a quiz such as the ones we saw may not help the designer develop systemic understanding in science, since a quiz only requires that he or she know the right answers to a series of unconnected science facts.

Content/animation screens are the most difficult to create, but they also afford the most learning benefits, both in terms of technological fluency and systemic understanding. Even the most basic kind of content page, one with only text and/or pictures, requires deeper levels of thinking about astronomy than the disjointed kind of knowledge represented by a quiz. Because students had to think about their users, 3rd and 4th graders, they had to write all the text sections in their own words and explain astronomy phenomena in language that younger students would understand. This consideration discouraged practices such as cutting and pasting of text from the Internet or copying word-for-word from books. Opportunities for even deeper thinking about users, programming, and the subject matter are afforded by more elaborate content pages, which use animation to depict some astronomy phenomenon. Creating animations requires the designers to learn Logo beyond relying on the basic point-and-click controls of the Microworlds system, because they have to direct the turtle in complex patterns and series. Most importantly, animations afford remarkable growth in systemic understanding. They require the designer to comprehend something well enough to create a model of the whole phenomena, as opposed to merely possessing a descriptive understanding of "what happens."

From the preceding analysis and discussion it is clear that instructional multimedia development is a challenging enterprise for young software designers (as it is also, incidentally, for most professionals). One could argue that the concurrent learning requirements might have hindered more than helped students. On the other hand, while schools traditionally introduce these subjects sequentially, we see a special synergy in learning them together at the same time. For one, it is difficult to imagine a course about multimedia design without students being engaged in designing media about something. Design has to be situated within a particular context or domain, so that designers as well as users can judge the value of their implementations. Furthermore, situated multimedia design provides an opportunity for the learners/ designers to approach subject matter from a different vantage point than their own. Instructional design, as implemented in this project, affords particular learning possibilities not only for the designated user of the instructional material but also for the instructional designer. We found that interactive and dynamic aspects of screen designs provided a good indicator for learning that integrated the programming and science. The development of instructional animations facilitated students' better understanding of systematic aspects of science while it led them at the same time into more sophisticated programming and vice versa.

Designing multimedia software presented students with complex issues, some of which became evident in the previous discussions. Students needed to coordinate multiple demands in designing and implementing their work. Based on our observations and analyses, we found that elementary students' experiences and associated conceptions do not adequately prepare them for managing long-term, less well-defined design projects, which require more flexibility and iterative planning strategies. Furthermore, we found that students need more support in their collaborative work if the design situation is to be an effective learning context for each individual team member. It is obvious that the transition from a multimedia consumer to a multimedia producer is not an easy one. Yet the potential benefits make it a worthwhile learning experience.

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An Evolution of Concept Maps: Computer-based Interactive Qualitative And Quantitative Knowledge Maps Applications Model in College Level Science Courses.

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Abstract: This paper shows how concept maps, a tool utilized rather widely these days, can be advanced to new horizons using computer-based approach. The authors discuss general structure of concept maps, their use as dynamic instructional tools, and then present a model for implementation of computer-based concept maps in college-level science courses. Most advanced concept maps are generated using multimedia authoring software and can be either qualitative or quantitative in nature. Such computer-based concept maps, located either on a computer in a classroom or on the Internet, can become a very powerful and unique tool contributing to other learning techniques and assessment methods.

Concept Maps: An Introduction

A concept map is defined as a graphical knowledge representation which hierarchically links concepts. Novak (1984), a leading authority on concept mapping in education, proposed that different learners structure their new current and new knowledge in a variety of ways, therefore validating use of concept maps in teaching and learning.

Joseph Novak stated that

> a good curriculum design requires an analysis first of the concepts in a field of knowledge and, second, consideration of some relationships between these concepts that can serve to illustrate which concepts are most general and superordinate and which a re more specific and subordinate. (Novak, 1979, p. 86).

If the instructor's role is to guide the learner in creating new meanings and deeper levels of conceptual understanding, then concept mapping can be an effective instructional and assessment tool to use in undergraduate lower division science courses. Knowledge is accumulated in a continuous fashion, and developing connections between prior and new knowledge is critical to the learning process.

In a traditional concept map design, the most general or most important concept is placed at the top of map, and concepts on lower levels are subsequently more detailed. Key concepts are connected by links that have descriptive words on them explaining the relationship between concepts. Concepts maps, by their visual presentation, have traditionally been used as very effective vehicles for organization of concepts within the domain. Traditional concept maps were of "paper and pencil" type, and were used mainly to organize qualitative or conceptual knowledge. Thus, in rethinking course curriculum at the undergraduate level, the number, organization and plan for the systematic development of concepts are worthy considerations in terms of curriculum restructuring necessary for improved student performance.

As concept maps evolve, there are variations in their development, discussed by Shavelson et al (1994), including free-form versus hierarchial, concepts' position on the map, collaborative effort by a group of students. These variations provide for greater instructional flexibility as well as for more diverse learning experience. In the last decade, a noted increase in interest in and use of concept maps has resulted in the identification of many valuable instructional purposes for mapping. Concept maps are particularly useful as tools to:

1) plan and analyze instructional units of study, thereby identifying gaps in the curriculum
2) facilitate lesson planning and related activities
3) serve as an "advance organizer" for students to improve notetaking skills or as a guide to enhance student textbook comprehension.
4) serve as meaningful collaborative learning experiences
5) use as an alternative form of assessment.

A Model for Implementation of Computer-based Concept Maps in College Science Courses

An advent of computers, word processing and flow-chart software, as well as later developments in multimedia authoring software enables instructors to push the limits of usefulness of traditional concept maps far beyond "pencil and paper" representation. It is worth noting that in this respect the following stages of software development can be identified:

1) Non-dedicated word-processing or flow-chart software allowed for passive creation and use of computer-based concept maps
2) Software dedicated to generating concept maps results in production of more responsive and interactive computer tool
3) Multimedia authoring software for fully interactive knowledge building and assessment using computer-based/multimedia concept maps.

This article presents initial approach undertaken in implementation of concept maps in college-level science courses, and creates a model suitable for implementation in any science courses for computer-based knowledge building and alternative assessment using concept maps. Since this represents significant evolution of concept maps, we will refer to them as *(c)omputer-(b)ased qualitative and quantitative (k)nowledge (m)aps* (CBKM).

Software

For the purpose of this model, software from above mentioned stages 2) and 3) is used. Software dedicated to generating concept maps such as Inspiration ® (or comparable) is used by students almost exclusively. Instructors use Inspiration® for knowledge maps presented or developed during classes. These presentations are very effective and lead to interesting interactions when presented on a large projector screen. The set of standard knowledge maps as well as the ones developed during classes is uploaded on the Internet under the course's Web page.

Multimedia authoring software such as Authorware® by Macromedia (or comparable) is used by instructors to prepare highly interactive software used by students in- and/or out-of-classroom to build new knowledge, form linkages, and to build critical thinking and analytical skills. Multimedia authoring software enables instructors to provide students with an interactive study tool that provides them with an instant feedback, where each one of superordinate or subordinate concepts, linkages and propositions is a hyperlink providing immediate response or guidance. In addition to having such developed and customized software place on computers in science computer labs or individualized study labs, this software can be made available on the Internet.

Student Software and Concept Map Training

A session dedicated to concept maps and computer software is necessary for student involvement. Such training can take place either during the one of the first classes or during a lab period. Students have to become familiar with operational definitions of terms such as: concepts, propositions, principles, theories, relationships, hierarchy, cross-links, and general-to-specific examples. Then, utilizing subject matter from the first chapter of a textbook, students should become engaged in creating concept maps in groups of 2-3 persons. The authors of this article found in teaching concept maps to many students and college instructors that a typical response indicated very positive reception of this tool. About one-hour hands-on orientation into the concept of concept maps, their role, and advantages is sufficient for college student to become proficient in constructing them and using appropriately. Additional twenty-thirty minutes is needed for a student to master software, and this is gained when working on first concept maps.

Implementation

It is an established phenomenon that concept maps can serve to align curriculum and instruction. Additionally, growing research evidence points to utilization of concept maps as assessment tools. Shavelson et al (1994) and Wallace & Mintzes (1990) provided extensive analyses of its use a research tool to assess student conceptual change. Carefully designed implementation CBKMs can facilitate a very effective accomplishment of the following:

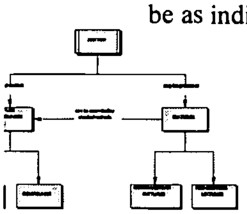
1) Assessment of student prior knowledge of fundamental concepts upon initial attendance of the first general chemistry course.
2) Building new knowledge, providing linkages, and the "big picture".
3) Building critical and analytical thinking skills
4) Assessment of new knowledge, critical thinking, and ability to manage data
5) Formative (ongoing) evaluation as well as summative evaluation (end of instruction).
6) Collaborative learning experiences
7) Information management

Assessment Items: Examples of Qualitative and Quantitative Knowledge Maps as applied in Alternative Assessment of Students' Prior and New Knowledge

Example 1: *Assessment of prior knowledge of fundamental concepts.*

Problem: Organize the concept map for the concept of *matter* using:
mixtures, pure substances, compounds, elements, heterogeneous mixtures, homogenous mixtures
Use terms as propositions: "can be separated by physical methods into", "may be present as".

Response: One of possible representations indicating students knowledge of this fundamental concept would be as indicated on the Concept Map 1 below:



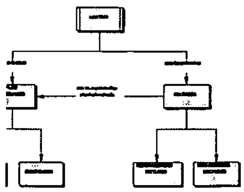


Figure 1: Concept Map 1

Example 2: Organizing quantitative new knowledge for a "big picture" and understanding of relationship among quantities and constants in stoichiometric calculations.

Problem: Present a comprehensive representation of stoichiometric relationships in a chemical reaction of 0.5 mole of sodium chloride with an appropriate amount of hydrogen chloride.

Response: Concept map 2.

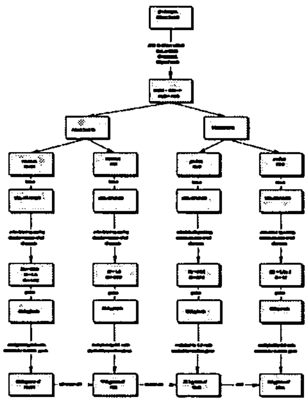


Figure 2: Concept Map 2

Conclusions and implications.

Computer-based, qualitative and quantitative knowledge mapping is a tool that can be used by both instructors as well as students to meet the challenge of planning, organizing, teaching and learning. Computer-based knowledge mapping assists students in fulfilling quality outcomes in learning science. Used traditionally, concept maps provide concrete visual help to organize information to be learned. Science instructors for lower division courses at colleges who have been exposed to this tool are finding that they provide a logical basis for deciding which main ideas to include in a course. Computer-based knowledge maps can be as large as the entire course, one or more unit, or even a single class period.

It has been shown before that traditional concept maps are valid vehicles for documenting and exploring conceptual change (Wallace & Mintzes, 1990). This proposed model of computer-based qualitative and quantitative knowledge maps that is currently used as a pilot in a limited number of chemistry classes, in conjunction with authors experience in practical using concept maps, have provided convincing evidence that many instructors would be able to present more continuous learning experience for their students, who in turn would benefit from CBKMs as described above. Computer-based knowledge maps can be a powerful tool, that contributes to the other learning techniques and assessment methods, and addresses both knowledge and its organization.

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Explanation Text based Presentation Animation Generating Method in Virtual Environment

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Abstract: This paper proposes an automatic presentation animation generating method in a virtual environment. This method generates 3D animation based on a speech text that explains objects in the environment, and this animation shows a presentation performed by an agent in the virtual environment. In order to generate the animation automatically, we categorize the presentation motions of the agent into three classes, pointing, moving, and gesturing. Based on this categorization, our system extracts words from the explanation text. In order to determine what the target object is and to extract detailed information about the object, the system accesses a scene graph that contains all the information about the virtual environments. The system can find the object based on its characteristics that are explained in the text, and can then extract information about the object such as its size, position, and weight. This information is used for determining details to generate the agent's motion.

1 Introduction

Animation is one of most powerful tools in the broad area of education. It improves both desire to learn and comprehension of an object of students. However, it is not easy for teachers to create animation for their classes. In this paper, we propose an automatic presentation animation generating method in a virtual environment. This method generates 3D animation based on an explanation text, and the animation shows presentation performed by an agent in the virtual environment. In many cases, ordinary animation is used to show physical and mathematical simulations. Our animation, on the other hand, shows the explanation of something in the virtual environment.

Presentations are very important activities in educational, academic, and commercial settings. Many presentations are often performed in many different places. However, these kinds of ordinary presentations have several limitations. For example, students wishing to attend a presentation must go to where the presentation is being held. Animation performed by a presentation agent in a distributed virtual environment, however, can resolve these problems easily. Thus, a student can access a service presented in a virtual environment setting from anywhere and at anytime. A screen shot of the service is shown in Figure 1.

The use of animation performed by a presentation agent has many advantages. However, the motion authoring and programming of the agent have to be done as a 3D basis [Vince 92], so it is often very difficult for teachers less familiar with these procedures. In order to avoid difficulties, an automatic motion generating method for agents [Wavish 97] is introduced. The input information of the system is an explicit description of the motion. This method makes the system generating motions easy, but the author still has to describe the motion clearly. This work is also not so easy for those less technically oriented. Therefore, the development of easy authoring method is strongly required to make the presentation method popular.

The method we introduce in this paper realizes easy authoring for animation performed by the presentation agent. The input information in our method is in the form of an explanation text that the agent will speak. This kind of explanation speech text is usually written by the people who want to make a presentation. Therefore, it has the advantage that any individual can prepare his or her own presentation text without too much trouble. The motions performed by the agent, however, are not expressed explicitly in the text, which means our system has to guess the motion. Our system executes a guess based on the explanation text and the scene graph that contains information about all of the objects in the virtual environment.

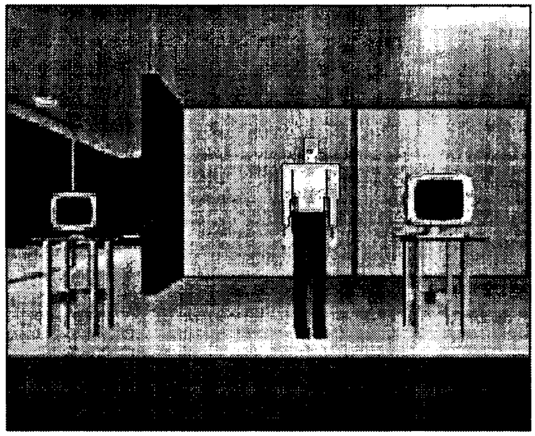


Figure 1: Screen shot of a presentation.

2 Presentation in the Virtual Environment

As already mentioned conventional presentations are usually performed in person, but such presentations have many limitations. A presentation in a virtual environment by an agent, on the other hand, has many advantages. In this section, we discuss the advantages of the presentation agent in the distributed virtual environment.

2.1 Time and Space

Live presentations performed by persons are the standard way to present. However, these presentations have a drawback in that both students and teachers must meet at specific location and at specific time. Such a limitation can create problems for both parties. Teachers usually spend much in the way of time, energy, and money towards a presentation, witch leads the teachers to want to show the presentation to many students. Similarly, if students want to see a particular presentation, they may have difficulty attending it if the presentation's location and schedule does not match their own.

2.2 Viewpoint

If we want to avoid some of the limitations of a live presentation, we might use recorded media such as videos and slide-shows. However, such a presentation is recorded as a 2D basis. In such media, the viewpoint is fixed at the time of creation and the student can't move their viewpoint to where they want. A presentation in the virtual environment, on the other hand, is performed as a 3D basis. This gives the opportunity to shift their viewpoint to any location they chose.

2.3 Environment

In ordinary presentations, the variety of visual aides of the presentation environment is restricted by many practical elements such as money, time, space, and so on. However, in a presentation in a virtual environment, the teacher is able to prepare any kind of environment he or she can imagine. This method is especially helpful if an object that the teacher wants to explain does not exist in the world, the virtual environment then becomes an ideal environment to do this presentation.

2.4 Repetition

It is usually required that a presentation be performed many times. However, performing an ordinal presentation many times is difficult, because additional expenditures in effort and cost are required for each presentation. In virtual environment presentations on the other hand, such additional effort and cost are not required. The agent just replays the presentation when necessary.

3 Animation Generation of Presentation

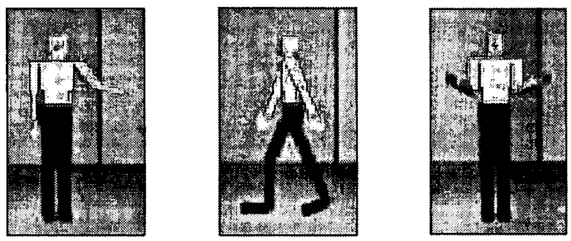
In this chapter, we describe animation generation method for a presentation agent.

3.1 Classification of Motion

In order to generate the motions of an agent automatically, we have to know what the agent's motion is in a presentation and when the motion is performed. We believe that the primary objective of presentations is to show target objects clearly, then to talk about their features. Based on the objective, we classify the essential motions of an agent into three categories, as follows.

(1) Pointing
(2) Moving
(3) Gesturing

We understand that presentation behavior is constructed from these motions, shown in Figure 2. In this section, we introduce the motions and discuss how can we guess the motion from the explanation text, and what kind of information is required for the motion generation.



1: Pointing 2: Moving 3: Gesturing

Figure 2: Motion Categories.

3.1.1 Pointing

Pointing is a motion that the agent uses to indicate a target object. In a presentation, we usually point to an object that we are referring to, and it is this pointing motion which is used to identify that specific object for the student. We believe the agent should perform a pointing motion when the target object is referred to in the explanation text.

The motion is basically performed by the agent's index finger, but the pointing motions have some versatility for example, an agent can:

- Point to an object with its index finger.
- Point to an object with an opened hand.
- Hold the object with a hand.

These pointing motions are performed in different ways depending on the situation. For example, if the target object is small, light weight, and near the agent, the agent could hold the target object in its hand. The decision table for the pointing method is shown in Table 1.

Table 1 Decision table for pointing method.

The number of object(s)	Position	Weight and size	Pointing method
Single	Far	-	Index finger
	Near	Light and small	Hold by hand
		Heavy or large	Point to with opened hand
Multiple	-	-	Point to with opened hand

In order to generate the pointing motion, the system basically has to know which object the agent should point to. In addition, the system also has to know the direction and the distance of the object from the agent. Moreover, in order to make this variety of pointing motions, the system has to know the size and weight of the object. The system extracts this kind of information from the scene graph of the virtual reality system, which will be described later.

3.1.2 Moving

Moving is a motion that the agent does to move from one position to another. Moving is usually performed by the agent to locate itself near the target object that will be explained. In the explanation text, the requirement of a moving motion is not explicitly expressed. However, the system can guess the motion from the explanation text, as to when and where the agent has to move.

In the case of the explained object being near the agent, the agent does not have to move. The agent just points to it and continues the explanation. In a different case, in which the explanation text refers to a distant object, demonstrative adjectives such as, "this" and "these" are used; the agent has to move near the object before the explanation will start.

In order to generate the moving motion, the system basically has to know what the object is that the text is currently explaining. In addition, the system also has to know the direction and the distance of the object in relation to the agent. The system also extracts this kind of information from the scene graph of the virtual reality system.

3.1.3 Gesturing

Gesturing is a motion that we use a great deal in live presentations, and it is a motion that we use to increase the power of expression in a presentation. Gestures are usually performed in conjunction with words such as adjectives, adverbs, interjections, and verbs. Therefore, the agent might perform such appropriate gestures when these types of words appear in the explanation text. We show some examples of gesture below.

- Counting on fingers.
- Explaining size or length with fingers and hands.
- Explaining shape with fingers or hands.
- Explaining motion with fingers or hands.

In this method, gesturing motions are decided upon only from an explanation text, so gestures that are associated with a particular word always appear with those words. However, we sometimes use different gestures for the same words. For example, in the case that we talk about something large, if an object's size is really large, we will open our arms to explain the size. If the typical size of an object is very small, but the object we explain is relatively large, we will open our index finger and thumb to explain the size. In order to create these gestures, the system has to know the typical size of the target object. The system also extracts this kind of information from the scene graph of the virtual reality system.

3.2 Scene Graph as Database

As described in section 3.1 , each class of motion needs not only the information from the explanation text, but also any extra information to generate the motion appropriately. In the real world, determining a target object from its specific features and getting some information related to that object is very difficult for a computer, because the computer usually does not have the information about objects in the world. In virtual reality systems on the other hand, information about the objects in the environment is stored in a database called the scene graph [Hartman 96, Wernecke 94, Sense8 96]. Therefore, it is possible to determine a target object from its specific features and to get some information related to that object.

The scene graph was originally designed for real-time 3D graphics system. The scene graph contains data about the objects in a scene, such their shape, size, color, position. Each piece of information is stored as a node in the scene graph. In the scene graph, these nodes are arranged hierarchically in the form of a tree structure. The 3D graphics system traverses the tree structure to get information, and renders appropriate scene based on the information.

The concept of the scene graph is very popular for constructing virtual reality systems. In the virtual reality system, the scene graph is extended for simulation. The scene graph for the virtual reality system contains not only data for rendering, but also contains data for simulation and human interface such as weight, and name. Therefore, the scene graph for a virtual reality system would have the following kinds of information about objects:

- Shape
- Size
- Color
- Position
- Weight

- Name

If we know some characteristics about an object, we are able to look up the object using this existing information in the scene graph. The system extracts these characteristics from the explanation text, and following that, the system traverses the scene graph to look up nodes that have appropriate characteristic. If the node is found, an object that contains the node in the sub-tree becomes a candidate of the target object. After fixing the target object, the system is able to extract additional information from the scene graph to generate the agent's motions.

3.3 Explanation Text Parsing

In our method, primary motions of the agent are generated from information about the explained object. Therefore, the system has to decide what the explained object is. The process is realized by the system by picking up a noun clause that mentions a target object in the explanation text. Therefore, our system doesn't understand the meaning of an explanation text, rather the system just picks up a word or words.

Sometimes, a target object is referred by a pronoun. In this case, the system make an anaphoric reference and refers to the previous noun as the description of the target object. The explanation text is constructed from well-developed and well-formed sentences. In the sentences, a target object is described clearly, so picking up a noun clause is usually not difficult.

The text parsing system also picks up words, such as verbs and interjections, to generate appropriate gesturing.

3.4 Scene Graph Access

The target object is basically referred to by a noun in an explanation text, as the following example will show:

I will talk about a cup

In this case, the system picks up the noun "cup" and looks for the object by using the scene graph database. The cup is found in the scene graph, and the system knows its position. Based on the position, the system calculates its direction and distance from the agent. If the object is near, the system generates a pointing motion in the agent. If the distance is far from the agent, the system generates moving motion in the agent. If many objects are listed, the system chooses the nearest object to the agent. This system decision is based on the heuristics that presenters usually present the object nearest to them.

The target object can also be referred to by a noun with adjectives, as shown below.

I will talk about a red cup.

In this case, the system also picks up the noun "cup" and looks for the object by the scene graph database. As a result, several objects are listed, and the adjective information "red" is also used to determine which object is the appropriate one. Consequently, the system generates the motion of the agent.

We can explain characteristics of a target object, also in this way, as shown below.

This cup is large.

In this case, the system, first, makes a list of all cups existing in the virtual environment. Next, the system calculates the average size of these cups. After this processing, the system generates an appropriate degree of gesture to explain the characteristics.

3.5 Motion Scheduling

The motions that the agent should perform are generated according to the explanation text. Therefore, the order of the motion sequence is defined by the explanation text, and this sequence is performed sequentially. However, the raw sequence of motions has some problems, so a motion scheduling phase is required.

The main purpose of motion scheduling is shown below:

(1) To synchronize motions with the speech

(2) To permit motions overlapping

Presentations in virtual environments are performed with speech and motions. It is imperative that these motions synchronize with the speech. For example, if an agent talks about an object, the agent should already be pointing at this target object. In order for this to occur, all motions performed by the agent must start in advance of the pointing reference. These kinds of adjustments are performed by the scheduler.

In order to synchronize motions with the speech, another kind of adjustment is also important. The duration time of the motion is extracted from two sets of data. One is the typical execution time of each motion, and the other is the pronunciation time in the explanation text. In our system, management of duration time is performed in each sentence. If the total duration time of motions is longer than that of pronunciation, silent time of speech occurs. In a presentation, silent times of speech are often awkward and are undesirable. Therefore, the scheduler tries to reduce these silent times.

To do this, the scheduler tries to overlap some motions in a sentence to reduce a silent duration. Pointing and moving motions can always overlap, because pointing motions use hands and arms, and moving motions use legs, so both motions are able to be performed at the same time.

On the other hand, gesturing and some of the other motions sometimes cannot overlap. We believe that the importance of gesturing is lower than that of pointing and moving. Therefore, if the motion of gesturing conflicts with the motion of pointing and moving, the gesturing motion is not performed.

4 Implementation

We have developed an experimental system on the SGI's CosmoPlayer. CosmoPlayer is a VRML browser, and it can be programmed with Java language. VRML and Java are platform independent technologies for the WWW, so the presentation on the system is able to be distributed anywhere in the world.

The system is constructed in two parts, one is a virtual reality system that realizes the virtual environment, and the other is a motion generation system. We show the system overview in Figure 3. Each part of the system is constructed from some sub-systems.

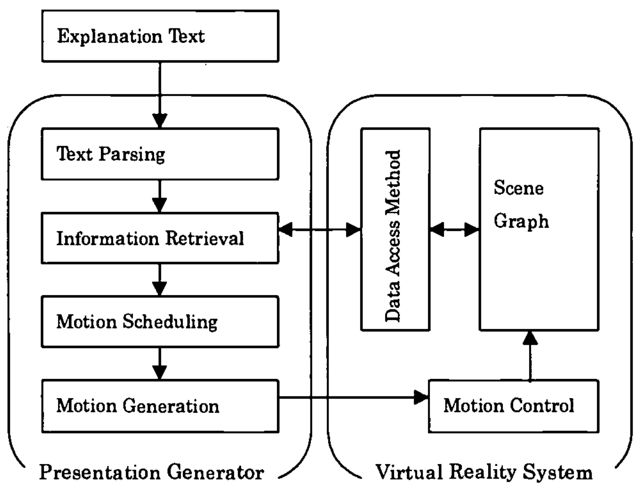


Figure 3: System Overview

5 Conclusion

In this paper, we introduced an automatic animation generating method for a presentation agent in a virtual environment. It generates an agent's motion from an explanation text and from information that is held in a virtual reality system. Our method makes it possible for teachers without a technical background to create individualized presentations in a virtual environment.

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PICCO in the Classroom

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Abstract: This paper describes a school experiment where the development of children's conceptual models of the selected astronomical phenomena had been examined. During a learning and teaching period the objects of the learning by the quidance of a teacher in class situations were the planets, the solar system, the Earth and the sun. The pupils were Finnish second graders on an average eight years old. During a break and one day after school, the children could use the pictorial computer simulation, PICCO, independently for four weeks. As a main result it could be stated that most of the children's conceptual models in this domain area developed quite a lot during the learning and teaching period. However, some children's models remained vague. The results support the theoretical model of the formation of children's conceptual models in the circumstances where seven year old children explored the phenomenon using PICCO independently and spontaneously according their own interest without a teacher's teaching.

Introduction

This paper describes a school experiment where the development of children's conceptual models of the selected astronomical phenomena had been examined. During a learning and teaching period concerning the Earth and space, children had possibilities to use a pictorial computer-based simulation, PICCO. The phenomena which was included in the teaching period were, amongst other things, the planets, the solar system, the Earth and the sun, the alternation of day and night and the succession of the seasons. These subjects were learned by the quidance of a teacher in class situations. During a break and one day a week the afternoon the children could use the PICCO program independently. The selected phenomena in PICCO was the variations of sunlight and heat of the sun as experienced on the earth related to the positions of the Earth and sun in space. The pictorial computer simulation shows the effects of the variations of sunlight and the heat of the sun on the earth in nature, and the origin of those variations caused by the interrelations of the Earth and sun as a part of the solar system. The school experiment had been carried out with Finnish second graders, the children's ages being about eight years old. Altogether, there were 22 children, and the research period during which the children could use the PICCO program took four weeks.

Conceptual Development in Astronomy

In several studies it has been suggested that children in everyday situations form conceptions in physics and astronomy which differ from the conceptions of scientific theories in question and seem to be robust and difficult to reconcile with currently accepted scientific knowledge. Vosniadou, for example, has concluded, on the basis of her findings, that "children start their knowledge acquisition in astronomy by constructing an intuitive cosmological model of a flat, stationary Earth in a geocentric solar system in which the sun and moon move in an up/down direction and cause the day/night cycle. Eventually this intuitive model changes to that of a spherical Earth, which rotates around its axis and revolves around the sun in a heliocentric solar system in which the day/night cycle is caused by the axial rotation of the Earth and not by the movement of the sun and the moon." In her findings Vosniadou has observed that "the process of conceptual change from these intuitive models based on a child's everyday experience to scientific models is a slow and gradual one and is characterized by the emergence of various misconceptions of scientific explanations. Misconceptions are caused when students try to reconcile the scientific concepts with their experiential beliefs." In current research there have been attempts to find the ways by which children could be guided in the formation of conceptions and the change of misconceptions. [See e.g., Vosniadou 1991, 1994; Vosniadou and Brewer 1992, 1994.]

Aim of the Research

The aim of this research was to investigate to what extent the use of the pictorial computer-based simulation, PICCO, together with the classroom teaching could support and help children in the formation of conceptual models of the phenomena in question.

In this research a conceptual model is seen as a mental construct concerning a certain natural phenomenon. The conceptual model of the natural phenomenon forms a basis for the cognitive action referring to the phenomenon in question. The more developed and integrated a conceptual model is, the better the basis it gives cognitive action concerning the phenomena in question. A conceptual model is formed from concepts and their interconnections which concern events, objects, properties and relations. The object of the present research was to study, especially the changes in a child's conceptual model concerning relations in the phenomenon in question.

Before and after the research period the children's conceptual models were elicited by using specifically designed procedures for this investigation. The eliciting of a conceptual model was achieved using procedures aimed at stimulating a recollection of the natural phenomenon in question. A child modelled the natural phenomenon from the basis of recollections and images through action, pictorially and verbally using different tasks. The modelling took place by showing, drawing, modelling and explaining. The phenomenon forms the wholeness which contains many, integrated phenomena and their interconnections. The main interest in this research was to study a child's conceptual model of the selected phenomenon, emphasizing relations and their changes in a child's conceptual models concerning the phenomenon in question. Regarding the natural phenomenon in question, attention was paid to the variations of sunlight and heat of the sun on the Earth, the interconnections of the Earth and sun in space, and interrelations of phenomena on the Earth and in space. In addition, attention was paid to the size, form and distance between the Earth and sun.

Description of the Pictorial Computer-Based Simulation - PICCO

The pictorial computer simulation concentrates on the variations of sunlight and heat of the sun as experienced on the earth related to the positions of the earth and the sun in space. In the simulation it is possible to explore the variations of sunlight and heat of the sun and their effects on the earth in a natural environment. It is also possible to examine the origin of these phenomena from the basis of the interconnections and positions of the earth and the sun in space. The simulation concentrates on phenomena which are close to the everyday experiences of children, such as day and night, seasons, changes in the life of plants and birds etc. The simulation program has been implemented in such a way that the knowledge structure and theory of the phenomenon are based on events appearing together with the phenomenon in question, and these events are illustrated. In the simulation all events and necessary elements are represented as pictures and familiar symbols. At the earth level the pictorial simulation represents the surrounding world, its phenomena and objects in a very natural and realistic way. In exploring the phenomenon at the space level the interrelations of the earth and the sun are represented with the help of an analogue model. The selected place on the earth from where the phenomenon has been modeled and simulated for a computer is the suburb of Lentävänniemi in Tampere, in Finland. The children who participated in this research live in this area. Therefore the exploration of the phenomenon with the pictorial simulation takes place in an environment familiar to the children.

The exploration of the phenomenon starts in Lentävänniemi on the 1st January at midnight. On a big screen is seen at that moment a dark, snowy, winter landscape in a direction of the south. The exploring can be continued by using icon pictures under the picture of the landscape, for example, a clock, a pictorial calendar, a picture map with different points of the compass and a space shuttle. The exploring of the phenomenon can be continued in many ways hour by hour, day by day, month by month, at different points of the compass and so on. At any moment it is possible to take a space shuttle and to look at the interrelations and positions of the earth and the sun at the space level. At the space level it is also possible to explore the interrelations and positions of the earth and the sun by using icon pictures which show the time in the same way as at the earth level. At every moment it is possible to choose how to continue exploring. Exploring can proceed at every moment using the existing alternatives.

When exploring at the space level the earth rotating around its axis and revolving around the sun on its elliptic orbit appears on the screen. The plane of the earth's orbit is shown as viewed from directly above this plane. When exploring the phenomenon at the earth level the following may appear on the screen: the changes of darkness and lightness daily with an accuracy of one hour, the sun's positions in the sky every hour, the place and time for the sunrise and the sunset every day round a year, typical plants, birds and animals according to seasons and so on. With the help of the icon pictures, binoculars, magnifying glass and microscope it is possible to explore flowers, trees, leaves, insects, birds, spores, animals and so on in more detail. On the screen a selected object is seen as bigger. At the space level with the help of a telescope it is possible to look at the earth at a larger size so that, for example, Finland is seen more clearly. From this picture of the earth it is possible to continue further and to see the map of Finland, and finally an air photo of Tampere. In the simulation it is also possible to explore the mutual size of the earth and the sun and to get an image of the distance between them. Also the position of the earth in the whole solar system can be seen on the screen. The pictorial computer simulation is constructed so that it is very easy to use and it does not presuppose an ability to read or write. A pictorial computer simulation [Kangassalo 1991] is described in detail in the articles by Kangassalo [Kangassalo 1992, 1994, 1996].

Conceptual Change after the Learning Period

Before and after the learning period the children's conceptual models of the phenomena were at very different levels. As a main result it can be stated that most of the children's conceptual models in this domain area developed quite a lot during the research period and the direction of the construction seemed to occur towards the currently accepted scientific knowledge. However, some children's models remained vague.

In seven children's conceptual models, the alternation of day and night and the succession of the seasons on the earth level were seen to be as a result of the Earth's rotation around its axis, when the Earth is revolving at the same time around the sun. Eight children had difficulties in reconciling the Earth's rotation around its axis with the Earth's revolving around the sun. In four children's conceptual models, some connections between the phenomena on the earth level could be seen connected with the interconnections of the Earth and sun in space. In their conceptual models, either the succession of the seasons or the alternation of day and night could be seen connected with the position of the Earth and sun. In three of the children's conceptual models the spherical earth rounded in one place or revolved around the sun although the order, continuity and regularities of the seasons on the earth level had not been organized.

The results are mainly in the same direction than in the preliminary theoretical model which is based on eleven first-graders spontaneous and independent exploration of the phenomenon using PICCO four weeks. In the preliminary theoretical model [Kangassalo 1997] the main noticeable direction in the construction of the children's conceptual models, when using PICCO, tended to be as follows:

1. The Earth began to revolve around the Sun.
2. Seasons were organized in the surrounding world and connected to the positions of the Earth and the Sun in space. The connections varied from weak connections to developed connections.
3. The alternation of lightness and darkness on the earth was seen to have resulted from the turning or revolving of the Earth in the Earth's orbit.
4. The alternation of lightness and darkness and the succession of seasons have been seen to have resulted from the rotation of the Earth around its axis once every 24 hours while the Earth revolved around the Sun, a circuit around the Sun taking place once a year.
5. In conceptual models in which before the use of the simulation the Sun revolved around the Earth, after the learning and exploration period, the Sun no longer revolved around the Earth.

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The Development of Intelligent Learning Environment for Supporting Meta-Cognition Enhancement

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Abstract: The purpose of this study is to construct a Companion Agent Learning Environment within the framework of a multi-agent system. The expected result is that by installing the Computer Companion (as one of agents), a real(human) student will be able to get a deep understanding of his/her own ability for problem-solving through observation and reflection. For such a learning process, recognizing the state of the peer agents accurately(meta-cognition ability) is required. For supporting the enhancement of meta-cognition ability intelligently, it is required to build a model which shows how a real student recognizes the state of companion agents. Therefore, the main purpose is to build a companion agent's understanding model. Based on this model, we constructed a system that evaluates a real student's meta-cognition ability and thus intelligently supports the enhancement of meta-cognition ability.

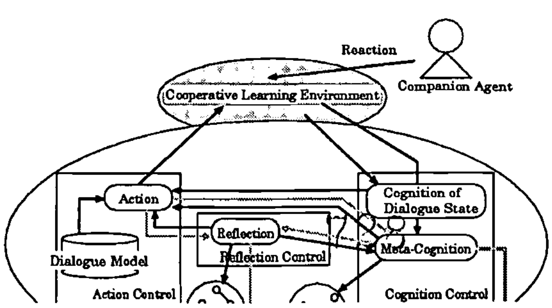
INTRODUCTION

The purpose of this study is to construct a Companion Agent Learning Environment (CALE) within the framework of a multi-agent system. The expected result is that by installing the Computer Companion (as one of agents), a real (human) student will be able to get a deep understanding of his own ability for problem-solving through observation and reflection. For such a learning process, recognizing the state of peer students accurately(meta-cognition ability) is required, as a student learns behavior which he judges to be necessary for himself from the state of companion agents, recognized from his actions in a Companion Agent Learning Environment. If a student lacks the ability, he learns a wrong behavior, but at the same time, he can learn a correct behavior from errors made by peer student. For these reasons, we have developed an agent based mechanism for enhancing meta-cognition (i.e. monitoring the state of companion agents and also monitoring the recognition process).

For intelligently supporting the enhancement of meta-cognition ability, it is required to build a model which shows how a real student recognizes the state of companion agents. Therefore, the main purpose is to build a companion agent's understanding model. Moreover, the system visualizes this model so that a real student can be conscious of the real state of the companion agent, who's state he was trying to recognize, and may notice his own misunderstandings. In this way, this system supports the improving of the meta-cognition ability by making a real student redo the recognizing process, this time with more chances of success.

In this paper, we describe the fundamental components of a CALE, a method of modeling a companion agent's understanding model and the visualization of its model for supporting the enhancement of meta-cognition ability.

A LEARNING ENVIRONMENT FOR SUPPORTING THE ENHANCEMENT OF



META-COGNITION ABILITY

THE EFFECT OF LEARNING BY ENHANCEMENT OF THE META-COGNITION ABILITY

Figure 1: A Model of Interaction in a Cooperative Learning Environment

[Fig.1] represents an interactive model among the students in a cooperative learning environment. There are two ways for a student to learn in a cooperative learning environment as follows.

1. an acquisition of problem-solving knowledge by way of Meta-Cognition.
2. a fixing of problem-solving knowledge by way of Reflection.

1. is learning by observing a peer student solving and explaining a problem. A student acquires the necessary knowledge from understanding the state of a peer student, by observing his behavior. So, if a student cannot recognize the state of a peer student correctly, the effect of the cooperative learning will be reduced by a half. For this reason, it is necessary for a student to recognize a understanding state of a peer student correctly in a cooperative learning environment. 2. is fixing of problem-solving knowledge by way of reflecting upon the structure of ones own knowledge. An effect of an acquisition of problem-solving knowledge is not to be expected by reflection, but an effect of acquiring skill within the knowledge which a student already has. Reflection produces such an effect by not only problem solving and explaining, but also by using meta-cognition. So, for a student, being conscious of meta-cognition facilitates the fixing of problem-solving knowledge by way of Reflection.

COMPANION AGENT LEARNING ENVIRONMENT

We construct a CALE as in [Fig.2] for supporting the enhancement of the problem-solving and meta-cognition ability. The system has two agents. One is the Computer Companion(CC), which has incomplete knowledge in the subject area. The Computer Companion aims to enhance the problem-solving ability of a real student(RS) and himself through collaborative dialogue with the real student according to a Dialogue Model(i.e. by putting questions to each other, solving a problem together etc.). The dialogue of the Computer Companion has two objectives as follows.

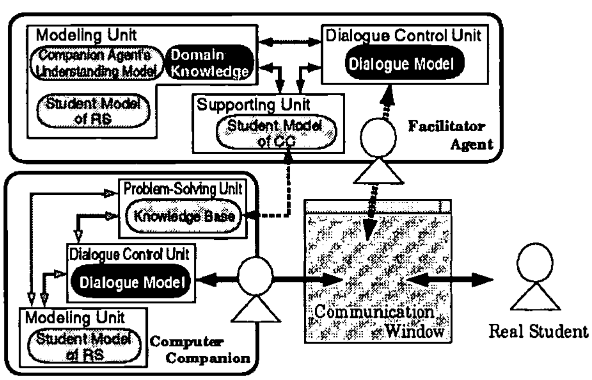


Figure 2: Companion Agent Learning Environment

- the enhancement of the problem-solving ability of the real student and the Computer Companion.
- getting information on how the Computer Companion's state is recognized by the real student.

In this study, we propose a dialogue model to make the Computer Companion behave as stated by the above two objectives. This model is formalized in predicate calculus to make it clear what the Computer Companion should do in each situation. We first describe the predicates used in the dialogue model. There are three kinds of predicates. The first kind shows a state of a problem such as ``*problem(P)*''(*P* is the current problem). The second kind shows a situation of learning such as ``*agent(A)*''(*A* is an agent who solves the problem). The last kind shows an action of each agent such as ``$explain_{A1}(A2, Operation)$''(agent *A1* explains to agent *A2* about *Operation* his own problem-solving knowledge). In this research, we prepared about twenty predicates and formalized a dialogue for each agent. For example, when the Computer Companion asks a question to the real student, one of the dialogue models is,

$$problem(P) \ \square \ prob\_cond(P,P\_cond) \ \square \ agent(CC) \ \square \ not(Know_{CC}\ (P\_cond, Operation) \ \square \square not(Neg\_Know_{CC}\ (Know_{RS}\ (P\_cond, Operation)))$$
$$\square \ ask_{CC}\ (P, Operation)$$

The intended meaning of the model is that the Computer Companion asks a real student how to solve a current problem *P* when it couldn't solve it and it doesn't know that the real student couldn't either.

The system adds and deletes primitive predicates in a working memory for recognizing the state of dialogue in a CALE whenever any agent does something. The Computer Companion behaves just right (i.e. points out, explains, asks a question etc.) in each situation defined by the dialogue model and the current working memory contents.

The other agent is the Facilitator Agent that is an expert in a subject area. The Facilitator Agent intervenes in the CALE only when a student asks for its help. The Facilitator Agent doesn't act, except when students reach an impasse and go in a wrong direction in the learning process. The reasons is that the educational effect in a cooperative learning environment is reduced to nothing, if the Facilitator Agent intervenes every time. So, the Facilitator Agent rejects any help message from a student in any other but critical situation. In this research, we formalized the interventions of the Facilitator Agent in predicate calculus in the same way as we formalized the behavior of the Computer Companion. Moreover, analyzing the dialogue between the Computer Companion and a real student, the Facilitator Agent builds and evaluates a Companion Agent's Understanding Model.

SUPPORTING THE ENHANCEMENT OF THE META-COGNITION ABILITY

MODEL OF UNDERSTANDING A COMPANION AGENT

The Facilitator Agent infers information on how the Computer Companion's state is recognized by a real student from the applied knowledge reasoned in the above way and the situation of dialogue obtained from the working memory. The way to infer the information is to use production rules which have conditional parts, including applied knowledge and dialogue situation[Kasai et al.1997]. One production rule, which gets information about the meta-cognition of a real student, is defined for each action of a real student and of the Computer Companion (expanding a problem, observation, question, explaining and pointing something out). For example, one rules is,

$$\text{if}(explain \ \& \ reduce \ \& \ \{ope_n\} \ \square \ \{f_m\})$$
$$\text{then } \{not\_know(Rule_n)\}$$
$$\text{else } \{know(Rule_n)\}$$

This is a rule applied in a situation when a real student explains to the Computer Companion away of solving a problem. In this rule $\{f_m\}$ is applied knowledge deduced by the Facilitator Agent and $\{ope_n\}$ is the operation list of the problem-solving knowledge Rule_n. It is possible to represent problem-solving knowledge by a problem-solving tree as in [Fig.3]. Problem-solving knowledge is defined by a set of one node and its child nodes in this problem-solving tree.

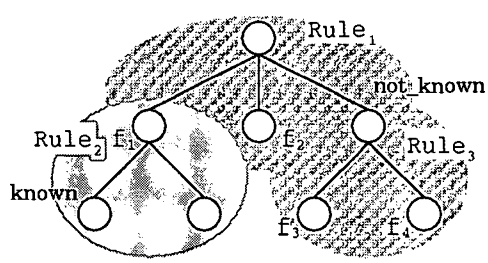


Figure 3: A Problem-Solving Tree

In this way, the system gets information on how the Computer Companion's state is recognized by a real student in each state of the dialogue.

THE METHOD OF SUPPORTING THE ENHANCEMENT OF META-COGNITION ABILITY

THE CONTROL OF A COMPUTER COMPANION'S DIALOGUE

A Computer Companion's dialogue is controlled when the information of about the meta-cognition of the real student is diagnosed as a mistake. The diagnosis is done by making a comparison with the actual problem-solving knowledge of the Computer Companion by the Facilitator Agent. When the information of about the meta-cognition of the real student is diagnosed as a mistake, its result is changed into the predicate ``*mis(Operation,How)*"(misunderstanding about *Operation*'s problem-solving knowledge such as showed by *How*) and sent to the Dialogue Control in Computer Companion. Then, the Computer Companion acts so that a real student can notice his own misunderstandings by means of a dialogue with the CC. In the following we show an example about how the Computer Companion actually acts when a real student's cognition is a misunderstanding.

When a real student explains something to the Computer Companion, the system diagnoses that the student's understanding about the CC's state is 'don't know', while the CC's actual state is 'know'. Then the Computer Companion answers to the student's explanation ``I have already known this!!". Such a dialogue with the Computer Companion can make a real student be conscious of meta-cognition. Moreover, it gives a hint to the real student to notice that his own cognition actually a misunderstanding.

VISUALIZING THE MODEL OF UNDERSTANDING A COMPANION AGENT AND COMPUTER COMPANION

In this paragraph, we describe how to visualize a Model of Understanding a Companion Agent and how this model is displayed for a real student. The system displays the model as a problem-solving tree as in [Fig.4].

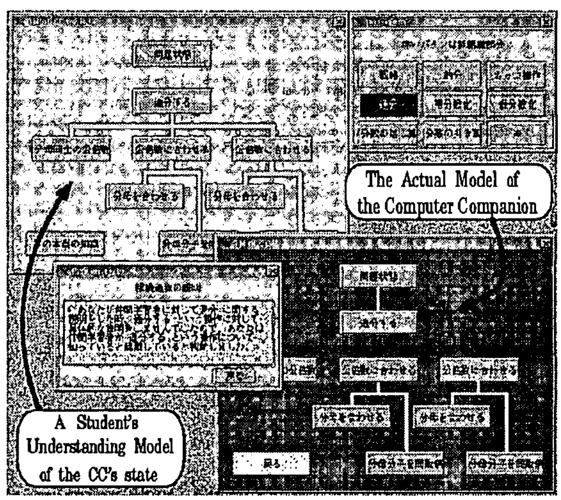


Figure 4: Visualization an information of meta-cognition

This problem-solving tree branches into sub-goals (i.e. mathematical fraction reducing, adding of fractions etc.). With this display, it is possible for the real student to confirm how the peer agent's state is recognized by himself at a glance. Each node of this problem-solving tree is a button which explains how the system reasons about this information, i.e., how a peer agent's state is recognized by a real student. This explanation has the educational effect that the real student reflects upon himself and evaluates each behavior for his own use. This function can support a real student in taking suitable decisions depending upon the state of a peer student in a cooperative learning environment.

Whenever the Facilitator Agent discovers a misunderstanding, the system changes the color of the button that has a sub-goal which includes this knowledge as shown in a right upper part of [Fig.4] so that a real student may notice immediately that he is recognizing the state of a peer agent mistakenly. We expect that the real student will try to ascertain the misunderstanding and will try to do the recognition, again.

In the above way, it is possible to expect that the real student is conscious of how the Computer Companion's state is recognized by himself and will try to ascertain a knowledge recognized mistakenly correctly again. But the result obtained after the second recognition is not necessarily always correct. According to circumstances, recognizing may reach an impasse, because a real student cannot recognize things accurately however often he may try. For this reason, we appended a function of visualization of the actual model of the Computer Companion and of the Companion Agent's understanding model as shown in [Fig.4].

If the system always visualizes the actual model of the Computer Companion, the educational effect of this study will be reduced to nothing, because the opportunity of recognizing the state of the Computer Companion from dialogue with him will be missing. So, we control the visualization of the Computer Companion's state with the following rule,

$$\text{if}(remodel(X_i, X'_i) \ \& \ misunderstanding(X_i) \ \& \ misunderstanding(X'_i))$$

$$\text{then } Manage(visual(Sub\_goal))$$

$$\text{else } Unmanage(visual(Sub\_goal)$$

$remodel(X_i, X'_i)$ means that a recognition X_i about a knowledge i is renewed as a new recognition X'_i; $misunderstanding(X)$ means X is recognized as knowledge, mistakenly; $visual(Sub\_goal)$ is a button to visualize the problem-solving tree of the *Sub_goal* which includes a knowledge i. With this rule, the system can judge that recognizing reaches an impasse when the real student can't recognize the same knowledge contents correctly for the second time, and will pop up a button which indicates a problem-solving tree if pressed by the real student, so if the demand exists. With this function, it is possible for a real student to understand the degree with which he misunderstood the Computer Companion's state by comparing his own recognizing state with the actual state of the Computer Companion, but can be activated only when recognizing reaches an impasse.

CONCLUSION

In this paper, we have described a CALE with the purpose to support the enhancement of the meta-cognition ability. For supporting the enhancement of this ability, in this research, the Facilitator Agent builds a Model of Understanding the Companion Agent, which shows how a real student recognizes the state of the Computer Companion. Moreover, we have described the way to support an enhancement of this ability by using a Companion Agent's Understanding Model. For the visualization of this model and the actual model of the Computer Companion, we can expect that the ability of recognizing a peer student's state is enhanced by being conscious of how he recognizes himself and modifying the misunderstandings.

Here we have to say, it is necessary to experiment this model first, in order to prove that this system can actually build a Companion Agent's understanding model accurately and can support the enhancement of the meta-cognition ability.

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A Knowledge Visualization and Its Evaluation

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Abstract: Visualizing the contents to be learned about an instructional material is an effective way to facilitate learning. However, the effectiveness is not always obtained only by looking at the visualized representation. The knowledge visualization accordingly requires learners to devote more attention it. Considering the context of learning a text, this paper gives an effective knowledge visualization called Diagram Tailoring, and demonstrates an intelligent learning system. This system presents part of a diagram as a visual representation, and encourages learners to construct the whole diagram so that their attention can be devoted to the visualized representation. This paper also describes an experiment on Diagram Tailoring. As a result, we have ascertained that partial diagram presentation makes a contribution to retaining knowledge to be learned from a text. Diagram Tailoring can be consequently viewed as an available way for allowing learners to obtain the intrinsic fruitfulness of knowledge visualization.

1. Introduction

Visualizing the contents to be learned about an instructional material enables learners to make sure knowledge which they are learning from the material, and to realize what has not been understood. Such knowledge visualization can be viewed as a fruitful way to facilitate learning [Merrill et al. 1992; Larkin and Simon 1987]. However, learners may only glance at the visualized representation, and may not elaborate on their knowledge with it [Barnard and Sandberg 1996]. In order to certainly get good results for learning with knowledge visualization, therefore, it is necessary to focus their mind on the visualized representation [Cox 1997; Kashihara et al. 1996].

This paper proposes an effective knowledge visualization which encourages learners to construct a visual representation by externalizing knowledge which they learn. In general, the knowledge externalization does not always occur because what to and how to externalize are often unclear [Chi et al. 1994; Cox and Brna 1995; Kashihara, Hirashima, and Toyoda 1995b]. Alternatively, the representation construction is not so easy because the learners may make excessive mental efforts which cause cognitive overload [Kashihara, Hirashima, and Toyoda 1995a]. In order to overcome these difficulties, we consider presenting part of the representation to be finally constructed. This corresponds to visualizing part of knowledge which they would learn. Such partial knowledge visualization gives the learners the directions what to and how to externalize, and contributes to reducing their mental efforts to complete the whole visual representation. In addition, moderate mental efforts of the representation construction will lead them to devote more attention to the visualized representation. The partial knowledge visualization can be consequently viewed as a fairly available way for allowing learners to obtain the intrinsic fruitfulness of knowledge visualization.

The technical issue in the partial knowledge visualization is how to decide which part of visual representation should be presented according to each learner. Considering the context of learning a text describing computer vocabulary, we have proposed an adaptive knowledge visualization called Diagram Tailoring [Kashihara et al. 1996]. This paper gives an overview of Diagram Tailoring, and demonstrates an intelligent learning system which accomplishes it. In this system, learners are encouraged to construct a diagram as visual representation. In order to facilitate such diagramming, the system presents part of the diagram so that the learners can elaborate on their knowledge with the presented partial diagram. This paper also describes an experiment on the basic idea of Diagram Tailoring which we have made compared with the whole diagram presentation. As a result, we have ascertained partial diagram presentation makes more contribution to retaining knowledge to be learned finally from a text.

We will first explain the knowledge visualization in learning a text in the next section.

2. Knowledge Visualization

2.1 Context

In this paper, we consider that learners learn a number of text describing computer technical terms in related order. In this situation, the learners are expected to identify the difference between and to classify the new term and the known terms they have already learned from the previous texts. Completing such an integration process can be viewed as building up a knowledge structure in mind [Chan et al. 1993]. Such knowledge-structuring process facilitates and deepens learning of a give text [Kashihara, Hirashima, and Toyoda 1995a]. The knowledge structure represents the contents which learners are expected to learn from a text.

2.2 Visual Representation

We provide a diagram such as IS-A hierarchical network with tables to visualize a knowledge structure finally constructed. Figure 1 shows a diagram which consists of three technical terms. A node in the diagram indicates a technical term, in which its name is described. The attributes with values which characterize the term are described in a table attached to the node. A link shows the relationship between nodes. There are two pre-defined links: difference link and *is a* link. Each link possesses its own table. This table describes the attributes which have different values between nodes.

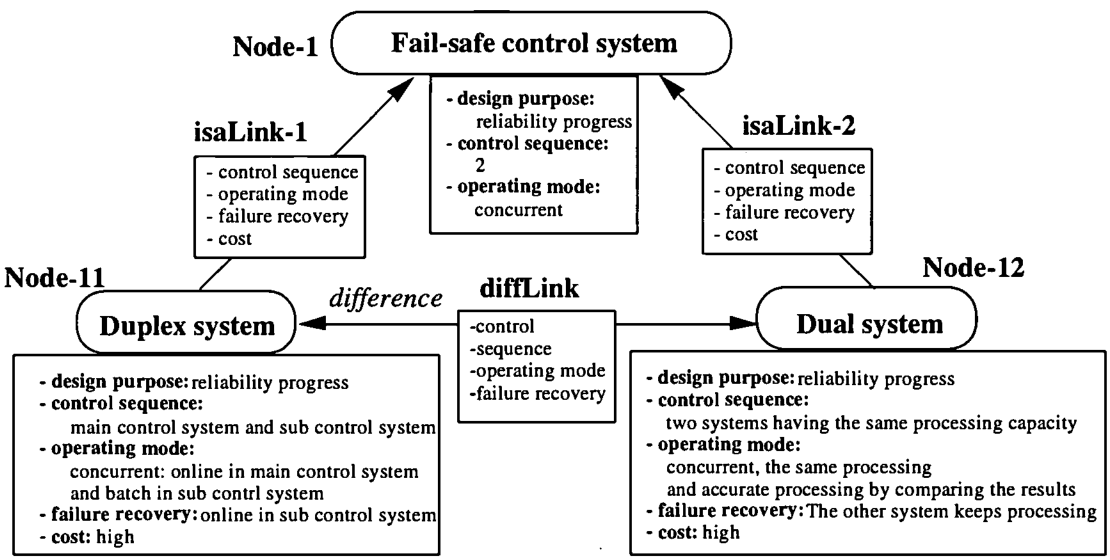


Figure 1: A Diagram

A text given to learners is represented as a sequence which consists of several units. Each textual unit gives a textual description of what attributes and values a component (node or link) includes. The text shown in Figure 2 has a textual unit sequence which consists of Duplex system (indicated by Node-11) and *is a* link between Duplex system and Fail-safe control system (indicated by isaLink-1).

The design purpose of duplex system is to enhance the reliability of the system. This system has two control sequences, called main control system and sub control system. These systems operate concurrently. The main control system usually executes online processing, and the sub control system executes batch processing as background processing. When the main control system fails, the online processing is kept on the sub control system. The cost of operating duplex system is high. **(Node-11)** The duplex system is a kind of fail-safe control system. The fail-safe system has two control sequences which operate concurrently. In the system, the failure recovery, operating, and cost are not considered. **(isaLink-1)**

Figure 2: A Text

Looking at a diagram with a text does not always enable learners to build up the knowledge structure in their mind. One way to lead them to structure their knowledge is to focus more attention on the diagram. Our approach to this problem is to encourage the learners to construct a diagram with a text and existing knowledge.

2.3 Representation Construction

The diagram construction process involves the following three mental operations: textual unit extraction from a text, related knowledge retrieval, and inference. These operations are externalized by making tables attached to nodes or links. The first operation requires learners to focus on keywords in the text to identify the components corresponding to the textual units. The second operation requires them to recollect related knowledge. The third operation requires them to distinguish and classify the identified textual units and the recollected knowledge to generate nodes and links. To generate a link, they particularly need to compare a node with the other node. The comparison involves discriminating, categorizing, or instantiating the attributes. To generate a node, they also need in some situations to differentiate and in other situations to generalize or specialize attributes (or values).

The amount of the mental operations can be viewed as cognitive load. There are three kinds of load in diagramming: the load of textual unit extraction, the recollection load and the inference load. Confronting each load contributes to retaining the knowledge structure built up [Kashihara, Hirashima, and Toyoda, 1995a]. However, the diagram construction is not so easy for some learners since it may impose cognitive overload on them. Therefore, we need to adapt the load to each learner. This adaptation corresponds to Diagram Tailoring.

2.4 Partial Knowledge Visualization

The basic idea of Diagram Tailoring is to present part of a diagram to reduce the load of constructing the whole diagram. The important point is how to decide which part of the diagram should be presented.

A diagram to be constructed consists of three parts: the part to be composed by extracting keywords from a text, the part composed by recollecting related knowledge, and the part to be inferred. We call these parts, text-scope, knowledge-scope, and inference-scope of the diagram. The basic procedure of Diagram Tailoring is as follows. When learners are expected to have difficulty in constructing a diagram, the text-scope is presented as partial diagram. When they are expected to have more difficulty, the knowledge-scope is also presented in addition to the text-scope. This intends to reduce the textual unit extraction load or recollection load, and to focus their still more attention on the inference scope. The inference operation requires the learners' attention not only to the inference-scope but also to the text-scope and the knowledge-scope. It is therefore the most important operation for calling the learners' attention to the diagram. That is why reducing the inference load is not considered.

3. Knowledge Visualization System

3.1 Interface

We have already implemented an intelligent tutoring system with a graphical user interface shown in Figure 3. Looking at a text, learners can construct a diagram by mouse-selecting NODE and LINK buttons. They can also use tables attached to these components as supplementary means. The attributes and their values to be described in the tables are prepared as menus. The learners can select words from the menus and put them into the tables.

When the learners reach impasses, they can receive supporting information by pushing Q/A button. The occurrence of the impasses is recognized when they are asked or an interval between the operations is longer. Although some learners may also make mis-diagramming, the system does not currently distinguish the support for their mis-diagramming from the impasse support.

3.2 Framework

We will next give an overview of Diagram Tailoring. The detailed explanation of Diagram Tailoring is omitted in this paper [See Kashihara et al. 1996].

Providing a number of computer technical terms in related order, the system exercises learners in constructing a number of diagrams. In the exercise, the system builds up and updates learner models representing the capabilities of textual unit extraction, recollection, and inference. These capabilities are diagnosed according to the number of impasses which learners cause in text-scope, knowledge-scope, and inference-scope of a constructed diagram. In other words, the fewer impasses learners result in, the higher their diagramming capability is. The learner models are used for Diagram Tailoring.

In the diagramming exercise, Diagram Tailoring is executed for each diagram construction. The system first decides a diagram as learning goal in consideration of the technical terms a learner has known. The system next generates a text including some components in the diagram. The system also estimates the diagramming process that the learner is expected to perform with the text and existing knowledge. Considering his/her diagramming capability and the diagramming load estimated from the process, the system then decides which part of the diagram should be presented.

The learner is next asked to complete the whole diagram. If the learner reaches an impasse, the system provides the supporting information as a text or as another part of the diagram. Using the monitored information, the system updates the learner model to adapt Diagram Tailoring for the next diagram construction in the diagramming exercise.

3.3 Examples

Let us show an example of Diagram Tailoring as shown in Figure 3. In this example, we assume that a learner has known the term of Dual system, and the system generates the text as shown in Figure 2. When his/her capability of textual unit extraction is diagnosed as low, the system displays the text-scope of the diagram as shown in Figure 3. In this case, the learner is encouraged to recollect Dual system and to infer the node of Fail-safe control system and the *is a* link between Dual system and Fail-safe control system although he/she does not need to extract keywords from the text. If his/her capability of recollection is moreover diagnosed as low, the system displays still more the node of Dual system in addition to the text-scope, and he/she is encouraged only to execute the inference operation. In this way, Diagram Tailoring individualizes a displayed diagram according to learners' diagramming capability.

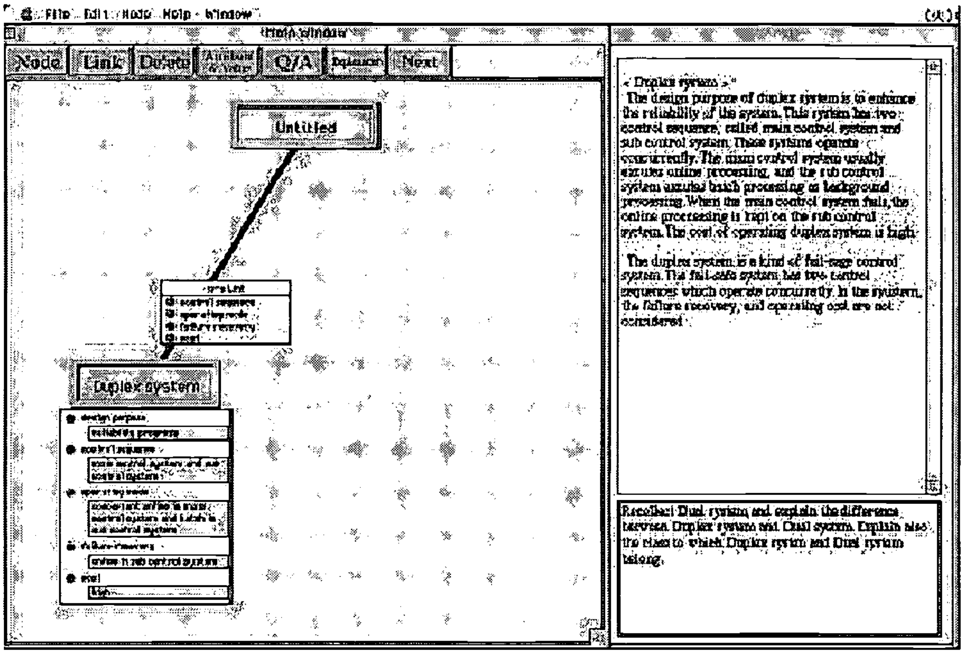
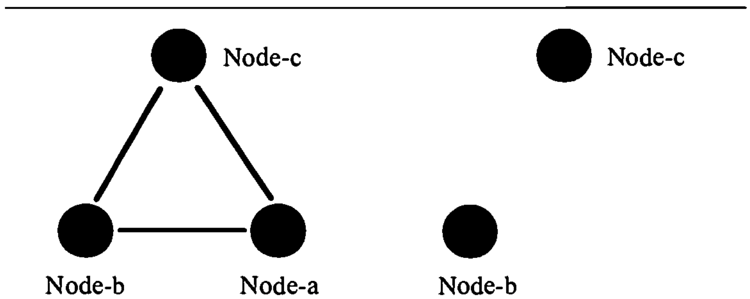


Figure 3: Examples of Diagram Tailoring

4. Evaluation

In this section, we will explain an experiment on the basic idea of Diagram Tailoring that we made. The main purpose of the experiment was to ascertain if completing a diagram with the presented part of the diagram is more effective for learning than just looking at the whole diagram without diagram construction. The learning effect was measured by retention of the diagram [Barron and Atkins 1993]. Tailoring the partial presented diagram to each learner is not considered in the experiment.

A diagram was composed of three nodes as shown in Figure 4 (a). Each node included 4 attributes. Each link included 2 different attributes between nodes. Subjects were 14 graduate and undergraduate students. We set two conditions. These were as follows: (1) the whole diagram presentation, and (2)the partial diagram presentation. In order to make each subject learn a text on each condition (within-subject design), we prepared two similar diagrams although these describe different domains. The influence of the domains on the results was counterbalanced.



(a) The Whole Diagram Presentation **(b) The Partial Diagram Presentation**

Figure 4: Diagram Presentation in Experiment

The experiment was done with the system as follows. The system first displayed a text which described a node indicated by Node-a, and required a subject to carefully read it. The aim of this careful reading was to make him/her acquire knowledge about Node-a.

On the first condition (Condition-1), the system next displayed a text which described all components of the diagram and the whole diagram such as Figure 4(a). The subject was then required to carefully read the text and to look at the diagram.

On the second condition (Condition-2), the system displayed a text which described Node-b and Node-c, and the partial diagram including Node-b and Node-c such as Figure 4(b). The subject was then required to complete the whole diagram by recollecting Node-a, and by inferring other components. When the subject reached impasses or made mistakes, he/she was given correct attributes with values. Learning on each condition took the same time (about 30 minutes).

After two hours, a retention test was conducted. In this test, each subject was requested to reconstruct each diagram with the system. The perfect score was 21. Table 1 shows the average score and standard deviation of the retention on each condition. The average score on Condition-2 was quite higher than the one on Condition-1. In addition, we performed an analysis of variance on the retention test. The result indicated that there was a significant difference between the average scores ($F(1, 13)=28.52$, $p<.01$). From this result, it was ascertained that the partial diagram presentation accompanied by the diagram construction made more contribution to reinforcing the retention of the visualized diagram than the whole diagram presentation.

Learning	The Whole Diagram Presentation Condition-1	The Partial Diagram Presentation Condition-2
N	14	14
Mean	5.14	12.93
SD	2.66	5.01

Table 1: Scores in Retention Test

Nevertheless, there were four students on Condition-2 whose scores of the retention test were less than 10. This indicates that the presented partial diagram and the diagramming operations required are not adapted to them. This finding implies that it is necessary to tailor the partial diagram to be presented according to each learner.

5. Conclusion

In this paper, we have claimed that visualizing knowledge should be accompanied by letting learners construct the visual representation. Following this claim, we have proposed a knowledge visualization with representation construction called Diagram Tailoring in learning a text. This paper has also demonstrated a system which has been already implemented. The system provides a graphical user interface in which learners can externalize knowledge learned from a text to construct a diagram. In order to facilitate the diagram construction, the system presents part of the diagram properly with the learner models which represent their capability of diagramming. The Diagram Tailoring technique makes the knowledge visualization more effectively since it leads the learners to devote attention to the visualized representation. In addition, we have evaluated the partial diagram presentation compared with the whole diagram presentation. As a result, it made more contribution to retaining knowledge learned from a text.

In our future work, we will apply the Diagram Tailoring technique to other learning contexts to make clear the limitation.

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A Mechanism for Knowledge-Navigation inHyperspace with Neural Networks to Support Exploring Activities

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Abstract : We propose a mechanism for the knowledge navigation based on the sub-symbolic approach to decide the appropriate navigation strategy. A neural network was used as a navigation strategy decision module in that system. Hypermedia is a tool for user-driven access to information. Adaptive hypermedia is a new direction of research within the area of user-adaptive systems. It provides an effective learning environment, where users can acquire some knowledge by exploring the hyperspace in their own way. Still, users often tend to ``get lost" in the hyperspace. Often, we have cases of redundant or sub-optimal path. To improve these undesirable redundancies, we have to construct a sophisticated hypermedia system which can identify the user's interests, preferences and needs and give some appropriate advice to the user in his/her exploring learning process.

Introduction

In this paper, we propose a user model that represents exploring activities in hyperspace and a mechanism based on a sub-symbolic approach, to decide appropriate navigation strategies. Hypermedia is a tool for user-driven access to information. It provides an effective learning environment, where users can acquire knowledge by exploring the hyperspace in his/her own way. But, users often tend to *get lost* in the hyperspace. Often there appears the phenomenon of redundant information access. To improve these undesirable effects on users, many researches have been working to construct sophisticated hypermedia systems which can identify the user's interests, preferences and needs and give some appropriate advice to the user in his/her exploring learning process.

Adaptive hypermedia is a flexible system which infers the learning goal of the current learning state, by using the exploring history, the structural characteristics of the hypermedia a.s.o. As a result of its inference, this system changes its own performance to adapt to the user. Brusilovsky classified the adaptive hypermedia systems from the point of view of the methods and techniques of adaptation [Brusilovsky 1996]. According to his paper, the methods for adaptation are of two types. One is the content-level adaptation. This method changes the contents of the node which the user will refer in next step. This type is also named adaptive presentation system. The other one is the link-level adaptation. This method changes the links in the current node. This is also named adaptive navigation support system.

We have developed an adaptive educational hypermedia system based on the sub-symbolic approach with two types of adaptation, the link-level adaptation and the content-level adaptation. In cases of educational use, usually, as the exploring aim of students is usually fixed by a teacher in advance, frequent interactions with the system may be obstacles for the free exploring learning of a student. This paper also describes the training procedure of the neural network and its result. The paper is structured as follows. In the next section we describe the indicators that evaluate the users' exploring activity in hyperspace and the goal and content of each navigation strategy. The details of the hyperspace structure, which is expected to be the environment of the exploring learning process, are presented in this section. In third section, the configuration of the navigation system is described. In fourth section the structure and the learning of the neural network, the expertise of the navigation and the learning results of the network are described. In fifth section the validity of our navigation system is described and in a concluding section we give some final remarks.

Hyperspace structure

Student exploring states

In this research, our purposes in giving guidance to the students for navigation towards their learning goal is *to support the smooth progress of the exploring study*. As a result of the observation of the exploring behavior of students and after interviewing them, undesirable cases, which are likely to happen during the learning process, are classified as follows.

- *blind in hyperspace*
- *lost in hyperspace* [Nielsen, 1990]
- *redundant or sub-optimal references in hyperspace*

Blind in hyperspace are the students who do not know how to follow the links to go to the target nodes. The target nodes are not read before. The students can not infer the relation between the current node and the target nodes. *Lost in hyperspace* are the students who do not know the relative position of the current node and referred nodes. *Redundant or sub-optimal references in hyperspace* are taken by students who follow a longer path than necessary to go to the target nodes or to achieve their learning goals.

Two types of data are needed, to distinguish between the students who are in the undesirable learning states we described above, and the other students. They are physical information on the exploring activity (e.g. reading or reference time, number of referred nodes, topics a.s.o) and semantic information on the exploring activity (e.g. degree of importance of the referred node, degree of relation between two nodes a.s.o). From these information, from the behavioral features of students in undesirable states and from the structural model of the hyperspace, we defined six indicators which represent the exploring activities in hyperspace [Kayama *et al.* 1997]. The labels and meanings of each indicator are shown in **Table 1**.

The needs of the students who are in undesirable states are considered to determine the strategies which will support their smooth progress during the exploring study. The structure model of the teaching material and the methods of presentation of the needed information are also considered, in order to develop the six knowledge navigation strategies. The labels and functional details of these strategies are shown in **Table 2**. Our system makes its adaptation by using both methods, the link-level adaptation and the content-level adaptation. To the first type of adaptation belong UOS and REH, to the other type MEC, FEC and CEC. The adaptability of our system is increased by including both types of adaptation.

Table 1: The indicators of the exploring activities and their computation ways

1	validity of the reference (VR)	combination value of the importance of the already read nodes and the degree of relation between referred link and current node
2	exploring stability (ES)	variance of the reading (reference) time of all referred nodes
3	rate of understanding (RU)	mean value of the frequency of the reference of all referred nodes
4	rate of glanced nodes (RGN)	ratio of nodes only glanced at, to thoroughly referred nodes
5	rate of surface understood topics (RSUT)	ratio of topics, whose number of referred nodes is less than the ideal ratio of referenced nodes, to all topics
6	rate of favorite topic (RFT)	ratio of the nodes in the topic, which has the maximal number of referred nodes, to all referred nodes

Table 2 : The knowledge navigation strategies

1	understanding the outline schema (UOS)	displays the hypermedia structure of the current teaching material (c)
2	magnification of the exploring concept (MEC)	recommends a node which has a link with the highest degree of relation to the current node (l)
3	focusing on the exploring concept (FEC)	recommends the unread nodes in the topic which has the maximal number of referred nodes (l)
4	changing of the exploring concept (CEC)	recommends the unread nodes in the topic which has the minimal number of referred nodes (l)
5	recognition of the exploring history (REH)	displays the explored nodes in order (c)
6	retreat (R)	recommends a node which has the greatest number of links among already referred nodes (l)

The structure model

This teaching material is organized as a two class model. The first one is a node class, which is a real hypermedia. The second one is a topic class. The nodes which have a semantic relation to each other are included in the same topic. This structure depends on the teaching style of each teacher, not on

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Figure 1 : The partial structure model oh the hyperspace

the contents or domain of the hypermedia system. The components of the teaching material (e.g. topic, node and link) are also depend on the educational point of view of the teacher (e.g. learning goal). **Figure 1** represents the structure model of the hyperspace. The attributes of each component of the hypermedia system are shown.

A *topic* has two attributes. One is the set of nodes which are included in it. The other one is the ideal ratio of referred nodes (IRR). The IRR is calculated as the ratio of the minimal number of nodes, which are needed for understanding the point of a topic, to all nodes in the current topic. A *node* has four attributes. They are identification number (ID), degree of importance (DI) and the standard and minimum necessary time for reading (SNT, MNT). The ID is a unique number in a hypermedia. Stored, this attribute shows the exploring history of a student. DI is defined as the degree of contribution towards the achievement of the current learning goal. Its values are integers from 0 to 5. SNT is the standard time necessary to understand the contents of the current node. This time is used to evaluate the exploring behavior, to judge whether it is effective to achieve the current learning goal or not. SNT is a useful indicator that evaluates the effectiveness of the node for the user and is used to evaluate the exploring behavior quantitatively. The last attribute, MNT, is the time needed for just glancing at the contents. These two attributes are represented in seconds. The minimum value is 1(sec) and the maximum value is not limited. A *link* has only one attribute, the degree of relation (DR) between two nodes. DR is defined as the strength of the relation between the contents of linked nodes. Its values are integers from 1 to 5. This value is used to evaluate the efficiency of referring that link between the nodes.

The knowledge navigation system which we have developed supports an educational hypermedia system with all of the attributes mentioned above. So, the teacher who wants to use our navigation system needs to arrange his/her hypermedia which is used as a teaching material. There are no limitations or rules to set concrete values for each attribute. Using those attributes of items of the hyperspace, we describe the formulas of each of the indicators mentioned above.

System configuration

Our navigation system has five modules and two databases and is shown in **Figure 2**. These modules are named as follows:

- *the exploring data recording module (EDRm)*
- *the exploring activity evaluation module (EAEm)*
- *the navigation strategy decision module (NSDm)*
- *the definite contents building module (DCBm)*
- *the navigation guide visualization module (NGVm)*

The databases are *the history exploring database (HEd)* and *the hyperspace structure database (HSd)*. The system interferes only when the user wants to be guided in determining his/her next exploring activity. The prototype system is working and the selected theme for the teaching material is ``The positioning at tennis (for doubles)".

Each exploring state (ID and reference time) of a student is recorded by the exploring data recording module as a piece of the history exploring database. When a student requests navigation guiding from the system, the exploring activity evaluation module develops the model of the current

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Figure 3:An example of navigation

state of the student. This model is expressed by the six indicators which were mentioned in the second section. The student model is handed over to the next module, the navigation strategy decision module, which contains a neural network as an classifier engine. Only one navigation strategy is selected by the navigation strategy decision module from the output of the neural network. The calculation mechanism of this module is described in the next section. The definite content of the navigation guidance information is created in the definite contents building module by using the strategy determined by the neural network engine and the knowledge of the hyperspace attributes from the hyperspace structure database. Then, the results of the processing are shown to the student by the navigation guide visualization module as the current navigation guidance information.

Figure 3 shows an example of navigation guidance information. The guidance message and recommended nodes are given to support the decision about the student's next exploring activity.

Navigation strategy decision module

The algorithm and input data of the neural network

In this research, a sub-symbolic approach is taken to develop the navigation strategy decision module. To infer the appropriate navigation strategy, the expertise on knowledge navigation is learned by a supervised neural network. This expertise is formed by the pair of learning state of the student and adapted strategy, which should help him/her find the right exploring path.

By using this sub-symbolic approach with the neural network, it is possible for the system developer to improve the flexibility and the generality of the mechanism of the navigation strategy decision processes. In case of using a sub-symbolic approach, the extraction of the expertise is equivalent to the collecting of the training data for the neural network. The training phase of the neural network means the arrangement of the expertise. These embedded processes make the task of experts and system developers easier. The neural network which is used as the classifier engine in our system is a supervised multi-layer feed-forward model. The engine learned pairs consisting of possible student states in exploring learning and the appropriate navigation strategies, by using the back-propagation (BP) learning rule. The BP is one of the most famous supervised learning rules. The input pattern is the student's learning state and the output pattern is the corresponding navigation strategy.

Extracting expertise on navigation from experts

The pairs of learning state and navigation strategy are prepared from the results of experiments whose subjects are experts in the given field of education. These five are all educational experts who have made hypermedia teaching materials and used them in their classes. These pairs of data are teachers' expertise on navigation. We call this expertise the navigation knowledge. The extracted knowledge is used as training patterns for the neural network. In preparation for this experiment, experts are given the explanation of the means and the ways of calculation of each exploring indicator, and the ways of navigation for each navigation strategy. Experts' understanding of the indicators and navigation strategies is confirmed by researchers. At the experiment, according to the questionnaire method, the sets of learning states are gathered from experts. The experts are required to answer in pairs of learning state and suitable navigation strategy. Also, the experts attach to each learning state grades for the indicators. During this process, learning states which are not needed to express a certain strategy are allowed to be included in the experts' answer. In this way, we reduce the mental load of experts during the extraction of their expertise.

In the process of arranging the results of this experience, all learning states are classified. The results are looked at **Table 3**. The learning states extracted are the ones computed by selecting the answer of the majority from the collected results. The rest of the data are classified as being *redundant* states for the navigation.

Table 3 : The extracted navigation knowledge

redundant	**390**						
necessary	**399**	UOS	MEC	FEC	CEC	REH	R
		9	81	60	90	18	81

The neural network structure

This network has three layers. The input layer has twelve units. One indicator is assigned two units so that three grades of evaluation can be expressed. The output layer has 7 units. These represent the six navigation strategies and the *redundant* output. The number of the hidden layer units are determined by successive training simulations. The final number of neurons in this layer is the number which assures the highest performance. Moreover, other parameters are needed to be tuned in order to achieve a better efficiency of the network. These network parameters are the learning rate and the momentum. The fine tuning parameters of the network are 1) number of units in the hidden layer is 16, 2) learning rate is 0.3 and 3) momentum is 0.5.

All of the navigation knowledge is learned by the neural network. It means that this trained neural network can decide upon an unique appropriate navigation strategy for each exploring state at the rate of 100%. The trained neural network is used as the classifier engine of the navigation strategy decision module. The learning process of the network is the process of implementation of the navigation strategy decision module. When the navigation strategies are changed or the relation between the learning state and the appropriate navigation strategy is changed, the system developer has only to retrain the neural network. The training of the network has to be done before replacing the old inference engine with the new one.

Examples of the user model

An investigation was made on several real users to evaluate the appropriateness of the student model. The real users were graduate and undergraduate students who have played tennis for a few years. To evaluate the appropriateness of the student model in our system, we have been recording data about users' exploring activities and about the navigation guidance information for fourteen days. Data which we have recorded are 1) the student's exploring state when he/she requests the system to give a navigation guidance, 2) the name of the navigation strategy applied for the user, 3) the shown navigation guidance (guidance message and recommended nodes or topics), 4) the node IDs which are accessed in the next step and 5) the reason for having demanded navigation guidance. 25 users have used the navigation system during this experiment. Navigation guidance was requested in total for 154 times. The mean time of learning with our system was 37 minutes per student.

Hyperspace structure of the teaching material

A fragment of the new hypermedia structure on tennis is shown in **Figure 4**. The topic layer (in the rectangle) is represented as a tree structure. The gray-outed part is a node layer.

Appropriateness of the student model in the navigation system

Path in **Figure 4** shows an actual path of students' exploring. The nodes with the circled numbers express the nodes searched by the students. The students who follow the path are searching for items relevant to each node one after another. Taking this Path, we describe the results of the evaluation of the exploring activities of our system. As results, 1) the values of six exploring state indicators, 2) the applied navigation strategy, 3) the shown messages for navigation guidance, and 4) the recommended nodes (or topics) are shown.

Path: (1 - 2 - 3 - 4 - 8 - 9 - 10 - 7)
This path shows a searching for nodes which are relevant to the previously accessed node, one after another. The navigation guidance was demanded when there were no interesting nodes any more or when the user could not find any more nodes related with his/her learning goal. The result which the system estimated is as follows.

As a result of referring the nodes which were of related contents one after another, the RSUT has become high and RFT has become low. The low value of the VR is due to the low importance of the accessed nodes. The navigation strategy which was applied to this student is the FEC. The navigation guidance information for the student is shown in **Figure 5**. The shown navigation message was ``You have referred nodes on many topics. How about learning more details on a specific topic?". The topics of the accessed nodes were recommended as a next destination to explore.

Conclusion

The exploring behavior which needs navigation guidance is collected from the results of the observation and the interview of the exploring students. Then, indicators which express the students' exploring states and the navigation strategies are constructed. The user model is developed by using these indicators in our navigation system. The navigation knowledge is extracted from education experts. Their knowledge is structured as pairs of exploring state, navigation strategy. The learning states which represent redundancies are considered in the process of pruning of input data. The expertise is learned by a three layer feed-forward neural network. As a result, the navigation strategy decision module in the navigation system is created.

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Evaluating Collaborative Learning using BBS - focusing on questions of learners

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Abstract: The goal of this study is to find out the cognitive activities which can act as a measure for evaluating whether collaborative learning develops effectively or not. I propose that one of these activities is learners' spontaneous questions. I describe a question model and report the evaluation of two case studies which use it. In each case, study students were given different tasks. One is creating a HomePage for virtual audience, the other is for real audience. As a result, this study has pointed to the influences that a task has and how it may help promote cognitive activities

1. Introduction

The socio-cultural approach has influenced education. Learning theory has changed from "transferring knowledge" to "constructing knowledge"(Scardamalia & Bereiter 1996). The latter means aiding learners in constructing knowledge for themselves rather than transferring knowledge by giving self-sufficient drills and practice tasks. The socio-cultural approach considers that learners are active rather than passive participants.

In this academic shift, there are many case studies of collaborative learning which have been designed to assist learners to construct knowledge for themselves. They include collaboration with experts, collaboration with peers, cooperation and so on. In Japan, most of the case studies is called "project learning". In project learning, learners are given puzzles or problems to solve and summarize collaboratively. However, during project learning learners limit themselves to gathering information, instead of actively solving the task. This is not the proper role of project learning. Project learning should lead to educational effects, such as gaining new knowledge, acquiring new skills for problem solving and so on.

On the other hand, there are several case studies of collaboration which have reported positive expectations (Scardamalia & Bereiter, 1991, Scardamalia & Bereiter, 1996, Merril,Reiser,&Merrill 1995). These case studies suggest that there are activities which are related to effective collaborative learning, such as conflict between learners, learners' explanations and so on.

The present goal of my study is to find out the cognitive activities which can act as a measure by which one can evaluate whether collaborative learning develops effectively or not. Questioning is one of these activities, specifically learners' spontaneous questions. Learners' questions can be observed; these questions represent the learners' cognitive activities. What learners ask others or themselves allows them not only to obtain information from each other's answers but also to progressively organize their necessary existing knowledge structures during the production of their questions. Questioning enables learners to externalize to others how they understand the concept underlying their questions and how it is integrated in their existing knowledge structures.

However, spontaneous questions only occur if some conditions are met. One of the conditions is that a learner is not left as a passive learner, that is a learner takes the initiative for the task in hand, and, in so-doing, learners should learn the knowledge and skills that are necessary for doing it, furthermore learners should spontaneously produce diverse primitive questions during their learning .

In this paper, I describe a question model which can act as a measure for evaluating collaborations, and I report the evaluation of two case studies which use it. In each case study, students were given different tasks. One was writing a report for virtual audience, the other was for real audience. When they had spontaneous questions, they participated into the collaborative learning between different academic departments using BBS(Bulletin Board Services), by which I can observe the students' questions and the tutoring techniques. In part two, the further analysis of questions which learners asked in the previous case study and a question model are described. In part three, two case studies and the evaluations will be described.

2. Understanding cognitive activities through questioning transformations

Recent studies of successful tutoring demonstrate tutors' tutorial guidance such as sophisticated strategies, techniques and so on. This guidance allow an extremely effective style of learning(Merril, Reiser, Merrill, and Landes 1995). Therefore it is undoubted that the tutors' guidance might improve the students' cognitive activities.

In my previous case study, which was cross-aged tutoring(Kayashima 1997), tutors criticized vague questions and recommended better ways of formulating inquiry. Tutors aided tutees to formulate inquiry, rather than simply offering the necessary knowledge. This advice transformed some of tutees' questions into questions to confirm their hypotheses. This advice implies that tutors monitored what cognitive activities tutees did through their questions, such as tutors recognizing a vague question as a question which tutees asked before they thought reflectively. In addition, the questioning transformation implies that this advice improved tutees' cognitive activities. Hence it may be possible to understand learners' cognitive activities by such analysis of their questions as tutors analyzing. Furthermore, the analysis may lead to a standard question model which represents learners' cognitive activities.

2.1 The analysis of questions

I can analyze and categorize tutees' questions into "*questions that request information*" and "*questions that confirm interpretation*". *Questions that request information* are questions that ask others to give their interpretation without attempting to integrate it themselves. For example, "let us know about ...". These questions asked tutors to explain "simply" or "using effortless interpretation". These imply that although tutees were aware of some necessary knowledge, they did not attempt to integrate it into their existing knowledge structure. This activity does not involve a reflective activity.

Questions that confirm interpretation are questions that learners ask in order to confirm their own interpretation(hypothesis). For example, one of the students in the study, when involved in learning about the binary system, asked the following : " I suppose that all information is represented as one or zero. If so, is hiragana or katakana[1] represented as one or zero?". This implies that the tutee attempted to integrate a new concept into her existing knowledge structures. However, her cognitive activity was not sufficiently developed and her knowledge was not enough to confirm her own interpretation. Therefore she asked others to confirm whether her interpretation was correct or not. *Questions that confirm interpretation* mean that tutees depend on others' cognitive activities and others greater knowledge instead of their own.

At the beginning of the tutoring, all students asked *questions that request information*. However, some of the students shifted to *Questions that confirm interpretation* after the tutors criticized and advised. Here is an example of a tutor's piece of advice; "I guess you are unsure about how to ask for help. When I was a junior student, I asked questions like yours..... You should make uncertain things clear when you ask somebody". This advice, that instructed students on how to ask questions, guided learners to try to integrate a new concept into their existing knowledge structure by themselves.

2.2 The Question model

The above-mentioned questions bring out that the ascent to cognitive activity is made in two basic phases. The novice learner takes the first phase toward the awareness of some knowledge. The second phase brings about the integration of some knowledge into their existing knowledge structure. The second phase is an ascent to higher level than the first phase. These are shown in Table 1.

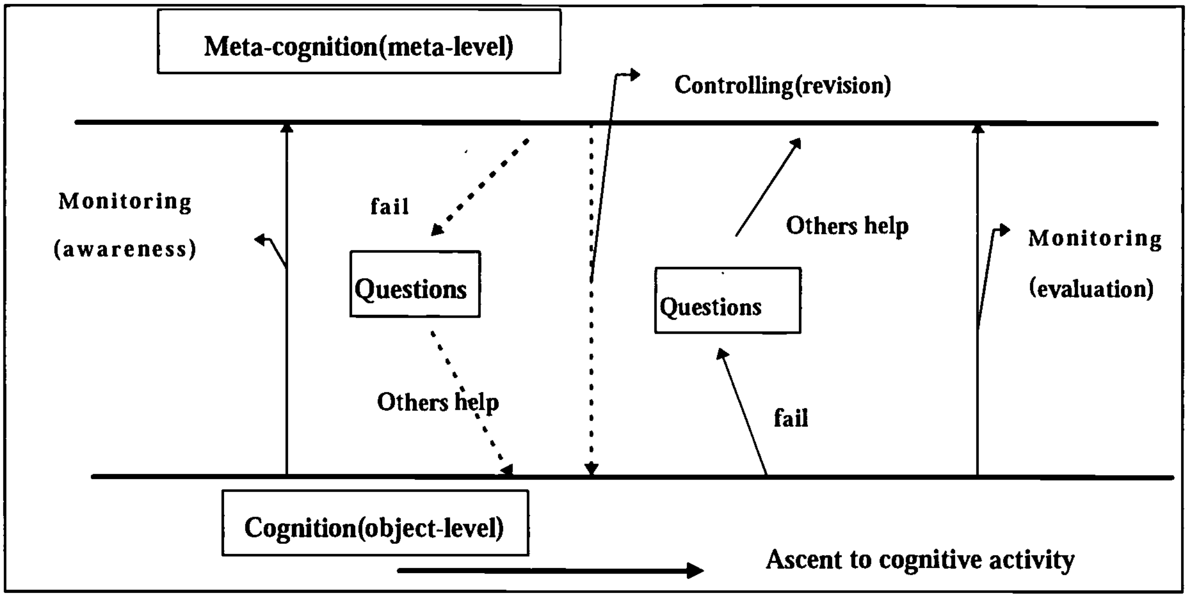
kinds of question	*ascent to cognitive activity*
questions that request information	awareness of some knowledge
questions that confirm interpretation	integration of it into existing knowledge structure

Table 1 Kinds of question and cognitive activities

Nelson and Narens developed a definition about meta-cognition(Nelson & Narens 1994): A monitoring is a *meta-level* (meta-cognition) that obtains some information from an *object level*(cognition), and a controlling is a *meta-level* that revises an *object level*. In the first phase, learners could do their monitoring, that is, obtain some information from an *object level* according to the definition. However, they failed their controlling, that is, could not revise an *object level* such as their existing knowledge structure. Hence they asked others for help in revising it. Others' advice should enable some of learners to revise it. In the second phase, learners did their controlling, that is, attempted to revise an *object level*. However, they failed their monitoring, that is, could not evaluate information from an *object level*. Hence they asked others for help in the evaluation of their controlling. Others answers should enable some of the learners to evaluate their controlling.

[1] Both Hiragana and katakana is Japanese character.

Figure 1 Question model on learning



This mechanism implies that learners' meta-cognition, which includes a monitoring and a controlling, is done by others' help and steadily develops. Hence questioning represents what cognitive activity learners need, that is, what cognitive activity learners could not work when they asked. This is consistent with Vygostky's claims: "Every function in the child's development appears twice, on two levels. First, on the social level, and later on the psychological level; first, between people as an interpsychological category and then inside the child, as intrapsychological category" (Vygostky 1978 p.128). These ideas are shown in Figure 1.

3. The analysis of the two case studies

I describe two case studies and report the evaluation of them which use a question model. In each case study, students were given different tasks. One is creating a HomePage for the virtual audience, the other is for the real audience. Each study lasted for 13 weeks.

3.1 The outline of the two case studies

One of the case studies was set up in the autumn semester of 1996 and the other was in the spring semester of 1997. The autumn case study consisted of 34 junior college students who belonged to the Department of Art. The spring case study consisted of 64 junior or senior college students who belonged to the Departments of Art, Engineering or Agriculture, who had no computer literacy and no knowledge about HTML(Hyper Text Make up Language) . There were 13 lessons. One lesson was 100 minutes. In the first 5 lessons, students learned computer literacy and HTML. In the final 8 lessons, the students were divided into groups of four to do project learning.

3.2 The different tasks

We designed two tasks. In the autumn, students interacted with a virtual audience and the students in the spring case study interacted with grade five students. These are shown in table 2.

The task in the autumn case study was to create a HomePage for a "virtual person" who is planning to buy a computer and is willing to spend 500,000 yen. The task in the spring case study was to create a HomePage explaining university students' answer to grade five students' questions about computers. As the elementary school was not connected to the internet, they communicated to the university students with a video tape exchange. They exchanged video tapes twice. The first time the fifth graders introduced themselves and asked questions about some computer mechanisms they did not understand. In response to this, the university students introduced themselves and promised to answer the questions as clearly as they could. The second time, the university students sent a copy of the HomePage they had created to clearly answer the questions about computer mechanisms. In response to this, the fifth graders sent a video tape in which they criticized the HomePage.

	reality of tasks	*source of help*
autumn case study	virtual audience	questions and answers about tasks
spring case study	real audience	questions and answers about tasks computer terminology HomePage

Table 2 task design and source of help

There were two sources of help for the university students. The first source was teachers and cooperators who do not belong to the university. The students could ask questions and receive comments from them through BBS. The other source was students at the Departments of Engineering and Agriculture. They created a terminology HomePage for the students at the Art Department to explain computer technology. The students in the spring case study created their own HomePage while referring to the terminology HomePage given to them. They could also ask those other students questions. The autumn case study could only use the first source but the spring case study could use both sources.

3.3 What questions were asked?

Many questions were asked in these two case studies. In the autumn case study, some of the university students asked *questions that request information* such as "What kind of computer should we buy for computer graphics?" or "What is a modem?" in the first lesson. After 3 months they still asked *questions that request information* such as "We can't get a PowerMacintosh with more than 8MB of memory and more than 350MB of memory on hard disk. Should we get the PowerMacintosh6100?"

In the spring case study, the university students had to answer questions such as "Do Tamagochis work on the internet?"[2]. Some of the university students then asked their sources *questions that request information* such as "Can you tell me the architecture of Tamagochis?" in the first lesson. However, they received vague responses from their sources like "Tamagochis have computers in them". Then the university students referred to the terminology HomePage and asked more specific *questions that request information*. For example, "If memory and a CPU were incorporated, how would these affect Tamagochis?" After 3 months, their questions were transformed into *questions that confirm interpretation* such as "We read your explanation about Tamagochis' mechanisms. We think there are many functions programmed in a Tamagochi. Is that true?". This transformation occurred without the tutors' advice on how to ask questions.

4. Conclusions

The article has proposed and modeled that students' spontaneous questioning is one of various cognitive activities which can act as the measure of evaluating collaborative learning, and reported the evaluation of two case studies which use it. The analysis of questioning revealed that questioning is related to learners' meta-cognitive skills. However, the present question model, which includes only two categories, is not enough to observe learners' complicated cognitive activities, because questioning is also related to the conversation rules in certain circumstances. Therefore I need a more specific, detailed analysis of questioning and to build a more sophisticated question model.

On the other hand, the evaluation of the two case studies indicates that the design of a task affects learning. These have suggested that the "non-virtual", the genuine interaction in the spring case study with the elementary school students and the students in the science departments who can aid as the external knowledge, led students to develop their own cognitive activities. A more detailed analysis of this result should be given in the future.

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[2] A Tamagochi is a popular, pocket video game

An Interactive Graphing Tool for Web-based Courses

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Abstract: This paper reports a project involving the development and formative evaluation of an interactive Web-based learning tool. The interactive graphing tool (IGT) permits students to sketch a graph on screen using the mouse and responds to a wide range of common graph types including logarithmic, exponentials, curves, and straight lines. The IGT facilitates an iterative approach to understanding graphical representations of knowledge by actively involving students in the construction of these representations and multiple modes of feedback. The examples provided in this paper relate to reaction kinetics and chemical equilibrium in undergraduate chemistry. However, the graphing tool is applicable to many other academic disciplines with similar needs to foster the development of student understanding of graphical representations of knowledge.

Introduction

Over the past few years two components for delivering courses via the WWW have emerged—the server-side applications (e.g., WebCT®, FirstClass®, TopClass® and Melbourne IT Creator®) and the client-side applications with which the learner interacts. While considerable efforts have been invested in developing course management software which functions from the server-side of course delivery to facilitate the linking of course content, Web pages, logging of student activity and reporting of student interactions only minimal (institutional or commercial) efforts have been made on developing pedagogically sound applications on the client or student-side. There remain two important issues affecting the application of new technologies which are crucial if there are to be any lasting improvements in student learning outcomes and the success of on-line courses. They are the:

- need to embed sound educational pedagogy into on-line courses; and
- facility for the content provider to be provided with sound pedagogical tools which are simple to implement.

This paper addresses the need for course designers (usually a lecturer appointed because of her or his content expertise rather than computer programming ability) to have available educational tools which engage students actively in learning and are simple to deploy. At the Multimedia Education Unit (MEU) in The University of Melbourne work has been focused upon developing generic learning tools which reflect sound educational pedagogies which are easy for non-programmers to use and implement. The interactive graphing tool (IGT) is one element in a suite of educational tools being developed by the MEU as part of the Learning Engines project [Fritze & McTigue 1997]. The remaining sections of the paper discuss the basic functionality of the IGT and the results of formative evaluations with students and academic staff.

The Design of the IGT

The IGT and Student Learning

The interactive graphing tool (IGT) has been designed and used within a framework that links the literature on student learning to that on understanding symbolic representations of scientific phenomena. The IGT is designed to actively engage students in constructing relationships between time-dependent data. For example, the macroscopic properties of matter and the symbolic representations used by chemists to represent those processes. While this paper focuses on the formative evaluation of the IGT, the use of such a learning tool must be seen as being incorporated into a computer-aided learning module which is merely part of a variety of curriculum experiences. In considering the design of any interactive learning tool it is here that the principles underlying constructivism are invaluable. These principles can be summarised as follows [McNaught, 1993]:

- Students have prior well-formed frameworks of ideas about many of the topics they study in science.
- Learners build up personal, internal conceptual maps as a result of interactive processes between each learner and her or his environment.
- Our frameworks embrace our sociocultural environment as well as our physical environment.
- Learning occurs as an active construction of meaning as a result of reflection on experiences.
- 'Reflection' is one of those concepts which deserves to be reflected upon. It does not just mean thinking over an experience, but implies a conscious integration of experience into an existing framework.
- The process of reflection is not purely rational; motivation and interest are essential.

Any computer-based learning tools we build in order to assist student learning must require students to actively interact with new material in ways which require reflection. It is not sufficient for students to understand an argument or explanation in a detached way. They need to make decisions in their work which show clearly what their own knowledge constructions are. This has serious implications for the design of IMM where there has been a heavy reliance on recognition rather than construction in the design of question or problem formats. It is our belief that IMM will only assist student learning when the tasks we design are based on the constructivist principles outlined above. The IGT has the potential to:

- engage the student actively in the construction of knowledge,
- allow for a variety of student inputs,
- provide an iterative approach to learning,
- provide immediate and appropriate feedback, and
- be simple and straightforward for a lecturer/ teacher to embed in computer-based media.

In many text books and IMM packages graphs are used widely to explain relationships between variables. The use of animations of graphs are widely used to explain how relationships vary over time, so that three variables are illustrated. However, students do not build these relationships themselves; they observe the developer's image of them. At best, they may be asked to select between various graphical representations in a multiple choice question.

It has become clear to us that giving students IMM which included a learning tool by which they can build they own images of the relationships between variables and then get feedback from the computer about how useful their images are would be a real advantage in enhancing their learning [Kennedy & McNaught 1997].

IGT Structure

The IGT has been developed in ShockWave® using Macromind Director®. The graphing tool is a ShockWave object which requires a Web browser (Netscape Communicator) with the current Shockwave plug-in installed. In a Web environment it has the potential to provide students with the opportunity to express the relationships between variables in an active learning environment which provides appropriate feedback, and can be linked to multiple representations (e.g., video images of chemical processes or animations) of scientific concepts.

All curves drawn by the IGT including logarithmic and exponential shapes are simulated by the use of Bézier curves [Plant 1996]. The range of current default curve styles are shown in [Fig. 1]. Each curve has a default set of values which include the start and end points, start and end angles, an optional critical point may be defined, and a mid point. A wide range of curve shapes can be generated by changing these parameters. In chemistry the range of curves that can be simulated include those used in reaction kinetics, chemical equilibrium, and pH titrations. The location of the pen tool is shown at the top of the graph and is updated as the student draws the graph. Errors are corrected by using the eraser tool or redrawing the graph.

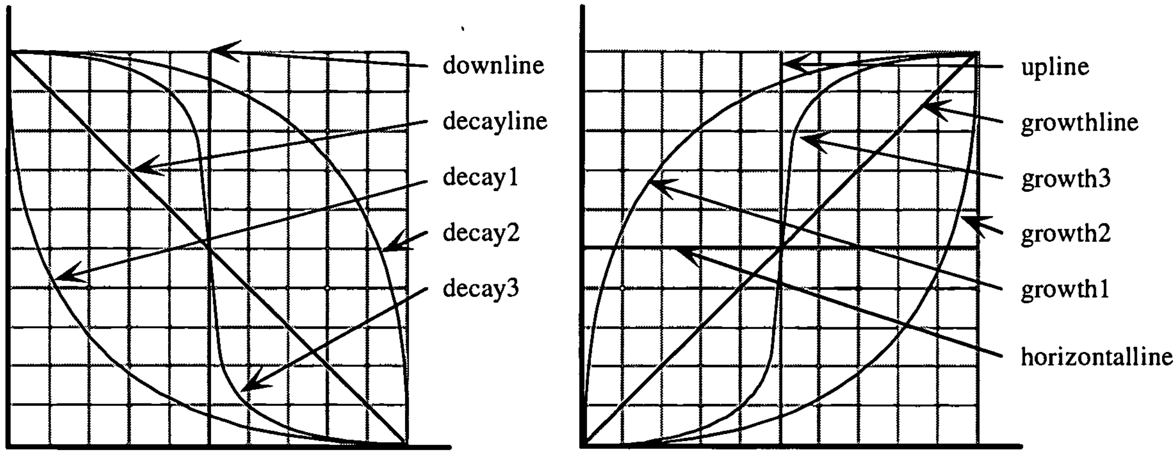

Figure 1: Default curves for the IGT

The axis for each graph can be set along with a suitable scale. The tool is able to pre-draw a wide range of curves also. To address any potential mechanical problems with using the mouse, the sketched graph is immediately redrawn by the IGT object. The process of redrawing student input is smoothed by 'snapping' the graph to the grid at 16 pixel intervals—the student has to be accurate but not precise.

Formative Evaluation of the Interactive Graphing Tool

Goals of Formative Evaluation

This study focused on two groups—students and academics. The specific goals of the formative evaluation with students focused on:

- their responses to the general on-screen layout, navigation and behaviour of the IGT (in particular the mechanics of using the mouse to draw the curves);
- comments on the nature and function of the feedback provided;
- the difference between the IGT and other forms of CFL representations of graphical information including static graphs or animations of graphical information;
- perceptions of the IGT as a tool to influence their learning outcomes;
- the difficulties encountered in using the IGT; and
- how the IGT might be improved.

The focus for academic staff was on all of the above plus the ways in which the IGT might be used in particular academic disciplines:

The Studies

The students who took part in the formative evaluation were self selected from first and second year undergraduate science (all names are fictitious). All were experienced users of the first year ChemCAL computer-aided learning package [McTigue et al. 1995] developed at The University of Melbourne. Students were paired and asked to complete four small modules—a tutorial module to gain experience in using the software, followed by three modules which investigated kinetics and chemical equilibrium. Students were asked to comment on each of the broad areas listed above as they worked through the modules. The first author was present at each session (to observe, ask questions and assist if the software crashed—it didn't) and all student responses were recorded using audio tape. Written notes were taken during and after each session—which required approximately 35 to 45 minutes per pair.

The academics who took part were either involved in courseware development at the university or known to the first author. The evaluation data was generated by the use of a questionairre. This was the less successful of

From Custom Text Books to Interactive Distance Teaching

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Abstract: The advent of the WWW and a rapidly growing number of networked multimedia capable PCs in labs and homes created a new wave of ambitious educational projects. This paper presents first use experiences with FernUniversität's Virtual University concept. The core of this comprehensive teaching model consists of a rich collection of multimedia course materials particularly designed for interactive and computer supported distance learning. Main objectives include reduced communication periods, motivation enhancement through active learning, and improved insight into complex structures and processes through visualization, animation, and multiple presentations. The approach is exemplified with a highly interactive course on distributed software engineering. This example also serves to demonstrate the need for synchronous collaboration tools exploiting the structure and semantics of the course materials communicated.

1 Introduction

Traditionally, European distance teaching universities used prepackaged self-instructional correspondence courses supplemented by video and audio cassettes that allowed their students to study at the time and location of their choice. This teaching model can now be replaced or enhanced with multimedia, interactivity, electronic communication, and custom navigation and annotation; the course material can be published over communication networks; and the elapsed time of about six weeks between sending out homework assignments, receiving the students' solutions and returning the corrections to them – all by snail mail – can be reduced tremendously by using email and other forms of electronic document exchange. In some cases, for example, in a programming course, Internet technology can be used to perform corrections interactively with the help of remote compilers and testing tools. All this is currently taking place in FernUniversität's Virtual University project [http://vus.fernuni-hagen.de/].

In networked learning environments interactivity allows students to manipulate input data, parameters and thresholds of real-time simulations or animations. Learners may also influence the progress and output of process or algorithm visualizations. They may experiment with their own solutions to course-related problems and access virtual or remote laboratories. Such features are likely to raise the attractiveness of the learning material and enhance the students' motivation by letting them apply and experience what they have learned to problems of their choice. Flexible navigation and annotation mechanisms allow them to find their own tour through the educational material and associate it with their personal notes. Active links to related material of the Web allows interested students to deepen their knowledge at their own pace and time. But interactivity has a second meaning with respect to learning being considered as a social process. Distance teaching and training have always suffered from a lack of personal communication, face-to-face collaboration, and positive and negative reinforcement through tutors and fellow students [Krämer 97b]. Today there is a chance to support some elements of this social process by extensive use of email, chat tools, virtual classrooms [Maly et al. 97], collaboration support for geographically dispersed teams [Krämer & Wegner 97], and smart inquiry systems. Combined appropriately they enable new forms of online tutorial support and remote group interaction, both tutor with students and students with students. Currently we are implementing an enhancement enabling synchronous interaction over a distance within a consistent, representation-independent object model.

the two evaluation processes—the major problems being time constraints on the academics and significant cross-platform and software issues (discussed later).

The Modules

All of the objects which are part of the Learning Engines project are designed to communicate (e.g., text input or user interactions) with each other. In [Fig. 2] there are two objects on screen. The top one which is shown in [Fig. 2] as a straight line graph is the IGT. The lower one is the Tutorial Item Set (TIS) object. This contains the text of the question (left box in [Fig. 2]) and generates the comments box (right box in [Fig. 2]). The IGT facilitates sketching graphs on screen using the mouse and the TIS object contains the question scripts and the functionality to respond to input from both students and the academic. The two learning tools facilitate an iterative approach to developing student knowledge constructions between non-graphical and graphical representations of knowledge.

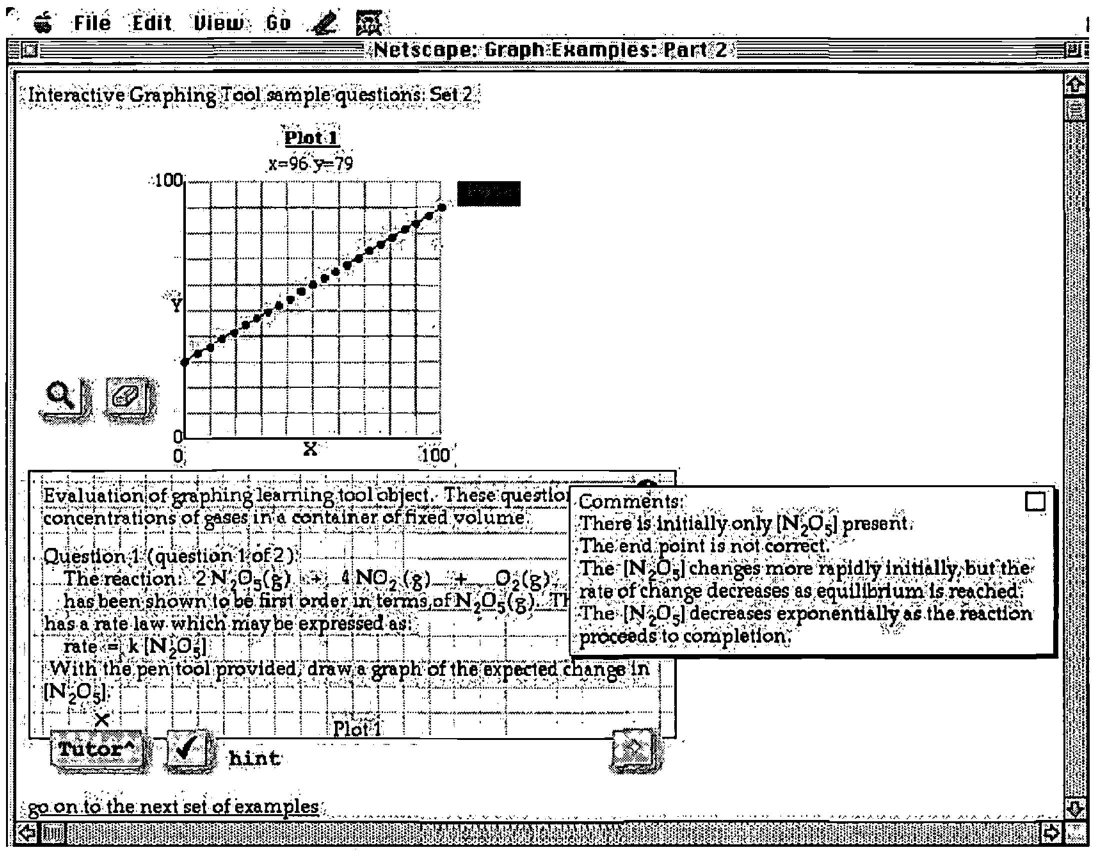

Figure 2: Screen capture of the prototype Interactive Graphing Tool

Figure 2 [Fig. 2] is a screen capture image of one screen. The straight line is illustrative of a response by a student. The question being asked of students is:

Question 1 (question 1 of 2).
The reaction:. $2\,N_2O_5(g) \longrightarrow 4\,NO_2(g) + O_2(g)$ has been shown to be first order in terms of the $N_2O_5(g)$.
The reaction has a rate law which may be expressed as:
rate $= k\,[N_2O_5]$
With the pen tool provided, draw a graph of the expected change in $[N_2O_5]$.

Factors such as; Where does the graph start?, Where does it finish?, What is the sha pe of the curve?, became immediate problems for students to solve. This is quite unlike selecting from a series of possible answers as in a multiple choice question. The feedback to the student depends upon input (what the student sketches) and comments defined by the content expert. The tutorial item in this example has been scripted to respond to the following components of any curve drawn by a student including the:

- start point (0,0) and end point (100,100) of the curve;
- start angle (>70°) and end angle (defined by the general form, decay1) of the curve;
- general form (decay1) of the curve (see [Fig. 1] for the generic shape of a decay1 curve).

Feedback can be as complete or as minimal as desired by the content expert. In the current version multiple levels of feedback may be specified in the TIS object. The TIS object analyses key parameters of the student input provided by the graph object and provides the appropriate response in the *Comments* box in [Fig. 2].

Student Formative Evaluation Results

The formative evaluation carried out with students in this instance has indicated that students find this type of task more challenging than conventional multiple choice selection problems. Construction is much harder than recognition. Quotes from student interviews support this statement.

DK *How is this different from other experiences of CAL materials of dealing with graphs—materials you have already used?*

Anne *You have to actively participate. A lot of time with other CAL materials (either static displays of graphs or animations), you watch it, you take maybe 5% of it in. With this you actually have to sit there and work it out... This is much more active.*

Mike *With the little movies they have in the current CAL labs there's no real insurance that you comprehend what you are seeing.*

The navigational issues and general layout of the two learning objects did not result in any problems. After minimal practice, all students were able to sketch a desired curve shape using the mouse. The feedback and the visual representations of the IGT were seen to be a very positive aspects of the software. For example.

DK *How is this (the IGT) different? This is the kind of question you would find in a book.*

Anne *You are visualising it instead of just seeing a bunch of numbers in front of you.*

Mike *Being able to see it (the graph you draw) helps out, rather than just the equation.*

At the conclusion of the modules students were asked to their impressions of the IGT as a learning tool. In particular "How is this approach different to that you have seen in multiple choice questions, static displays, or animations of graphical representations of graphical information?". Some of the responses were:

Nick *I think it's good for students. I'm surprised to say that because it actually makes it harder for them in that they really have to learn (think) about what they know.*

Mike *This (the approach to graphing using the IGT) makes it into something that is a serious learning tool.*

Anne *...if you do have a problem with it (the graph you are trying to sketch) you can't readily go and ask for feedback (with a book or static display).*

Formative evaluations from academics

The comments from the limited number of responses from academics tended to focus on issues of implementation within a specific academic discipline (e.g., physics staff require sinusoidal curves which are not currently supported), the need for specialised symbols in the text, and the issues of software compatiblity. The latter is a non-trivial problem for those involved in developing Web-based pedagogical learning tools. The internet is not a mature technology. Standards for hypertext markup language (html), computer operating systems, and even internet browsers are problematic. For example, the two major internet browsers have implemented the current version (4.0) of html differently. However, In response to the question "How is this approach different to other forms of representing graphical information, static displays or animations", an illustrative response is:

Rose *The primary difference must be that students can trial their own answers and get feedback on same.*

Problems And Solutions

A number of perceived deficiencies in the current iteration of the software were articulated by the students and academics. These problems included the lack of information on the axes and suitable scales, the initial graph drawn disappears once a new graph is started, and the graph disappears if the screen display is altered (e.g., scrolled in a manner to hide the graph object).

The authors were well aware of the first problem however it was not possible at the time to have this implemented. It will be part of the next iteration of the IGT. The second issue will be implemented in the near future. It is envisaged that once a student response has been checked and found to be not correct, that response will fade to 50%, then 25%, of the original while the student has a second or third attempt respectively. The third issue has been addressed by Macromedia. The latest Shockwave plugin preserves information on the screen. A cross platform font has been developed which facilitates the use of the IGT on a Macintosh or a PC using Netscape Communicator®.

Future Directions

The current work of the project is focused on the development of the authoring interface for lecturers and implementing the changes recommended by students and academics. Improvements currently being implemented include the ability to customise the types of curves recognised for different disciplines and pop-up menus to select the graph set appropriate to the particular content discipline.

The expectation is that the number of graph types recognised by the software will be increased as will be the degree of customisation of the graph types recognised by the software. There is no intention to have the IGT display or respond to sinusoidal curves or curves which are drawn right to left.

While the examples provided in this paper relate to reaction kinetics and chemical equilibrium in undergraduate chemistry, it must be stressed that the interactive graphing tool is applicable to many other academic disciplines with similar needs to foster the development of student understanding of graphical representations of knowledge. It is anticipated that the graphing tool will be used the future in other contexts—in subjects that also have a need to link the macroscopic behaviour of objects or materials with graphical representations of knowledge Discussions have been held with lecturers from pharmacology and physics and the requirements of these subjects have been addressed in the current iteration of the IGT. The comments from students in this study were very positive however, studies are currently ongoing to ascertain any changes to student learning.

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An Open-ended, Short Answer, Text Question Tool: Improving Interactivity on the Web

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Abstract: This paper reports the results of a study of the development of an innovative learning element designed to be implemented in a computer-facilitated learning (CFL) module. The learning element is an open-ended, short answer, text question tool (TQT) designed to be used in Web-based courses or incorporated into hybrid Web/CD-ROM systems. The TQT object facilitates the development of extended question-and-answer problems which overcome the limitations of the multiple choice question format. The TQT facilitates an iterative approach to developing student knowledge constructions of knowledge. The examples provided in this paper relate to questions developed for the Department of Anatomy, Faculty of Medicine at The University of Melbourne. However, it must be stressed that the TQT is applicable to many other academic disciplines with similar needs to develop student understanding of specific content domains.

Introduction

The development of the Text Question Tool (TQT) is an additional component of the Learning Engines project—work being undertaken by the Multimedia Education Unit (MEU) at The University of Melbourne to develop simple Web-based learning tools [Fritze & McTigue 1997]. The project is developing a number of generic learning tools for the implementation of Web-based, CD-ROM or Web/CD-ROM hybrid course materials. A number of these tools have already been produced including an a concept mapping tool, tutorial item set tool, and an interactive graphing tool [Kennedy, Fritze, & McTigue, 1997]. The Text Question Tool is designed to be a generic question tool which facilitates the construction of computer-facilitated learning (CFL) modules or Web-based courses. The functional aspects of the TQT are the:

- facility to allow students to type in short text-based answers in a field in a Web page based upon a question item;
- ability of the TQT to search for key words or phrases defined by the lecturer;
- ability to provide feedback to students based upon the number of key words or phrases found in the text string typed in by the student; and
- facility to respond to student requests for Hints, spelling of terms, and expert answers to the question.

Faculty members from the departments of Chemistry, Physics, Anatomy, Pharmacology and Economics at The University of Melbourne were surveyed to determine the needs of delivering on-line tutorials. While the needs of each academic discipline were varied, the TQT was perceived to be fundamental to the implementation of Web-based courses. The department of Anatomy is participating in the development, design and the formative evaluation of the TQT. The design of cognitive tools for student learning is an outcome of a theoretical framework developed to link what is known about sound educational practice with the design of interactive elements to incorporate into multimedia courseware [Kennedy, Fritze, & McTigue, 1997; Kennedy & McNaught, 1997].

The Text Question Tool and Student Learning

The TQT fulfils a number of educational requirements not available in current Web-based courseware tools. These are:

- allowing a student to express more complex concepts and ideas *in her or his own words* and receive immediate feedback in a Web-based environment;
- providing an environment in which students can refine and reflect upon their understanding of concepts which is non-threatening;
- allowing the content expert to decide the content matter and the appropriate form and language of the answer. It is the lecturer who decides the key words, hints and expert answers pertinent to a particular content domain; and
- providing an opportunity for students to learn in an environment which is supported by a sound educational framework.

A non-functional example of the look-and-feel of the TQT object with examples of questions may be found at <http://www3.meu.unimelb.edu.au/meuweb/staff/dkennedy/TQT.html>. The TQT has been through a number of iterations in discussions with academic staff from the department of Anatomy using the scenario-based approach. Scenarios have been chosen because they "are grounded in the work activities of prospective users; the work users do drives the development of the system intended to augment this work. Thus scenarios are often open-ended and fragmentary; they help developers and users pose new questions, question new answers, open up possibilities" [Carroll 1995], p. 5.

Example of a scenario in Anatomy: The student reads a question—in conjunction with an range of resources (e.g., an series of anatomical images, a video clip of the initial phases of the proceedure, or images of the radiological perspective) from the lower back in the Interactive Anatomy (IA) database—and is required to link the procedure with the underlying anatomical structures. For example, the insertion of a needle for a lumbar puncture requires an understanding of the anatomical structures the needle must pass through, the angle of insertion, and how far the needle must be inserted in order to obtain cerebrospinal fluid. The student is required to apply her or his anatomical knowledge in order to solve a clinical problem—which determines the success or failure of this procedure.

Teaching and learning

The advent of the World Wide Web (Web) and the shift to delivery of courses via the Web has provided the impetus to develop pedagogically sound learning tools for student learning. It has become clear that merely placing lecture notes on the Web is not sufficient for student learning to occur. However, there is a lack of suitable interactive learning tools which are Web compatible to actively engage the learner. A major purpose of any learning tool should be to provide teachers and lecturers with the facility to match the desired educational outcomes of a Web-based course with the learning elements which have the greatest potential to achieve those outcomes. For example, studies from many institutions over a period of many years "have drawn attention to the wide gap between the rhetoric describing the qualities lecturers say they want in their students' responses, and the tasks they set" [Biggs 1989], p. 15—however, the on-line learning tools which actively engage students are currently very limited. The TQT is potentially one such tool. A general schematic view of the TQT is shown in [Fig. 1].

In the Interactive Anatomy project the TQT will be used to:

- develop the ability to analyse clinical problems by utilising students' knowledge of anatomical structures,
- link procedural knowledge with anatomical knowledge, and
- promote active learning.

In addition the TQT can be utilised in this project and other academic disciplines to:

- provide a mechanism for self-assessment,
- develop procedural knowledge, and
- facilitate the development of descriptive terminology.

There are a number of components in the TQT environment They include:

- a field into which the student can type an answer to a question,
- the hints assigned by the lecturer,
- the spelling helper,
- the expert answers, and
- the facility to print a record of a students' responses and self-assessment to disk for later review (by the student).

Student Learning

Learning is the way in which an individual changes the way s/he conceptualises the world. *Teaching* involves a lecturer constructing learning opportunities for students. One of the major difficulties in the design of computer-facilitated learning (CFL) is the gulf between the instructional or educational design of CFL and what the research literature indicates is good teaching practice [Ramsden 1992]. There is considerable evidence that students need to be actively engaged in knowledge construction through a variety of learning experiences [Laurillard 1993]. The need to make learning environments as rich as possible to enhance students' ability to construct knowledge and resolve conceptual difficulties is fundamental if courseware is to be a significant part of course delivery in the next 10 years. Only limited examples exist where CFL has replaced part of the traditional approach to academic learning in higher education. At present there are very few learning tools of the type being developed by the MEU (Learning Engines, [Fritze, & McTigue 1997]) available for lecturers to construct learning opportunities which actively engage students. The self-assessment component of the TQT is one valid method of determining the 'distance' between the student response and the expert answers provided by the content expert.

The TQT is not intended to:

- supplant conventional examinations (formal assessment) although it may be possible to do so in the future,
- address syntax, grammar or content other than in a very fundamental way (key words), or
- address open-ended essay type questions.

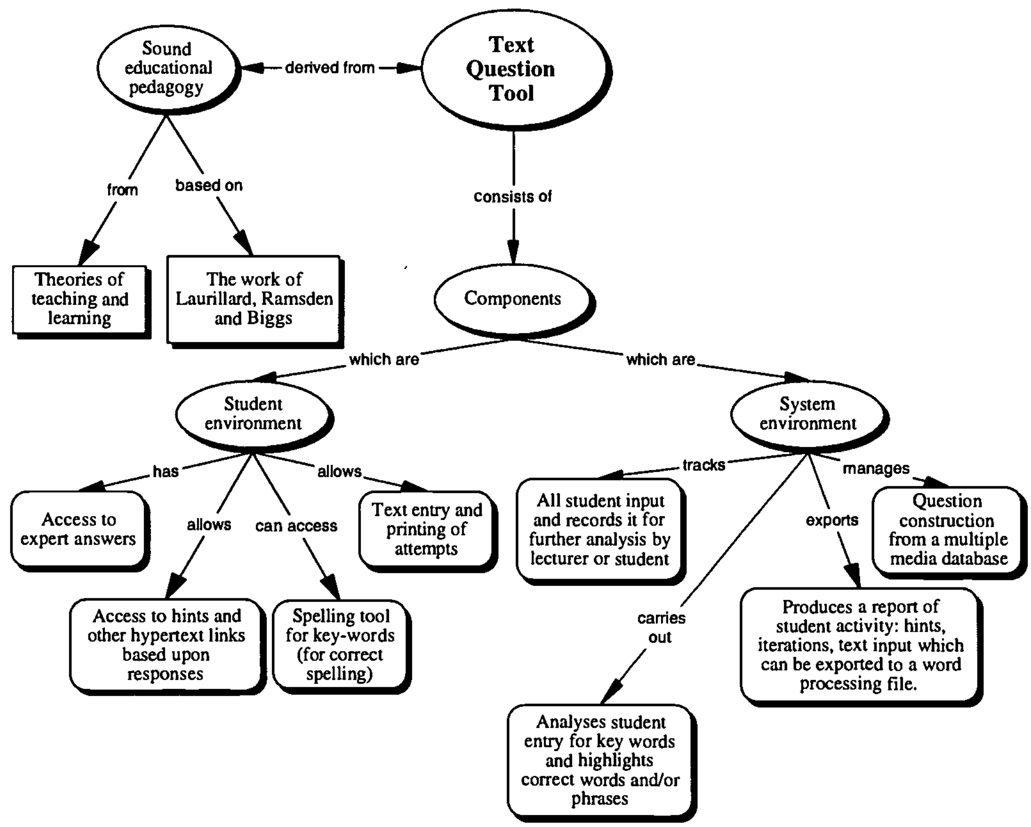

Figure 1: The structural view of the TQT

A Functional View of the TQT

A functional view of the current iteration of the TQT object is shown in [Fig. 2]. The structure of the authoring environment is critical as the tool is to be used by lecturers with limited computing experience. Design of the authoring environment is guided by work carried out as part of Learning Engines Project. A key component of the intended authoring environment is the ability to incorporate graphics, animations etc., as sources of question objects. Currently, the functionality of the TQT is linked to a database. The lecturers have a proforma which sets the:

- the key words, spelling terms, expert answers, and hints for students; and
- structuring of questions with multiple forms of media (video and images from the Interactive Anatomy database).

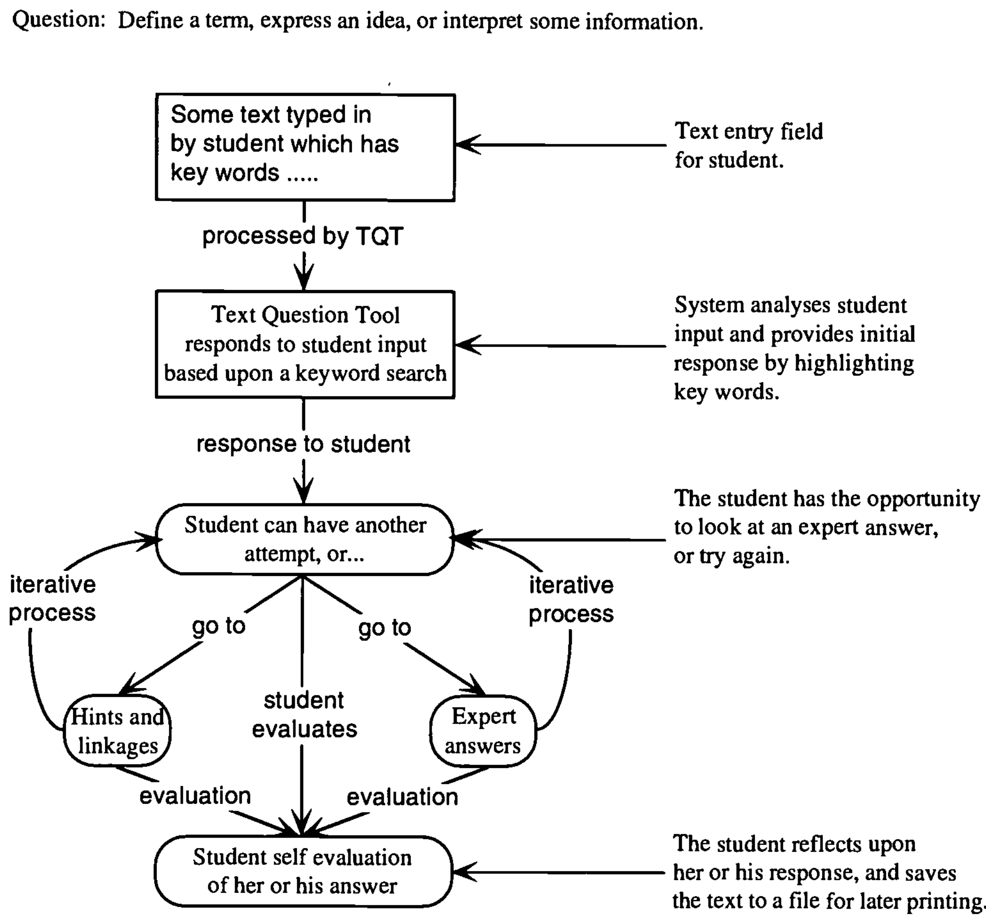

Figure 2: A functional view of the TQT object

Current Development and Evaluation

Preliminary work on the TQT has been completed. The development of the TQT is focused on the Interactive Anatomy project currently nearing the end of its first of two years in the Medical Faculty. The first 8 of 16 PhotoCD disks have been completed. Currently the design team is developing the first two modules for use with students in 1999. The TQT will be incorporated into interactive tutorials on CD-ROM which will facilitate the development of anatomical knowledge in a case-based clinical approach. Student evaluations of the modules will take place in early 1999. A screen capture of the prototype is shown in [Fig. 3].

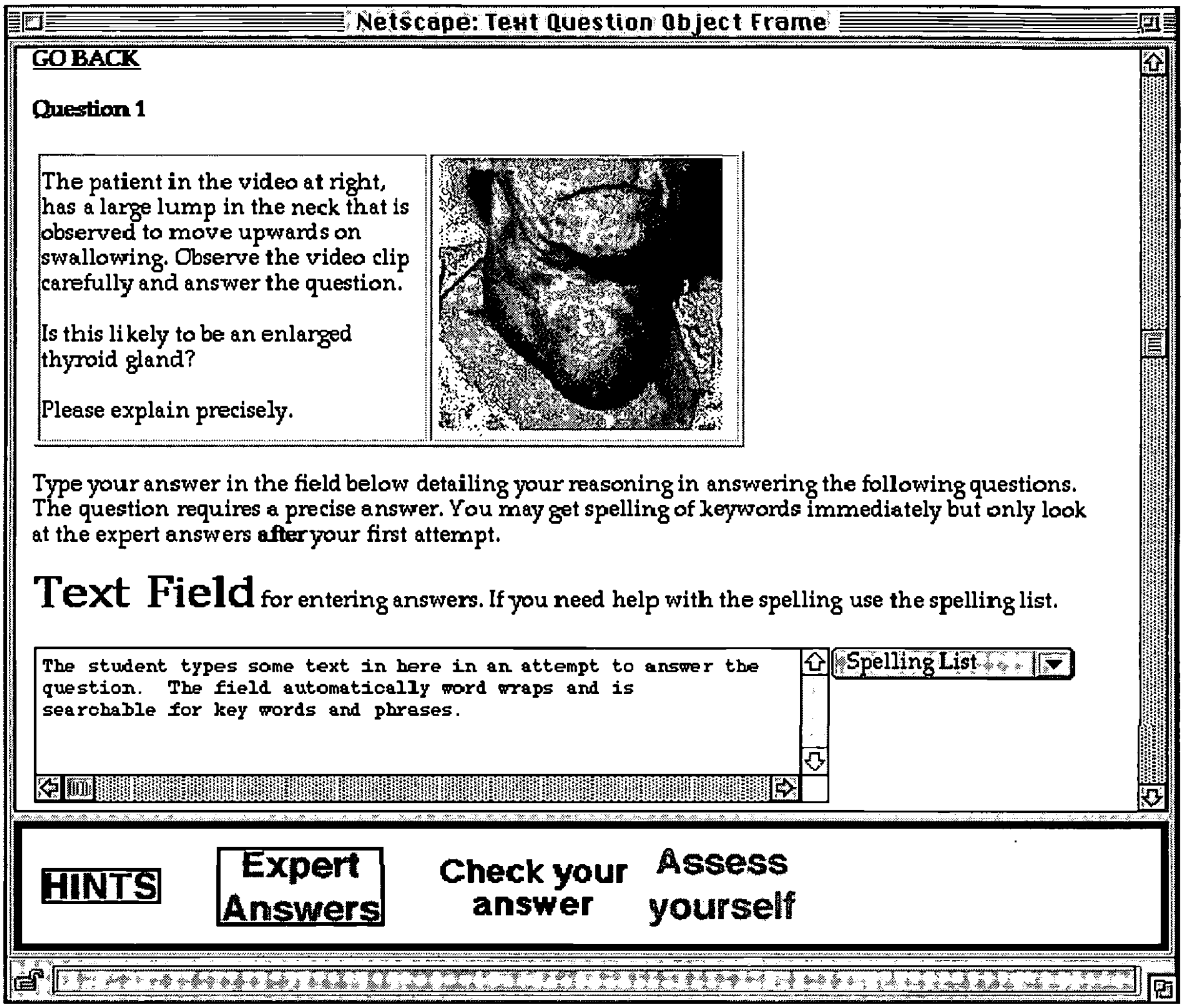

Figure 3: Prototype of the Text Question Tool

Sample Questions and Answers from the Interactive Anatomy Project

The Interactive Anatomy CD-ROM project is a large interactive multimedia project at the end of its first year which is part of the restructuring of the curriculum in the Medical Faculty. In each question the student would be told to type her or his answer in the text entry field to answer the question. Information in the *Help* section for the student will include:
"These are technical questions requiring technical answers. You may get hints of keywords, check your spelling in the Spelling Tool or look at the expert answers after your first attempt. Once you have reached a decision, check your answer against the expert answer(s). You will be told how many of the key words or phrases you have entered which are appropriate to the question. You may try again if not satisfied or check your answer against the expert answer(s) provided and estimate your mark. These results can be saved to disk and printed out later."

Two example questions are shown in [Tab. 1].

Summary

This project differs from the investigations into artificial intelligence and full text recognition and analysis of text by computers in a number of important ways. Firstly, it is not intended that the TQT would be semantically coherent, that is, be able to analyse a student response as an experienced teacher of the subject matter. There is considerable evidence (discussed earlier) that this level of complexity is not required in order to significantly enhance student learning. The second major difference is the assessment of student answers. The students are expected to assess their own answers and provide a mark or grade for their future reference. In the future it may be possible to construct a basic marking algorithm based upon the number of key words or phrases used; however, this is not perceived to be an educational requirement—students can learn without formal assessment. The TQT is an interactive learning tool which has the potential to enhance student learning.

Year	Question	Expert answer	Keywords and/or phrases
First Year Anatomy	The patient in the photograph, has a large lump in the neck that is observed to move upwards on swallowing. Is this likely to be an enlarged thyroid gland? Please explain precisely [Fig. 3].	It is in the midline and the thyroid gland moves on swallowing as it is in the pretracheal fascia which attaches to the oblique line of the thyroid cartilage (of the larynx).	pretracheal fascia, oblique, thyroid cartilage, larynx, midline
Second Year Anatomy	Explain the difference between a direct inguinal hernia and an indirect inguinal hernia?	A direct hernia pushes through a weakness in the posterior wall of the inguinal canal and is found medial to the inferior epigastrc artery. An indirect hernia exits the abdominal cavity via the deep inguinal ring into the inguinal canal and is lateral to the inferior epigastric artery.	medial, lateral, inferior epigastric artery, inguinal canal, posterial wall, deep inguinal ring

Table 1: Example proforma for anatomy questions

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Grimtor: A Co-operative Multimedia Authoring System

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Abstract: Most of previous authoring systems have at least the following two problems for producing multimedia titles or coursewares. The first problem is a separation between authoring and planning. Since many authoring systems provide only authoring facilities, users have to manually plan titles. The second problem is an insufficient management of objects used for authoring titles. For instance, since many authoring systems do not provide retrieval facilities for finding objects, users have to remember all of the objects to be used. As a solution of these problems, we present a co-operative multimedia authoring system called *Grimtor* that can be used for not only authoring but also planning titles. To support the co-operative authoring environment, *Grimtor* allows a hierarchical structure: *titles*, *scenes*, and *cuts*. A *title* can be planned in terms of the hierarchical structure and a page for each *cut* can be created independently by an author. *Grimtor* also provides authors with a hybrid user interface metaphor so that they can easily construct titles.

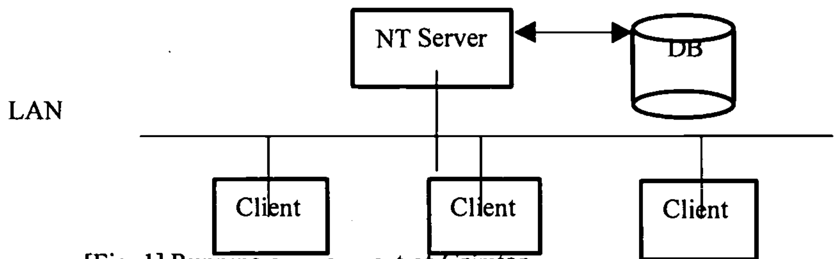
1. Introduction

Most of multimedia authoring systems are mainly used for authoring titles. However, the production of multimedia titles is not only an authoring task. It also includes several tasks: planning, data preparation and maintenance, task control, and so on. Since the previous multimedia authoring tools provide only authoring facilities to authors, they have to manually handle other tasks for producing titles. In addition, since many authoring systems do not sufficiently maintain objects used for authoring titles, users often have difficulties to find out wanted (or planned) objects. In this paper, we present a co-operative multimedia authoring system called *Grimtor* that provides both authoring and planning facilities. *Grimtor* also provides authors with a hybrid user interface metaphor so that they can easily construct titles.

User interface metaphors are increasingly become a prominent part of commercially available software [Carroll et al 1988] [Madsen 1994]. In authoring systems, user interface metaphors are specially important to authors. They are often classified as three categories: book/page metaphor, timeline metaphor, and flowchart metaphor [Koegel 1994]. Toolbook [Aymetrix 1994] is one of the popular authoring systems that adopt a book/page metaphor. The user of Toolbook constructs a *book* that consists of a series of pages. Each page may have one or more objects such as lines, circles, buttons, graphic, text, and so on. These objects are activated by associated procedures that are programmed in a scripting language, called OpenScript. In a flowchart-based authoring system (for example Authorware [Authorware 1992] and IcornAuthor [Koegel et al 1992]), authors create the paths that a user could take by placing icons on a flowchart and linking them to other icons. A timeline-based system (for example, Macromedia Director [Macromedia 1994]) allows authors to organize time-based media such as audio and video along the timelines.

Grimtor has a hybrid user interface metaphor that integrates all of the three kinds of user interface metaphor: flowchart metaphor, timeline metaphor, and book/page metaphor. For the planning process, *Grimtor* adopts a flowchart metaphor, since a title can be easily planned in a form of flowchart. For the authoring process, *Grimtor* allows users to use both timeline metaphor and book/page metaphor, since users usually like to use a timeline metaphor or a book/page metaphor depending on the types of authoring objects.

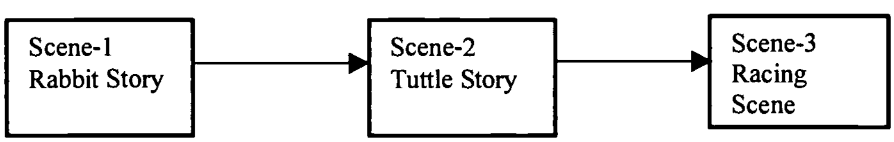
Grimtor is a client/server-based model. The client part consists of a planning module and an *authoring* module. The server part consists of a database module and a communication module. Using the database module, *Grimtor* maintains all of the information about objects used in the processes of authoring and planning so that authoring and planning processes can be properly integrated. [Fig. 1] depicts the running environment of *Grimtor*.



[Fig. 1] Running environment of *Grimtor*

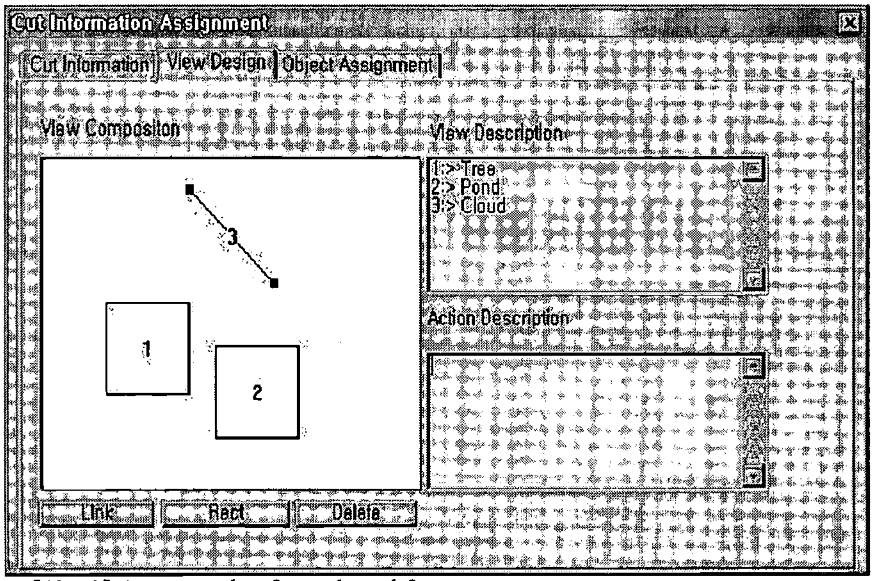
2. Planning for Co-operative Authoring

Recently, some of authoring systems [Fujikawa et al 1991] [Ogawa et al 1990] allow structured authoring in order to provide users with different views of a title, for example a hierarchical view and a channel view [Hardman et al 1993]. *Grimtor* supports the co-operative authoring environment that allows structure-based composition of titles: *titles*, *scenes*, and *cuts*. We suppose that a *title* consists of *scenes* and a *scene* consists of *cuts*. Therefore, a *title* can be planned in terms of the hierarchical structure and a page for each *cut* can be created independently by an author. In the process of planning, author constructs a *title* map as shown in [Fig .2] that describes a scene-flow of a *title*. Similarly, each *scene* is planned using a *scene* map that represents a cut-flow of a *scene*.



[Fig. 2] An example of a *title* map

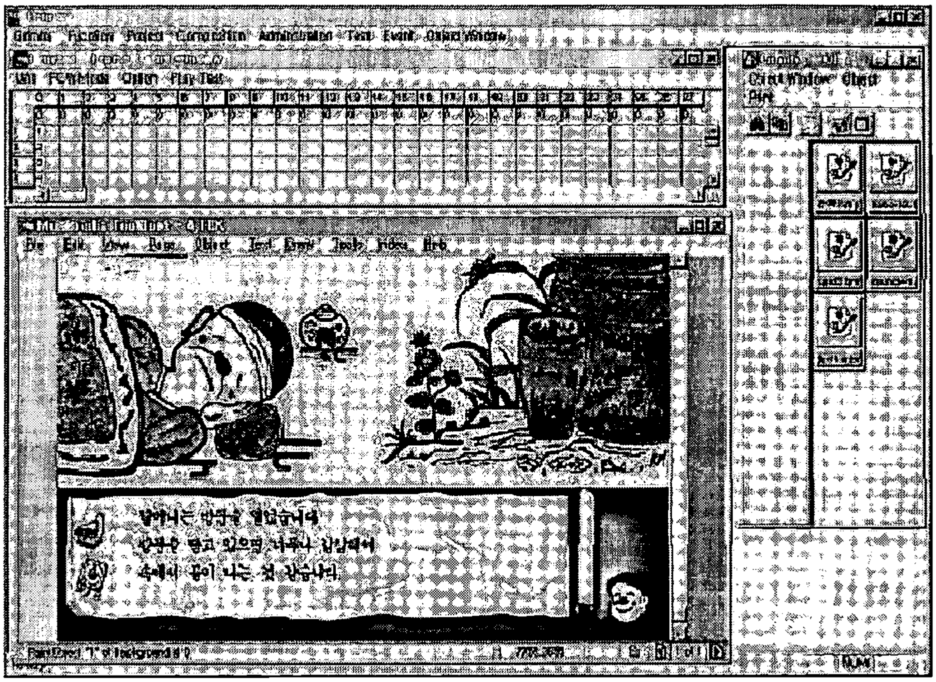
Grimtor provides each cut with a storyboard [Koegel and Heines 1993] in which a background picture, appearing characters, occurring events, and etc. are explained. [Fig. 3] depicts an example of a storyboard for a *cut*. In the process of planning, *Grimtor* allows users to assign objects to a *cut* and to make a path (i.e., a hyperlink) from a *cut* (or a *scene*) to other *cut* (or other *scene*). It is convenient for users to assign objects to a *cut* during the process of planning, since users can easily find out the objects that are needed to construct the *cut*. In Section 4, we will explain more about integration of planning and authoring.



[Fig. 3] An example of storyboard for a *cut*

3. Authoring based on a Hybrid Metaphor and an Object Database

For the authoring process, *Grimtor* allows users to use both timeline metaphor and book/page metaphor. Users usually like to use a timeline metaphor or a book/page metaphor depending on the types of authoring objects. For example, when users synchronize video with audio, in a book/page metaphor-based system they usually write a program (a script) for the synchronization. It is not easy for users to write such a program. In this case, it is much easier for users to use a timeline metaphor. In *Grimtor*, the book/page metaphor-based authoring system is just Toolbook, while the timeline interface is implemented. When users are authoring using the timeline interface, the result is displayed in a Toolbook window. [Fig. 4] shows an authoring environment for a *cut*. The top window in the left of [Fig. 4] depicts the timeline interface and the bottom window in the left of [Fig. 4] shows Toolbook window.



[Fig 4.] Authoring environment of *Grimtor*: the top window is a timeline interface; the bottom window is a Toolbook window; the right window is an object list window.

For the process of authoring, *Grimtor* supports a retrieval system to manage objects to be used. This retrieval system has an object database in a server so that users can register and retrieve their objects in the database. Users can register objects during the both processes of authoring and planning. When users assign objects to a *cut* in the process of planning, these objects are automatically registered into the database. The right side of [Fig. 4] depicts an object list window in which the registered objects in a *cut* are listed. Using the object list window, users can easily find out objects that can be used to construct the *cut*.

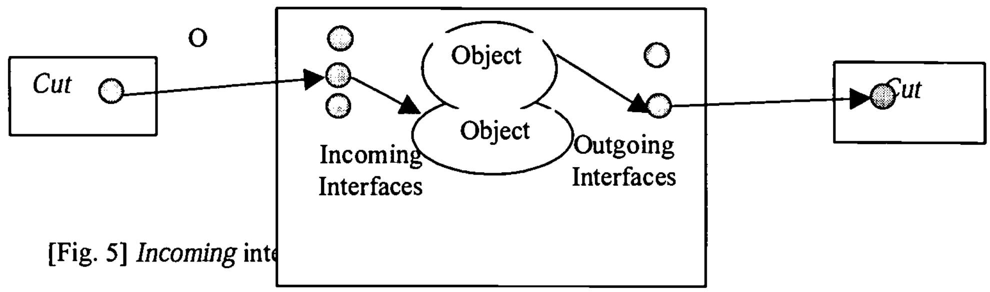
Another convenient authoring feature of *Grimtor* is that users can easily put some actions on objects without writing scripts. For example, suppose that a user wants to make a circle object in a *cut* as a button such that when the button is pushed down, jump to other *cut*. To do this, a user can choose the push-down-action in the action list provided by *Grimtor*. Then, the user makes a jumping event from a *cut* to other *cut*. Making a jumping event will be more explained in the next section.

4. Integration of Planning and Authoring

As described in the above, if users assign objects to a *cut* in the process of planning, then these objects are automatically registered into a database. When users are authoring, from the database they can easily find out objects assigned in the *cut* and construct the *cut* with these objects. This is one way to communicate a planning process with an authoring process. Using this kind of communication, one person can plan a *scene* (or a *title*) that contains *cuts* and distribute the *cuts* to authors so that they can independently construct the *cuts* or objects registered in the *cuts*. In this way, *Grimtor can* support a kind of co-operative authoring.

Another connection between planning and authoring is to make a path (i.e., a hyperlink) among *cuts* (or *scenes*). In *Grimtor*, every *cut* and *scene* can have *incoming* interfaces and *outgoing* interfaces. Every path coming to a *cut* (*or scene*) has to come in through the *incoming* interfaces of the *cut* (or the *scene*). Every path going from a *cut* (*or scene*) has to go out through the *outgoing* interfaces of the *cut* (or the *scene*). [Fig. 5] depicts *incoming* interfaces and *outgoing* interfaces of a *cut*.

Cut



[Fig. 5] *Incoming* int

To make a path from an object to a *cut* (or a *scene*), users first declare an outgoing interface of the *cut* (or the *scene*) that contains the object, and make a connection between the object and the *outgoing* interface. Then, users set a jumping event to the object such that when the object, for example, is clicked twice, jump to other *cut*, actually an *incoming interface* of the other *cut*. This linking method gives a restriction such that it is not possible to directly jump from an object to a *cut* (or a *scene*). However, this restriction allows users to make a hyperlink among objects during the both processes of planning and authoring. Since *Grimtor* maintains all of the information about *incoming* and *outgoing* interfaces for every *cut* and *scene* in a database, if users once define *incoming* and *outgoing* interfaces, then they can simply make links by making connections between the interfaces without seeing specific objects in a *cut*.

5. Conclusions

We design and implement a co-operative authoring system called *Grimtor*. *Grimtor* support not only authoring facilities but also planning facilities. In the planning, users can make a plan of a title that is associated with the authoring process. Therefore, according to the plan, authoring tasks can be distributed to many people. After finishing authoring tasks, some people can integrate the tasks into a title. *Grimtor* also provides users with a hybrid user interface metaphor so that they can choose their preferable metaphors. In future, we attempt to find a tutor model for planning and authoring so that teachers can easily develop multimedia coursewares.

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Interactive Simulation Based Tutoring System with Intelligent Assistance for Medical Education

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Abstract: This paper presents a tutoring system for the ear domain in medical education as an application of the Interactive Simulation based multimedia system (InterSim). The InterSim approach is based on the principles of cognitive apprenticeship. It enables exploration of the subject domain and acquisition of both domain knowledge and skills through multimedia based interactions, especially interactive simulations. With its main focus on cognitive skills acquisition, the system adapts to user actions and supports learning activities with intelligent assistance in the form of guidance and dynamic feedback as well as system assessed testing.

1. Introduction

Acquisition of domain competence for any professional discipline includes both domain knowledge and skills. While the analytical disciplines focus on domain knowledge, the task oriented disciplines emphasise skill based competence. For successful learning in the task-oriented medical profession, learning in a work environment is an essential part of curriculum supplementing the learning in an academic institution. While the academic learning provides the core knowledge that is relatively weakly situated and more abstract in nature, the work environment facilitates the learning of task related skills that are specific and strongly situated. Computer based educational systems provide benefits of both approaches by facilitating learning in the form of observation, imitation, feedback and evaluation in a simulated environment that provides the necessary context for adaptation, enrichment and refinement. The components of multimedia technology such as animations, explorations and simulations provide all the necessary ingredients for learning both the domain knowledge and skills and thus may help the learner in becoming an expert or at least a fluent practitioner in the field [Baumgartner & Payr 1996].

This paper discusses implementation of a tutoring system for the *ear* domain being developed under the InterSim project. It benefits from the cognitive apprenticeship approach and aims to provide knowledge of the structure and functionality of a human ear as well as the skills involved in diagnosis and treatment of auricular diseases. The basic domain knowledge in the InterSim project is provided by tutoring and explorations whereas the acquisition of advanced knowledge and related cognitive skills is achieved through simulations with the help of repetitive learning process. The system complements other educational media (such as traditional lecturing, texts etc.) used by medical students and doctors in continuing medical education. Since the primary focus of the system is on advanced knowledge, it is simulation oriented and provides intelligent assistance throughout the learning process. It judges a learner's need and adapts to it, provides interactive feedback and makes recommendations without obstructing the active learners in self-exploration at will. It provides authoring facilities to add and document real cases, serving as a communication medium among doctors besides assisting teachers in case-based teaching.

2. Characteristics of the InterSim System

The InterSim educational multimedia system can be used in and outside educational institutions and is suitable where the constraints of space, time or resources limit the possibility of regular institutional access. It may be combined with other means of education to suit different learning environments such as classroom based, open, and distance learning. The system facilitates competence not only in domain knowledge but also in related cognitive skills that are difficult to obtain in absence of 'hands-on' training in real working environment. The learning environment follows the *cognitive apprenticeship* model [Collins et al. 1989] that fulfils the requirements of both academic and situated learning. The system is activity oriented and supports acquisition of cognitive competence in both knowledge and task oriented performances. It should be noted that interpretations and decision making are also regarded as activities. The following are the characteristics of the learning environment.

- *Modelling:* In this environment, the learners can study the task solving patterns of experts to develop their own cognitive model of the domain as related to the tasks, tools and solutions.

The technical support provides guided tours (demonstrations and simulations) and textual explanations. The learners can work with the tutorials and perform interactive imitations of the demonstrated simulations.

- *Coaching:* The environment allows the learners to solve tasks on their own by consulting a tutorial component.

The technical support provides exploration tools for the learners to search for possible solutions, try them out and to solve any attendant problems. The technical support also provides consultation facilities for solving notorious errors.

- *Fading:* The environment's tutoring activity is gradually reduced in line with a learner's improving performance and problem solving competence.

The technical support provides a learner with adapted intelligent assistance in the form of recommendations and support throughout the learning process. Such assistance is based on the learner's progress in understanding the subject matter and thus the novice learners are provided with a much higher level of assistance.

The InterSim system, incorporating the above learning environment, is beneficial with respect to various socio-technical factors. The system provides a risk free simulated environment for explorations by a learner without the fear of harming a fellow human and includes real world scenarios based on actual patients. Such systems are applicable to a wide geographic area, since multimedia techniques facilitate the adoption of multilingual support with little effort. After the initial prototyping investments, systems based on the InterSim approach are likely to prove economically viable as they offer immediate savings in terms of human and laboratory resources and a longer life cycle due to well established domains and low rate of subject matter obsolescence.

3. InterSim Tutoring System for the Ear Domain

The system aims to facilitate acquisition of competence in the subject matter by providing basic and advanced knowledge of the domain as well as the associated cognitive skills. The skills are sought to be developed in a constructivist manner through repetitive learning process whereas knowledge is reconstructed from what learners do in their experiential worlds [Akhras & Self 1996]. The learner is able to explore various paths in the learning process in an exploration environment and the system extends assistance as adapted to the learner's degree of domain competence.

The system not only facilitates self learning by medical students and doctors but also enables knowledge sharing among doctors as it provides tools to add and document real cases within the system. These cases also become available in the system's simulation environment for learner observation and exploration similar to the "master" solution for an apprentice in any cognitive apprenticeship system.

4. The Main Functional States of the InterSim System

The InterSim system provides learning according to the demands of the domain, for example, the ear domain requires a deep understanding of the structural and functional aspects so the learning strategies emphasise visual and spatial learning aids. Since the exploratory learning approaches (simulation based) are implemented in combination with the logical approaches (rule based path determination towards the solution), the learning in the InterSim system is based both on *learning by doing* and *learning from other's experiences*. The system can be set by a user into three main functional states:

1. The Learning State enables access to all the learning contents of the system and provides immediate (*dynamic*) feedback on user actions with a view to facilitate active learning.
2. The Assessment State is for testing a learner's learning and retention of the domain knowledge and skills. The system allows a learner to make mistakes and provides a delayed (*static*) feedback after the work is assessed.
   As [Routen 1992] observed,
   > "*There are advantages with both forms of student monitoring. Static feedback perhaps is less obtrusive ... while dynamic feedback prevents students from making gross errors and getting completely lost.*"
3. The Case Authoring State provides authoring facilities to doctors and teachers for adding real life cases to the system.

4.1 The Learning State

The Learning State initially instructs the knowledge of the domain and progressively enhances a learner's competence in the application of that knowledge in working environment. Various multimedia techniques are used to enrich the learner-system interactions, for example, animations, simulations, hypertext links, sensitive image-maps etc.

Although the learning process takes place in an integrated exploration environment, it is conceptually divided into four sub-processes within the system. The aim of the system is to make the distinction between these sub-processes as transparent as possible for a learner. The learning process is not assumed to be sequential in terms of these sub-processes and smooth transition to any sub-process is allowed from any point within the system, subject to a learner's state of domain competence. The four sub-processes are discussed below.

1. *Coarse grained instruction dominated learning*

The learning activities are concerned with the basic knowledge of the subject matter and obtaining an overview of the domain, for example, structure and functionality of the ear, with the help of tutoring and guided tours. The system employs textual explanations, demonstrations and guided explorations for this type of learning.

2. *Fine grained knowledge construction*

The learning activities target the domain at a detailed level to acquire an advanced understanding of specific areas. The system utilises intelligent interactive simulations to support this type of learning. For example, a learner learns about sound energy loss from outer ear to inner ear through interactive simulation of the energy loss occurring in air to fluid sound transfer, thus improving the understanding of the role played by ossicles in reduction of such losses.

3. *Cognitive skills development*

The learning activities relate to acquisition of competence in the cognitive skills. These skills are acquired in a constructivist manner through training in a repetitive learning process. An example in the ear domain is the development of skills related to the diagnosis of ear diseases and prescribing appropriate treatments. However, the system design is currently limited to development of cognitive skills and excludes the development of physical skills which requires senso-motoric training.

4. *Application of the acquired knowledge and skills*

The learning activities, based on cognitive apprenticeship, aim to identify and correct any misconceptions acquired or gaps left in earlier learning. The system presents different problems, including notoriously difficult cases recorded in the field, for the learner to attempt diagnosis and solution. The learner is able to evaluate the problem solving procedures employed and match the interaction strings with those of others such as a peer learner or an expert. The system also provides appropriate feedback and comments on the efficiency of the learner's approach to the problem resolution.

4.2 The Assessment State

In the Assessment State, the learner is presented with problems similar to those faced when applying the acquired knowledge and skills within the Learning State but have to solve them without any assistance from the system. On submission of the solution, the system assesses it in comparison with its master solution and provides static delayed feedback based on the deviations from the master solution. The learner is tested for acquisition and retention of the knowledge and skills and on achieving success at this state of learning, acquires confidence to apply them to real life situations.

4.3 The Case Authoring State

The system provides authoring facilities for doctors and teachers to add real life cases to the system. They can document the cases and share them with each other, thereby using the system as a means of communication and also to build up a repository of cases that might help in further research and developments. The system provides access to these cases for learning and assessment purposes as already discussed and the teachers can also employ the documented cases to provide case-based teaching away from the system, if so desired.

5. Intelligent Assistance and Dynamic Feedback

The system provides intelligent assistance at various stages of the learning process and adopts adaptive behaviour according to learner needs. The *exploration-space-control* methodology [Kashihara et al. 1997] is employed to facilitate a proper learning and assessment environment for all types of users. According to this methodology, the users within the Learning State of the system are able to use several dedicated interaction support tools through suitable graphical user interfaces to explore the learning space, thus reducing cognitive overload that normally accompanies a large exploration space. Within the Assessment State, the implementation of *exploration space control* assists in selecting suitable problems to match the individual user's level of learning. To facilitate quick analysis of the learners' performance and progress of learning, the system constructs individual learner models and based on user actions continuously updates them.

An important example of intelligent assistance using *exploration space control* is the concept of "main path" and "excursions" which the system employs within the Learning State. While interacting with the system, the learner would explore along a main learning path linking a sequence of learning units and the system provides intelligent support and guidance geared to the main path. Whenever the learner needs to deviate from that path to some loosely related units, the system allows such excursions but limits the span of the information resources presented in these excursions by tailoring them to make them relevant to the main learning path. The learner is able to remain in these excursions as long as necessary but the system maintains a subtle reminder for returning to the main learning path by always providing a return button. The learner can cancel a previous main path and convert the current path into the main learning path but this process needs explicit user intervention. The further exploration avenues in an excursion are not emphasised to ensure that the learner does not get distracted and lost in the hyperspace of excursions. For example, a learner, exploring the structure of the middle ear, would be able to get an excursion in "physics of sound" to understand how the sound travels through the mechanical linkage of ossicles but the information presented in "physics of sound" is tailored for better understanding of sound travel in the ossicles. On the other hand, the learner, whose main learning path may be concerned with the "physics of sound" is able to get the knowledge presented in a wider context. This is not to say that the information is inaccessible or hidden in the excursions, but system's focus and presentation styles are different for "main path" and "excursions".

The interactive messages provided by the system to the learners are also adapted to the situation and a learner's current needs. There are two kinds of dynamic feedback messages provided by the system.

a) *Handling messages* are context adaptive navigational aids to the learners to help them identify various interactions available in the system. This is an important aspect since the learning in task oriented disciplines depends on learner's interactions with the system and on the amount of useful exploration. For example, the learners may keep exploring the aspects which are not relevant to current learning theme, and hence may not benefit from the system as much as they would if the explorations were made in proper direction.

b) *Learning messages* are concerned with the subject domain and are driven by the learner interactions. The system infers the state of knowledge and competence from these interactions and evaluates against the defined learning criteria for particular units. Based on the learner model, the system also provides suitable recommendations for further explorations. For example, if the learner has studied the animation depicting the movements in the middle ear, the system updates the learner model to reflect completion of this activity and if the learner model indicates that the functionality of the ossicles has not yet been learnt, the system would recommend its learning at that point.

The intelligent assistance also helps the learners at the level of interaction with the system. In the Learning State, it provides a subtle strategy to widen the learning perspective. For example, in the healthy ear units, pictures of various parts of the ear contain sensitive image maps indicating various constituents. When the learner takes the mouse pointer over any sensitive region, the boundary of that constituent gets highlighted, and its name appears at the mouse pointer. If necessary, the system also provides a hint that more information can be obtained by clicking on that region. If the learner single clicks, a short descriptive message appears on the screen motivating the learner to explore a bit further and learn more about the constituent. On double-click of mouse by the learner, the system either transfers the learner to a detailed description of the constituent or recommends going to an intermediate learning unit which connects the learning of that constituent with the current learning unit. This strategy not only facilitates a gradual acquisition of concepts by the learners but also provides motivation for successive explorations. This implementation further helps the learners in the simulation based fine grained knowledge construction where learning is predominantly based on explorations.

6. The Cognitive Apprenticeship Emphasis of the System

The InterSim system employs various techniques in order to benefit from cognitive apprenticeship approach. A learner can learn the subject matter through observing various animations and textual explanations. The process facilitates development of learner's own cognitive model of the domain. The learner can then try to imitate the observed processes with the help of simulations and interactive feedback and thus take the necessary corrective measures with the help of the system's coaching. Once the domain's knowledge is grasped, the learner can practice its application to various problems in a problem solving environment and the system gradually reduces its assistance with a view to build the learner's confidence.

Various simulations are provided in the malfunctioning and disease related units of the system where the learners can observe, analyse and reflect on the normal and abnormal behaviour of the various parts of the ear by altering various environmental and disease related parameters [Fig. 1]. Learners can attempt to solve various problems presented by the system to practice the application of their knowledge and skills while the system evaluates their solution and provides feedback to rectify any misconceptions.

The cognitive apprenticeship approach has also been emphasised by allowing the teachers and expert doctors to document and add real life cases to the system. These cases let the learners observe real life problems and their resolution by experts just as an apprentice observes a "master" accomplishing tasks.

7. Conclusion

This paper described an implementation of a tutoring system for the medical domain with a major emphasis on interactive simulations. What differentiates this system from the currently existing systems is the intelligent assistance to the learners to facilitate interactive and dynamic support wherever required.

There are systems which provide exploration environments where a learners can explore the subject domain without any interruption by the system. These systems are usually based on a hypermedia approach where various simulations, textual explanations and other teaching aids are embedded within a hierarchical structure. There are also relatively passive systems which provide domain knowledge to the user in an environment where the interactive assistance is limited to navigational aids or search facilities. However, the literature does not indicate any serious attempts where intelligent assistance has been provided within a simulation based system for the learning of both domain knowledge and cognitive skills. The InterSim approach attempts to fill this gap and the tutoring system for the ear domain is an implementation of this approach. Besides intelligent assistance, the InterSim approach adopts cognitive apprenticeship principles for attainment of competence in the cognitive skills, due to distinctive suitability of the cognitive apprenticeship approach in a task oriented discipline such as medicine.

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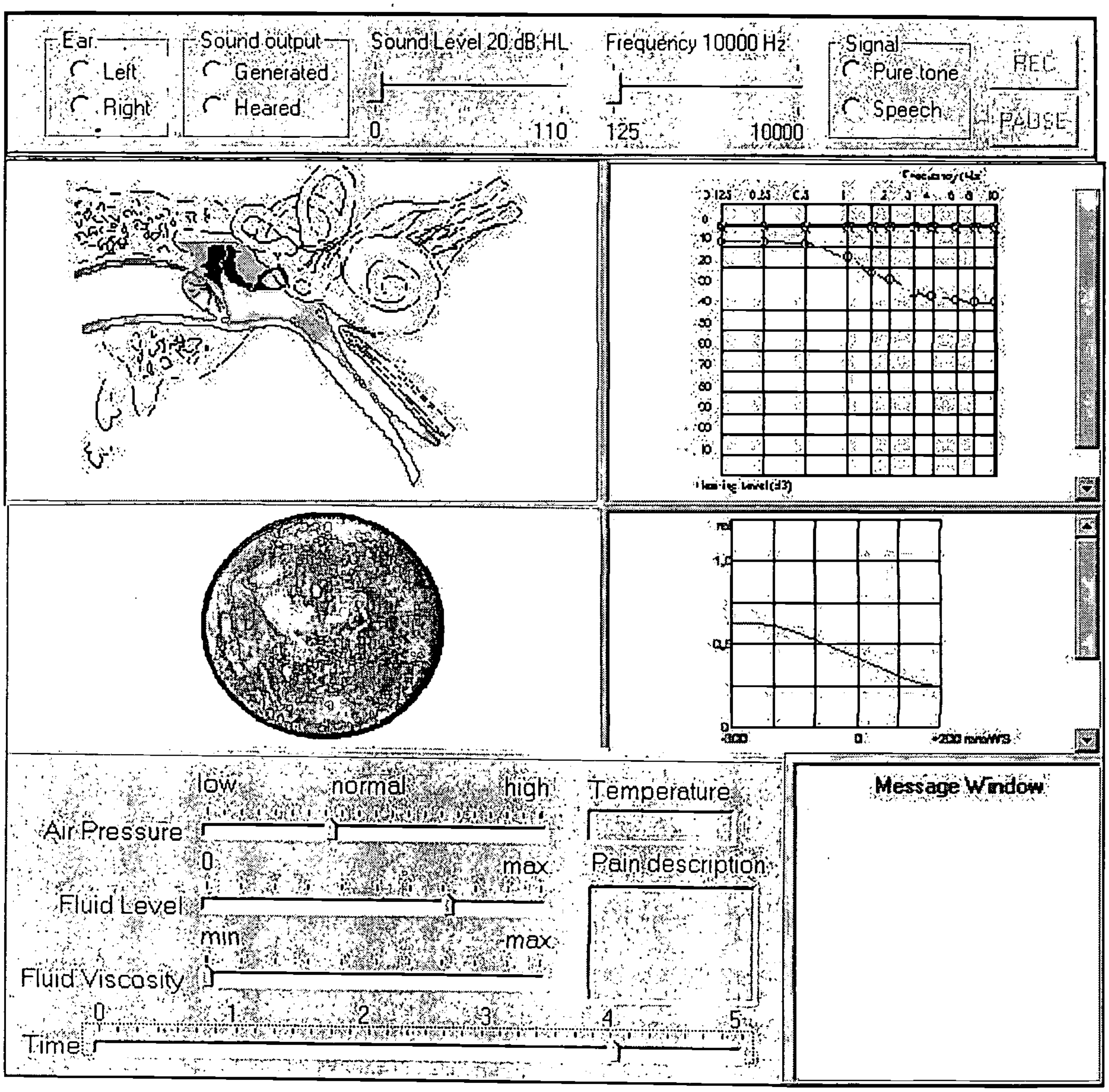

Figure 1: Screen-shot of simulation for Acute Otitis Media in InterSim ear system

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Using Critical ThinkingThrough CD-ROMs To Improve Reading Strategies of Reluctant and Remedial Readers

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Abstract: Since 1993, the Critical Thinking Cooperative (TC^2) has initiated projects with school districts and universities throughout British Columbia, Canada. To date, the main emphasis has been on Social Studies with the exception of some recent work in language arts; however, no research has examined the application of this model to computers, specifically, CD-ROMs and children who experience problems with reading. This paper investigates this application of the model, concentrating on the intellectual tools (background knowledge; criteria for judgment; critical thinking vocabulary; thinking strategies; habits of mind), and discusses the author's data with remedial readers as they work through CD-ROM adventure games.

Introduction

Critical thinking through technology has not been a major area of research in the last ten years nor has critical thinking been used extensively with struggling readers. This paper will examine the use of critical thinking through CD-ROMs to increase reading strategies in remedial and reluctant readers. First, I will outline the three major components of the critical thinking model adopted: (1) community of thinkers; (2) critical challenges; (3) intellectual tools, explaining how each forms an integral part of the model. Then, I will exemplify the five intellectual tools: (i) background knowledge; (ii) criteria for judgement; (iii) critical thinking vocabulary; (iv) thinking strategies; (v) habits of mind (see Figure 1). Next, I will demonstrate how this model and these tools can be applied to CD-ROMs in the area of Remedial Reading. Specifically, examples from a popular CD-ROM adventure game, *Indiana Jones and the Search for Atlantis*, will be shown and I will walk through each of the elements of the TC^2 model by modelling the questions asked of the reluctant or struggling reader. Special attention will be given to the interaction between the reader and the teacher so it is clear that the role of the teacher is, initially, the sage on the stage while the ultimate role of the teacher is to be the guide on the side to create an independent reader. The paper will end with a rationale of why this technique appears to be effective for this type of reader by presenting data from my on-going research and emphasizing the importance of having reluctant and remedial readers read small pieces of text over an extended period of time rather than having them read large reading passages and give up.

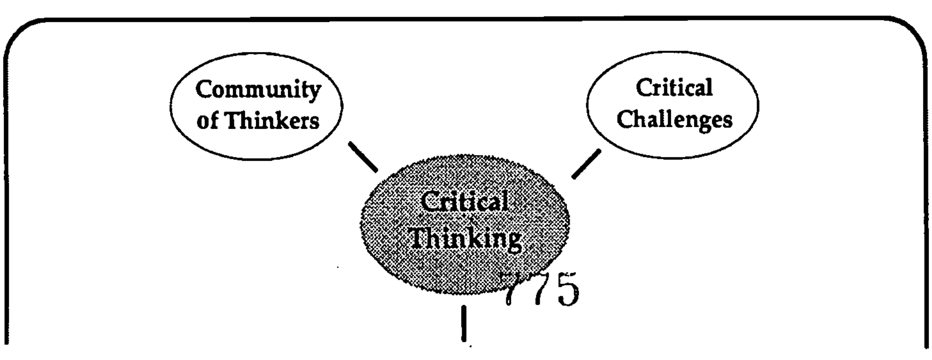

Figure 1: TC^2 Components

TC^2 Components

The TC^2 model [Bailin, Case, Coombs, & Daniels, 1993] has been used extensively in Social Studies [Case, Daniels, & Schwartz, [Eds], 1996] and recently, in Language Arts [Kitchenham, 1998, July], but to date, it has not been adopted in technology studies. The TC^2 model proposes that there are three components which will promote critical thinking in the classroom [Bailin, Case, Coombs, & Daniels, 1994]: (1) community of tools; (2) critical challenges; (3) intellectual tools. A *community of thinkers* is a classroom in which reflective inquiry is valued and that is driven by the premise that critical thinking is not the work of an individual but rather relies on other like-minded individuals [Vygotsky, 1987]. The *critical challenges* are the problematic situations set for the students to complete and are guided by four questions (Does the question or task require judgement?; Will the challenge be meaningful to students?; Does the challenge address key aspects of the subject matter?; Do students have the tools or can they reasonably acquire the tools needed to competently address the challenge?). These challenges appear to be based on a information processing model [Piaget, 1970]. The intellectual tools will be discussed in the next section, [Intellectual Tools].

Intellectual Tools

The intellectual tools component is a fundamental element of the TC^2 model of critical thinking. There are five intellectual tools: (1) Background knowledge is the information about a topic required for thoughtful reflection. (2) Criteria for judgement are those criteria or grounds for deciding which of the alternatives is the most sensible or appropriate for the critical challenge. (3) Critical thinking vocabulary is defined as the range of concepts and distinctions that are helpful when thinking critically. (4) Thinking strategies are the repertoire of strategies, heuristics, organizing devices, and algorithms that may be useful when thinking through a critical thinking problem. (5) Habits of mind are the values and attitudes of a careful and conscientious thinker [McDiarmid, Manzo, & Musselle, 1996].

It needs to be stressed that the TC^2 model, in general, and the intellectual tools, in particular, are grounded in educational psychology theories and, therefore, are very reliable. Vygotsky's *zoped*, or zone of proximal development, is prevalent in the model as the student is moved from his present ability level towards his potential ability level with the assistance of a more experienced reader and thinker [Vygotsky, 1987]. In addition, the notion of scaffolding thinker [Vygotsky, 1987] is built in the model since the student works through various levels of mastery and builds on his own *background knowledge* in an attempt to beat the computer. It is, without a doubt, an information processing model and finds support in the Piagetian notion of child development [Piaget, 1970]. Lastly, it is built on the idea of a taxonomy and includes many of the higher order thinking skills and concepts argued the pioneers of educational taxonomies [Anderson & Sosniak, 1994].

Application to CD-ROMs and Struggling Readers

This model, as applied to reluctant and remedial readers, is quite successful. The primary method of delivering the model to the student is through question and answer emphasizing the five intellectual tools required. Although it is not necessary to include all five tools when applying the model to competent readers, for struggling readers, it is far more advantageous if the teacher attempts to include each of the five intellectual tools.

Initially, the teacher discusses the *background knowledge* needed to understand the game. Specifically, the teacher and the student review (or teach) the characteristics of an adventure CD-ROM such as a quest to be performed by a main character, puzzles to be solved, decisions for which a strategy or tool would be required to master a particular level, and the need to remember codes to go back to starting points in the various levels of the game. In many cases, the reader is quite familiar with these characteristics but they need to be brought to the forefront so that the student remembers them throughout the game. For the more inattentive (e.g., ADD) or distractible students (e.g., ADHD), the qualities of a CD-ROM adventure game are displayed above or beside the computer monitor. In this way, the teacher can make several references to the characteristics as a memory cue or can point to them whenever the student does nor remember them. Within the *background knowledge* concept would the notion that content and procedural knowledge would be transferred from one adventure game to another. In other words, if a student knew that scanning the rooms in the adventure games, *Myst* and *Riven*, meant finding necessary clues and artefacts in that game, then he may be more inclined to apply the strategies and knowledge to *Indiana Jones and the Search for Atlantis*.

In addition, the *criteria for judgement* are continually reviewed. For the most part, the student and teacher go through a series of five "generic" questions:

- Is my estimate accurate?
- Is the interpretation plausible?
- Are our sources reliable?
- Is the conclusion fair to all?
- Is my proposal feasible?

In the case of *Indiana Jones and the Search for Atlantis,* the student might consider whether Indiana Jones would need to take a "logic" route, a "fist" route, or a "team" route and estimate the pros and cons of each route. He may go through an inner-speech dialogue [Berk, 1992] weighing working with Sophia ("team") versus fighting his way through the game ("fist") and decide that working with another person would slow down Indiana Jones (i.e., plausible interpretation). The reader might consider his sources very carefully by looking at a clue book, talking to other players, checking for websites, or considering his past performance in the game. The issue of fairness is quite clear in the "team" route as Indiana has to make many decisions which jeopardize both his and Sophia's lives so discussing the choice with the teacher before executing it is paramount and continuously emphasized throughout the session. Lastly, the student is asked to make predictions at virtually every screen and level of the game and to evaluate whether the proposed prediction is feasible. In *Indiana Jones and the Search for Atlantis,* he needs to decide in which order to perform certain tasks or which of the objects he possesses would be useful and how to use it in a logical or creative manner.

Throughout the sessions, the student is cognizant of any *critical thinking vocabulary* that may be used in the course of the game. For example, in the "fist" route, the student may notice through "direct observation" that he should hit the soldier first and continuously or Indiana will tire while his "inference" may be that the more times he gets in a fight without a rest, the faster Indiana will "die" and the game will be over. Other key vocabulary would include "logic," "informed decision," "generalization/overgeneralization," "educated guess," extrapolate," and "cooperate."

In addition, the *thinking strategies* needed to master the game, such as decision making models, information organization, and role taking, are either modelled by the teacher or discussed between the teacher and the student. Clearly, in *Indiana Jones and the Search for Atlantis,* decision making models are a constant. As stated earlier, the player has to decide which of the three routes to take which, in turn, dictates various paths and levels already programmed into the game; which tools to use in which order; whom can he trust and who is an enemy; which responses in which order will get the answer to a puzzle; which response to a friend or enemy will result in success or failure; and the list goes on. When Indiana is in the maze, an information organizer such as drawing a rough sketch of which rooms contain certain machines or artifacts is extremely helpful in remembering how to get out of the rooms without running into soldiers. And role taking is also an excellent thinking strategy for this CD-ROM. Whenever Indiana has to make a major decision, the teacher encourages the student to put himself in Indiana's shoes and to think through what may happen or what Indiana may be feeling which may, in turn, affect how he will react. In short, the student tends to use higher order thinking skills [Anderson & Sosniak, 1994] and hypothetical reasoning [Piaget, 1970].

Lastly, there are the four *habits of mind*: (1) open-minded; (2) fair-minded; (3) independent-minded; (4) inquiring attitude. Throughout this game, the student is encouraged to pursue his own hypotheses for what might happen based on a choice he makes (e.g., leaving Sophia by herself, knowing that she could be kidnapped); however, he is also expected to consider evidence which refutes his hypothesis and to make a new hypothesis, using the new evidence (i.e., open-minded). Often, the teacher will pose an alternative point of view to the student (e.g., Sophia may be able to help Indiana work out how to get the knife from the knife-thrower in Algiers), expecting that the student will argue or accept the new view, temporarily (i.e., fair-minded). In this challenge, the student sometimes will not accept the new hypothesis (i.e., independent-minded); however, he must always supply concrete evidence for why he is standing behind his view (e.g., last time, Indiana was trapped when he went into the machine room). Consistently, the reader must question his own claims (i.e., inquiring attitude) and be willing to seek justification, when needed (e.g., taking a balloon versus the camel to cross the desert).

Rationale

Now, to why this technique seems to be effective for the struggling reader. Based on my on-going research, there are three salient reasons this technique is so successful: (1) the reading material; (2) the familiarity of the genre; (3) the series of mini-successes which build to the major goal.

Based on my ten years of working with struggling readers, I feel confident in saying that most reluctant and remedial readers do not like to read for long periods of time. When they do read, it is usually material which is pleasurable for them and chosen by them. The reading material in *Indiana Jones and the Search for Atlantis* is between the grade three and grade seven reading levels (based on a modified Fry readability formula), but more importantly, the passages are quite short so that the struggling---either reluctant or remedial---reader believes that he is receiving manageable sections of text. In fact, the student reads about 10 to 12 words in each line of dialogue so with four lines of dialogue, the student reads approximately 2000 words over a thirty-minute period. In addition, much of the dialogue has an immediate payoff so that the reader knows that he will be moving on in the game whereas in many books and short passages, the reader has to wait a long time to see the evidence of his hard work of slogging through the text. The familiarity of the Indiana Jones movies and videos also adds to the overall understanding. Lastly, the reader tends to feel empowered as he is making many of the decisions in reading even though the teacher has both direct and indirect input.

Many children are familiar with the genre of CD-ROM adventure games and therefore, the teacher is beginning with a framework with which students are already comfortable. In my private practice, I have discovered that over 90 percent of the struggling readers know that the CD-ROM adventure game frequently involves a quest, it has some form of puzzles, and that the player must always be ready for surprises---not to mention, remembering to save the game a lot! My latest observations of children working with the next generation of *Myst*, indicates that *Riven* may be even more successful based on the child's familiarity with *Myst*. Lastly, the remedial and reluctant reader knows that good will overpower evil as long as he knows how to get there.

Adventure games are based on a building-blocks, or scaffolding [Beyer, 1997] concept. As the player learns more strategies, acquires more tools, codes, or artifacts, and learns from his mistakes, the pace of the game increases but also, the level of the game increases. That is, the game allows the player to receive a series of successes which enables him to move toward the end goal [Vygotsky, 1987] of winning the game and "beating the computer." For a struggling reader, seeing tangible evidence of these victories in the form of moving through a level faster the second or tenth time or knowing that a particular response will cause the villain to react in a certain manner is absolutely crucial.

Conclusion

In sum, the TC^2 model, using popular CD-ROM games, clearly increases the reading strategies of remedial and reluctant readers. Paramount is the confidence these readers have after several hours of working with the genre. There are other strategies. The remedial student understands the importance of anticipation and prediction which are major elements of the reading process; he increases his sight vocabulary and has many words reinforced throughout the game; he learns the importance of metacognitive (inner) dialogues. The reluctant reader tends to become a risk-taker and will attempt to sound out or guess at unfamiliar words; he will read voluntarily even if it is only for a slightly longer time; he often makes predictions based on previous passages or prior knowledge. Both the remedial and reluctant reader also learn about the importance of sources for clarification. Thus far, this model and the use of CD-ROM adventure games has proven to be more successful than any technique I have used in the past.

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A Visual Authoring Tool for the Web-Based IntelligentCAI and its Evaluation

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Abstract: This paper discusses courseware authoring for CALAT, a Web-based intelligent CAI system, mainly from the standpoints of courseware design support. CALAT has the ability to adapt to individual learners, dynamically selecting the material to be presented based on each learner's comprehension and other parameters. Most of conventional adaptive intelligent CAI systems required spending a much time and having know-how for courseware authoring, making it difficult for specialists in the field of learning to create courseware. In our system, a design method based on courseware knowledge structured around learning goals and a scenario was introduced to overcome these problems. This paper describes the authoring tool for creating this courseware knowledge in the design step, providing 1) visual editing for courseware knowledge, 2) spiral-type designing support, 3) automatic generation of courseware. An experiment in which subjects used the prototype authoring tool to create courseware, showed that the spiral work flow consists of a few different types of circle and the tool is working effectively in the courseware design process.

1. Introduction

The use of computers as learning support systems goes back many years to the days of drill-based systems that were little more than page-turning machines. In time these developed into intelligent CAI systems, able to adjust their contents to individual learners based on comprehension success and other learner-specific factors. The research devoted to intelligent CAI systems, however, has traditionally focused on obtaining a detailed model of student characteristics and developing teaching strategies accurately pegged to this model [Wenger 1987]. Creating courseware for these systems requires nearly the same degree of effort and know-how as for system development. By no means is courseware authoring something that can be performed easily by instructors whose specialty is in the particular field of learning rather than programming. Recently some authoring systems are trying to make it easier to create courseware for intelligent CAI [Brusilovsky 1996][Murray 1997].

In the field of software engineering technology, meanwhile, the integrated development tools, which cover all development stages such as the analysis, design, implementation and make possible to build software in spiral-type, has lately attracted considerable attention. It is reported that the trusty software can be developed rapidly, making prototype repeatedly. There are few tools supporting spiral-type design in the field of courseware creation because the importance of the methods might not be recognized yet.

We have been developing CALAT, a Web-based intelligent CAI system [Nakabayashi 1995]. The aim of CALAT is achieving both a high degree of adaptation to individual learners and a courseware authoring system that can be used readily by specialists in the courseware field even without system or programming skills. The basic idea is integration of both the ease of courseware creation in frame-based CAI and the capability of adaptive behavior in intelligent CAI. The frames, that is, are presented to the learners like frame-based CAI, inferring from the courseware knowledge attached to each frames in order to achieve the individual adaptation. The visual authoring tool for creating the courseware knowledge provides the functions for not only data entry but also courseware design, supporting spiral-type design methods for rapid courseware development.

In the following sections we give a brief introduction to CALAT and explanation of the courseware structure. We then present an authoring tool for supporting the courseware design step and describe its evaluation in actual courseware creation.

2. Courseware Structure

2.1 Outline of CALAT System

CALAT (Computer Aided Learning and Authoring environment for Tele-education) is a client-server type distributed intelligent learning system using the World-Wide Web, which provides intelligent CAI services.

Students using a Web browser such as Netscape Navigator or Microsoft Internet Explorer simply access the CALAT server. By presenting their own ID, they can enjoy the CAI services from anywhere in the world, at any time. All the courseware is located on the server. While the student is on line, the server monitors "Next screen" requests and exercise results, determines the next material to be presented, and sends the screen images and audio information to the student terminal. The learner's comprehension is measured based on practice exercises, and on this basis the system selects and orders the materials presented to each learner. A learner who is relatively slow to comprehend is therefore given detailed, repeated instruction and practice, with remedial lessons as needed, whereas a learner who is quick to grasp the contents is moved along at a more efficient pace.

This system is configured of courseware knowledge, which is the systematic knowledge in the particular field of learning, teaching strategy knowledge relating to how instructors impart learning, and student information keeping track of each learner's comprehension of the material and other learner-specific factors. Of these, the courseware author need be concerned only with courseware knowledge; the others are provided in the system itself as generalized knowledge not dependent on the courseware contents. Input by learners is passed to the teaching strategy part, where teaching strategy inference is carried out based on the courseware knowledge and student information, and the material to be presented to the learner is decided. The student information itself is continuously updated by the teaching strategy part so that the latest learning status is always reflected.

2.2 Courseware knowledge

Courseware knowledge consists of the multimedia materials (expression layer) presented as courseware "scenes" to the learner, and courseware structure knowledge describing the logical structure of the courseware itself (logical layer). The latter knowledge is essential information making up intelligent CAI courseware. The expression layer and logical layer are of course different in representation, but ideally they should describe the same contents. In reality, however, the logical layer descriptions tend to be highly complex, imposing too great a burden on most courseware authors. An important requirement in courseware authoring is to realize a high level of teaching effectiveness while defining courseware structural knowledge that allows for ready implementation. Our system describes the courseware structural knowledge as follows [Fukuhara 1995].

1) Learning goals: The learning goals list the knowledge to be taught to students, in specific statements such as "be able to do x" or "understand what y is." This is also called "what" knowledge. Once the courseware subject is determined, the list of learning goals should be practically the same regardless of the courseware author.
2) Scenario: The scenario defines the courseware story (what will be taught in what sequence). It corresponds to the chapter and page arrangement of a book. This is also called "how" knowledge, and will likely be different for each courseware author even if the field is the same. In our system, chapter and page of book is called "Section" and "Element", respectively.
3) Relational information mapping the scenario to the learning goals: This information defines the correspondence between the learning goals and the scenario sections and elements. Since one element may teach two or more learning goals and one learning goal may correspond to two or more elements (taught in different ways), the two have a many-to-many correspondence. A relationship is likewise defined between each of the questions asked in a practice exercise and the learning goals they cover.
4) Relational information mapping the scenario to multimedia materials: Defined here is the screen information presented to students on each element of the scenario. In CALAT the relation to screen information is designated as a URL (Uniform Resource Locator), so potentially any multimedia information available on the Internet could be designated [Maruyama 1996].

In the process of conveying knowledge (for example, when writing up a plan or a report, or writing a book), the above systematization of knowledge into learning goals and a scenario occurs quite naturally. In many cases the learning goals may not be laid out explicitly, but we can always expect them to exist in the thought process. This kind of courseware structural knowledge is both natural and clear-cut, so it enables an individually adaptive learning environment to be provided with little burden on the courseware author.

3. Courseware Authoring Tool

3.1 Courseware creation procedure

When courseware is created for CALAT, there are four main steps: (1) courseware planning, (2) courseware design, (3) data entry (multimedia materials preparation), and (4) evaluation.

1) Courseware planning

Determine the intended users of the courseware to be created and the primary learning goals.

2) Courseware design

Carry out the following steps in order. Of these, 2-2) and 2-4) may be carried out in parallel.

2-0) Gathering information: Obtain and study information on the courseware field.
2-1) Organizing the learning goals: Make a list of things to be taught (learning goals).
2-2) Designing the scenario: Decide the courseware story (sequence in which the learning goals are to be presented; the chapter-section arrangement) and then make the relation between the scenario and learning goals.
2-3) Creating exercises: Make exercise problems for each learning goal, and define their relation to the learning goals.
2-4) Making drafts of the multimedia materials: Create a rough sketch of the scenes to be presented to students, and define the relation between scenes and the scenario.
2-5) Testing: Check the courseware data to make sure it is complete and consistent.

3) Data Entry (Multimedia materials preparation)

Create the scenes presented to students using tools for each of the media used. Note that materials created by others can be reused by pointing to information resources elsewhere on the Internet as URL.

4) Evaluation

Evaluate the courseware by prospective users and also check it not to have wrong descriptions by expert in the field of learning.

In the following section, we mainly describe the support functions for courseware design step.

3.2 Tool for Courseware knowledge design

With the original authoring system used for CALAT, all courseware design is done on paper. The courseware author, following the procedures outlined above, organizes in table format the courseware knowledge consisting of learning goals, scenario, practice exercises, and the correspondence between learning goals and scenario, etc. Only after this work is completed and found to be free of any inconsistencies is the design information entered in the authoring system, using table-based editors. This approach, however, has certain drawbacks.
a) At the design stage the courseware author has to go through a repeated process of trial and error to refine and develop the courseware knowledge. For example, arranging the learning goals and scenario involves repeated breaking down and grouping in order to achieve the desired results, yet the process of refining the courseware knowledge during the design stage is not given any support functions.
b) Since system entry takes place only after the design is completed, the courseware operation cannot be checked until the final stage of authoring. In other words, the steps of design, entry and evaluation proceed sequentially in a so-called waterfall development style, making it difficult for the courseware author, let alone others, to get a good grasp of the overall courseware image at an early stage.
We therefore implemented the following two courseware design support functions to alleviate these difficulties [Kiyama 1997].

3.3 Design information editing tool

The courseware design tool is highly visual and fully integrated. The tool, as shown in [Fig. 1], consists of an

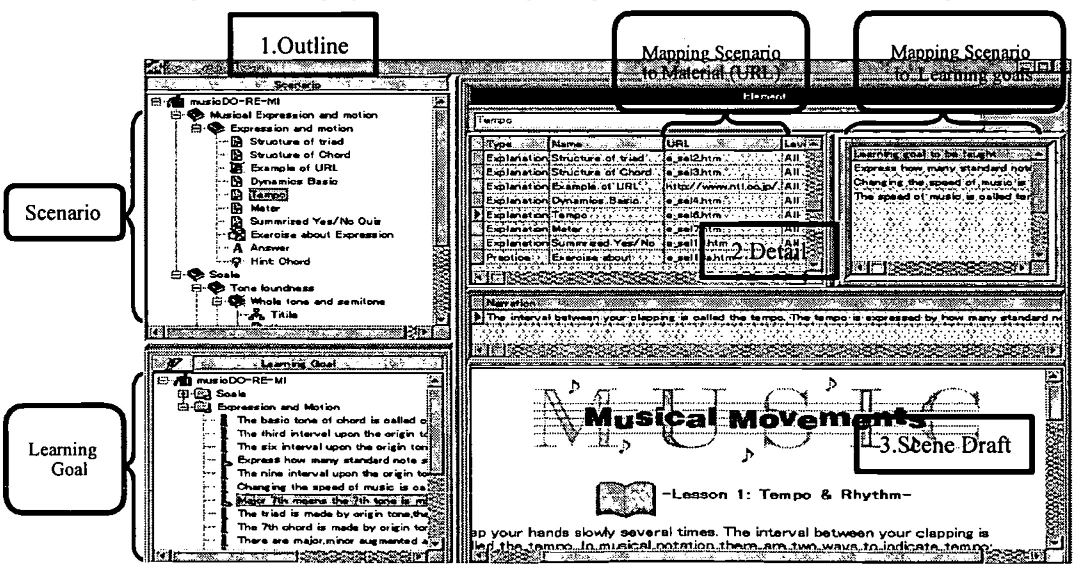

Figure 1: Courseware Design Tool

outlining function (left part of the screen) and detail design function (right part). The outliner shows the learning goals (lower part) and scenario hierarchy (upper part), while the detail design function displays the detailed attributes of each learning goal and scenario division (upper part) and scene draft (lower part). The outliner enables the moving of any part up or down the hierarchy or to any place, insertion and deletion, the making items void temporary and so on. It is therefore useful for refining the learning goals and scenario by changing the breakdown and grouping as necessary. The detail design function already has default values set for each of the attributes, making it possible at the initial design stage to create working courseware simply by editing with the outliner, without having to make any other entries. Data entry for attributes can be made as the design work proceeds and details become fleshed out. In this way a spiral-type RCD (Rapid Courseware Development) design approach is realized, enabling courseware operation to be checked as soon as the basic and essential information has been entered, followed by a gradual refining and improving of the quality. In addition, the knowledge mapping (relating learning goals to scenario and relating scenario to multimedia materials) is carried out visually, with the scene draft shown and edited in the same window as the scenario attributes.

3.4 Automatic generation of courseware knowledge

Even with the courseware design tool, there is still a large amount of information to be created, compared to a traditional Frame-based CAI system. Automatic generation of courseware knowledge is another possible way of advancing RCD. Here automatic generation means creating courseware knowledge based on other existing courseware knowledge, for example, generating a scenario from the learning goals. The results of the automatic generation process do not have to be perfect; it is assumed that the courseware author will make corrections and adjustments as necessary.

We indicated a courseware design procedure that starts by listing learning goals and then creating a scenario. That, however, is simply a typical approach. Observing the actual courseware authoring tasks, we can see that there are three possible cases described below. The automatic generation input and output are different for each case.

[Case 1]: A specialist in a given field creates the courseware from scratch.
The courseware author should be able to list the learning goals easily, but in many cases will find the task of making a scenario difficult or troublesome. In this case support can be given for generating the hierarchical scenario structure from the learning goal structures. The relation between learning goals and scenario sections is 1-to-1 simply.

[Case 2]: Courseware is created based on textbooks and reference works.
The author can make use of the existing table of contents and organization for the scenario, but may need help drawing up learning goals and mapping them to the scenario. Here support is given for automatic generation of learning goal structures from the scenario layers. The relation between learning goals and scenario sections is 1-to-1 simply.

[Case 3]: Courseware is created based on actual test problems.
The author can readily prepare exercise information, but the problem will be organizing the courseware sections corresponding to the exercises, creating explanations and other parts of the scenario, and mapping learning goals to the scenario. Support functions will take the form of automatic generation of the scenario organization from the test problem configuration, and generation of information mapping scenario explanation pages to learning goals based on the learning goals of the answers and problems. Each question may be categorized in a few groups.

Obviously, courseware generated in these ways will not be very good courseware. These functions can, however, serve the purpose of providing the courseware author with an initial design proposal as part of a spiral design process.

4. Evaluation

4.1 Experimental approach

The authoring tool has a function for saving the operation log as a file. The subjects were asked to use the tool in actual courseware authoring, then the recorded logs were analyzed.

The environmental issue of "acid rain" was assigned as the courseware topic. The subjects first received a brief (approximately one hour) explanation of the courseware creation procedures as described preceding chapter, and of the authoring tool operations. Then they were given another hour to practice with the tool in order to master its use. After they had learned how to work with the tool, they were handed a 12-page textbook on acid rain and asked to being creating courseware. Their task was limited to the courseware design steps, including scene draft creation, and did not cover multimedia material creation. The finished courseware consisted of from 20 to 30 scenes, equivalent to about one hour of courseware when filled out with narrations and the like. Three subjects were involved in the experiment, consisting of one (A) with no courseware authoring experience, one (B) with experience both in courseware authoring and with the use of the tool, and one (C) with courseware authoring experience but no experience with the tool.

4.2 Results and analysis

[Fig. 5] reconstructs the courseware design steps based on a subject's log information. The lateral axis shows the number of operations (elapsed time), while the vertical axis shows the individual processes (sub-processes) within the overall design process. These sub-processes consist of (1) setting learning goals, (2) making a scenario (sections), (3) making the scenario elements, (4) making exercise elements, (5) mapping the scenario to the learning goals, (6) creating scene drafts, and (7) testing the courseware.

In each of the subject's logs a spiral design pattern is to be discerned, by which they move back and forth among the sub-processes. The spiral consists of larger cycles and smaller loops within the cycles. A large cycle runs from the start of courseware authoring or revision to the completion of testing. In the case of subject A, in cycle C1 a courseware prototype was created, and in cycles C2 and C3 the courseware was revised to improve its quality. The scale of C1 is rather large (around 800 operations), whereas cycles C2 and C3 were only about 300 operations each. The smaller loops within the cycles consist of efforts to acquire, organize and refine the knowledge in repeated trial and error. For example, for subject A, cycle C1 consists of four small loops, L1 through L4, of around 100 to 300 operations each.

(L1) Learning goals → Scenario (sections) →

(L2) Learning goals → Scenario (sections, elements) →

(L3) Mapping scenario to learning goals → Learning Goals → Scenario → Scene draft

(L4) All sub-processes

When asked about the process of courseware authoring, subject A explained the approach as one of first

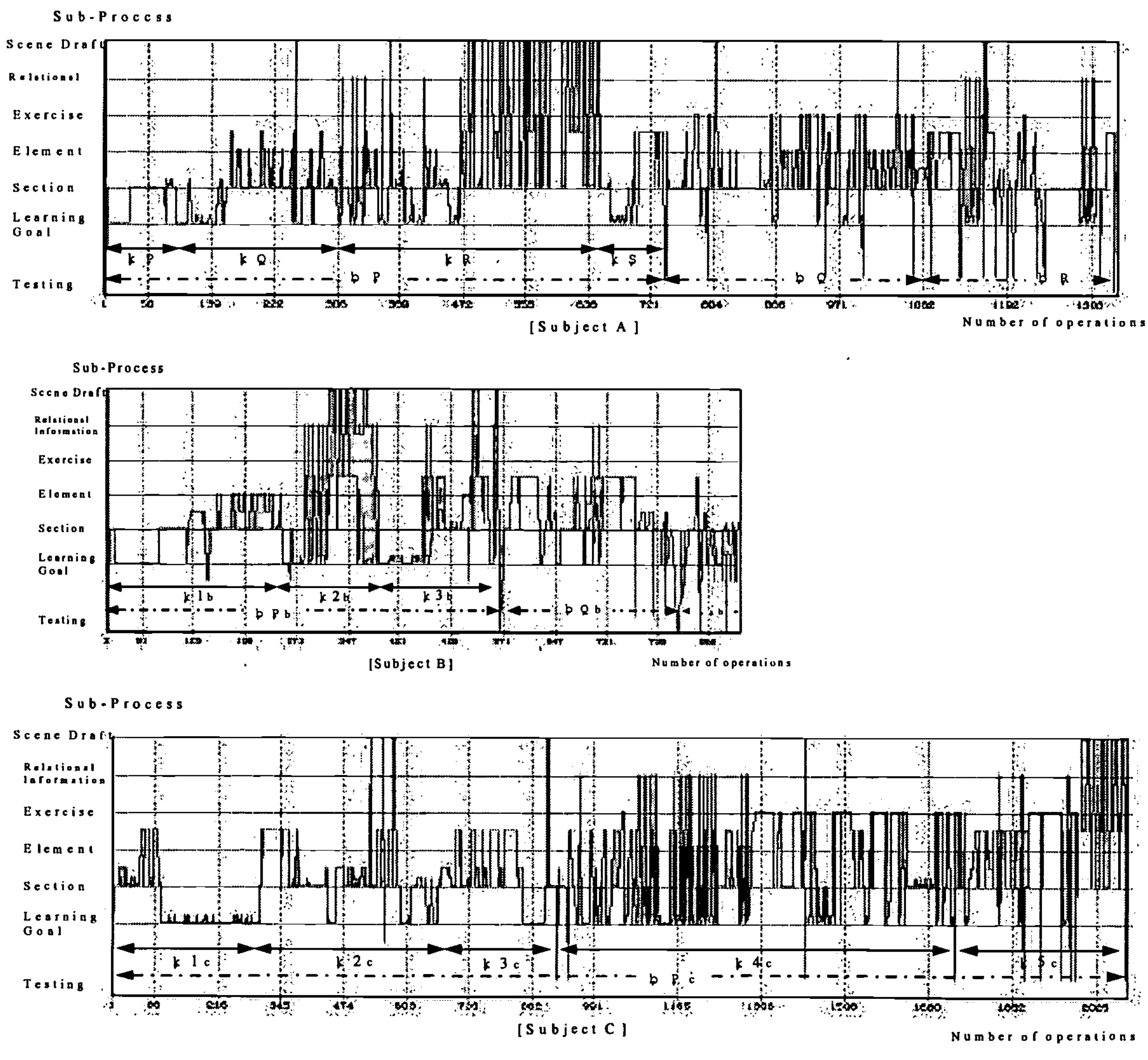

Figure 2: Analysis of Courseware Design Steps

deciding the broad outline of the scenario based on the most important learning targets (L1), then coming up with other related targets to make a more detailed scenario (L2), further refining (adding and revising) the learning targets in the process of mapping the targets to the scenario (L3), and finally shaping the courseware by changing the presentation sequence, etc., in order to make it easier to follow (L4).

In the process of designing courseware, moving back and forth among sub-processes is a highly natural approach. The experiment showed that a spiral work flow is applied also when using this tool. This is one indication that the tool is working effectively in the courseware design process.

Table 1: Use Frequency of Refinement Operations (Subject A)

Cycle	Operation Count	Percent of Total(%)	(Total operations in cycle)
L1(C1)	9	9	95
L2(C1)	30	13	238
L3(C1)	54	16	347
L4(C1)	39	57	69
C2	36	11	324
C3	21	8	262

Subject (B), who had previous experience with the tool, exhibited an absence of wasted operations, with fewer overall operations and a lack of meaningless transitions between processes. Yet the number of cycles and loops differed little from subject A, a rank beginner (3 small loops and 3 cycles). This suggests that the tool can be useful regardless of whether the user is experienced or not.

Subject (C) took a different approach from the others, starting not from learning targets but from the scenario writing step, then listing the learning targets. The sequence of sub-processes may well differ depending on the author and the subject matter; but this tool lends itself naturally to a diversity of courseware authoring approaches, making it possible to start from any desired point.

An analysis was also made of the courseware refinement process. This tool supports a trial-and-error approach to designing courseware, with operations for changing and moving the learning targets and scenario sections or elements, for grouping elements or breaking them down, and so on. [Tab. 1] shows the number of times refinement operations were used and their percentage of the total operations (subject A). Apart from L4, L3 was highest in number of operations (54) and percentage (16%). The reason for this result is likely that the initial design stages (L1, etc.) are used mainly to extract knowledge and do not require very many refinement operations, whereas the subsequent stages involve more trial and error. The percentage of refinement operations in L4 was the highest at 57%, but these were used for shaping the courseware and are not to be considered pure trial and error.

5. Conclusion

An intelligent CAI system using the World-Wide Web is attracting attention as a system that makes possible individually adaptive learning at any time or place. A conventional intelligent CAI system, however, requires a similar degree of effort and know-how for courseware authoring as for system development, and does not enable courseware authoring to be carried out practically by instructors or other experts in the field of learning. The authoring methods described here makes use of a courseware knowledge structure consisting of learning goals and scenario, and enables courseware with a high level of individual adaptation to be created readily by specialists in the courseware fields. For efficient courseware creation, we have proposed a visual authoring tool for supporting courseware design step in which the spiral-type design and knowledge refinement operations are required. Analyzed the design process when using this tool, it was found that spiral work flow consists of 3 circles and 3 or 4 smaller loops for one hours of courseware. Issues for the future include devising ways of reusing existing courseware and resources on the Internet, and creating a framework for courseware evolution.

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Using a modular construction kit for the realization of an interactive Computer Graphics course

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Abstract: In [Klein & Hanisch 1997] we described the concept and realization of a interactive computer graphics course combining lectures, example applets, programming exercises, documentation etc. within a common sophisticated web-based framework. This course allowed for adequate teaching of topics that require both, visualization and interaction. Although it greatly simplifies teaching and learning of the various contents extending the course is still difficult for several reasons: the restricted reusability of its programmed components, the complexity of the particular applets, the complicated low-level programming of the applets and various inhomogeneous API's.
Recently, new platform independent software component models like JavaBeans appeared that allow to write reusable components and compose them in a visual builder tool into new applications. In this paper we describe how we used such models to transform the existing course into a modular construction kit consisting of components of teaching text and program classes. The program classes consists of Java Beans which can be composed together into an application using a Visual builder Tool.
Although the components are used for the generation of a computer graphics course they are much more general and might also be used for the generation of other extendable and interactive Web-based courses.

1 Introduction

Visualization and *interaction* are the major topics of current computer graphics. Teaching this issues using only traditional teaching methodologies and tools, such as blackboards, slides, and even videos cannot provide real-life examples. Only in real-life settings teaching can react flexible on the different questions occurring during the discussion of a certain subject and as in physical research, computer graphics problems and challenges can only be recognized through the exploration in experimental setups [Owen 1994]. In computer graphics such experiments consist of interactive programs which allow to manipulate parameters and animate and visualize complicated algorithms. Working with such a program not only helps to illustrate problems but also to motivate students. Furthermore, providing the student with these programs enables him to repeat the experiments, to build up his own settings and to deepen certain aspects. This greatly improves the consolidation of lectures at home. As a major goal of the exercises the student should learn to implement the graphics algorithms dealt with lecture [Naiman 1996].
In the meantime the World Wide Web (WWW) together with embedded Java programs (applets) and Hypertext provides an appropriate framework to generate common interfaces for the integration of all elements of interactive teaching courses, such as lectures, programs, exercises, and consolidating literature references and there is already a number of computer graphics courses [Calgary/CS 1994, Owen 1995, Cornell/TC 1996, Shabo et al. 1996, Klein & Encarnação 1997] that benefit from these techniques including our own web-based interactive computer graphics courses "Computer Graphik spielend lernen I & II" [WSI/GRIS 1996/97].
Although our course greatly simplifies the teaching and the learning of computer graphic topics, extending the course is still difficult for several reasons: the restricted reusability of its programmed components, the complexity of the particular applets, the complicated low-level programming of the applets and various inhomogeneous API's.
Recently, new platform independent software component models like JavaBeans appeared that allow to write reusable components and compose them in a visual builder tool into new applications. In this paper we describe how we transformed the existing course into a modular construction kit. This kit contains on one hand tools to integrate components of teaching text into one Hypertext document containing links to corresponding Java-applets and vice versa, and on the other hand it contains software components that can be composed together into demonstration application by teachers and students. A similar approach was chosen by Wernert [Wernert 1997].

He describes a unified environment for presenting, developing and analyzing graphics algorithm based upon IRIS Explorer, a modular visualization environment which provides a visual data flow language and allows user to link computational modules in order to create visualizations. A further similar approach is described in [Land 1994]. This nice system allows high level programming (network wiring) to analysis problems to more traditional coding of new modules. But there are also some drawbacks. First of all IRIS Explorer is not platform independent and only available on high-end PCs and SGI-workstations. Second the application cannot be interlinked with a WEB-based environment like our own course. For students even more interesting are the financial costs of a commercial system like IRIS Explorer, AVS or IBM Data Explorer.
The rest of the paper is organized as follows: in section 2 we first give an overview over the existing courses. In section 3 we discuss the challenges we were faced with extending and improving the course. The section 4 of the paper describes the construction kit and the software architecture that we used to meet that challenges. This section includes the component based programming environment (JavaBeans) and the compilation tools developed to integrate the different parts of the course as well as examples how to generate an applet using existing building components. We conclude with section 5.

2 The Course

2.1 Contents

The course contains the following topics: Computer graphics hardware, raster algorithms with aliasing and anti-aliasing, 3D-transformations, visibility, color, local illumination schemes, modeling techniques, simple animation, texture mapping, global illumination techniques (ray-tracing, radiosity), and volume visualization, distributed into two courses. Both are based on, or related to, the books [Encarnação et al. 1996a, Encarnação et al. 1996b] and corresponding written for the Fernuniversität (Correspondence University) in Hagen, Germany.

2.2 Structure

A hypertext page [WSI/GRIS 1996/97] provides an unified interface to our Web-based computer graphics course. Starting at this page one can follow links to hypertext pages containing or referring to·

1. the instruction manual and editorial of the course itself,
2. the course text (script),
3. an index of all available applets and the application interface (API),
4. the programming exercises and
5. links to external documentations and sources.

The instruction manual first gives a short introduction to the course, hints for private studies and provides a list of symbols used throughout the course. In addition it gives a short overview over the design of the course, the programming architecture, the file structures and last not least it reports known bugs, such as the different behavior of certain applets on different browsers. This list of known bugs and comments can be extended by the user. The external links provide the student with tutorials e.g. for HTML and Java, public domain software, other Web-based courses and further useful stuff.

2.2.1 Course text, applets and API

The whole course text is available as hypertext and is presented in an own browser window. The contents and structure of the hypertext is the same as the one of the original course text. The hypertext contains not only cross references to figures, tables, literature, exercises and footnotes but also links to corresponding applets, to the API and a number of videos and slides that were shown during the lectures. If the user follows a link to an applet or a video, it is started in another browser window.
Vice versa the hypertext pages containing the applets also provides links into the course text. In such a way the user working with an applet can immediately get the corresponding theoretical background. In addition, to each applet there is a fourfold kind of documentation made available: An introduction, details on its features, a guided tour covering its essential topics, and general information on its programming architecture. The latter one also contains links to the API. Since the classes of the API also provide hyperlinks to applets that demonstrates their usage in real examples and hyperlinks to the course text (like e.g. Camera), the course text, the applets, their documentation and the API are fully interconnected. Note that all these elements are shown simultaneously in their own browser windows (cf. Fig. 1).

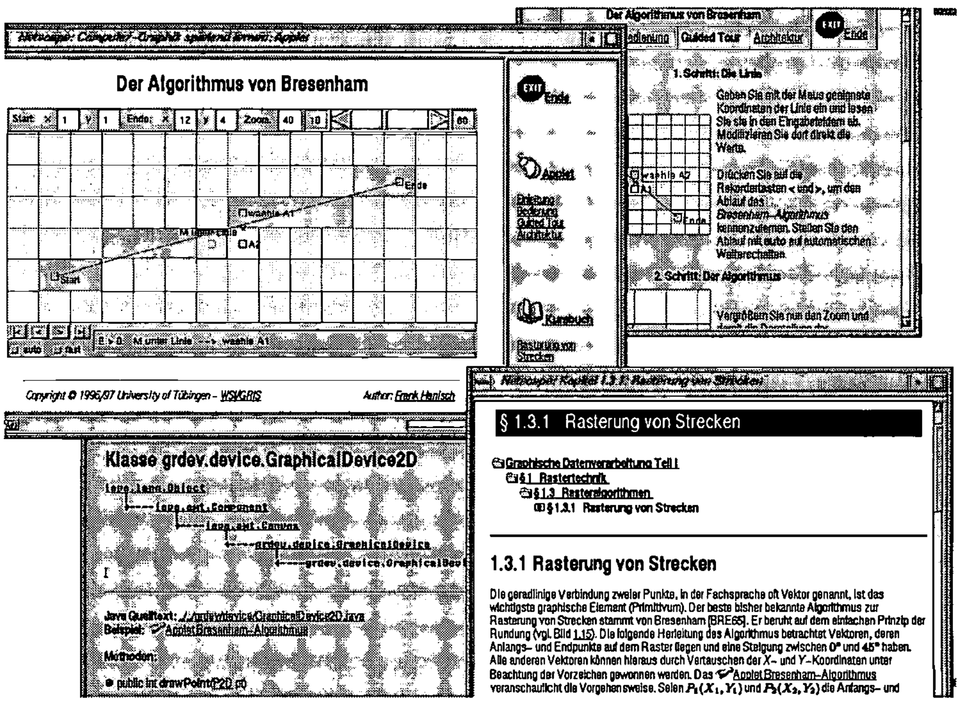

Figure 1: Interconnected course text, applet, documentation and API.

2.2.2 Programming exercises

In the programming exercises the students complete the code of a given Java-applet. The Java source code of the environment is available as a hyperlink and can be down-loaded by the students. A comprehensive written instruction is available for each exercise in the form of hypertext pages. In order to read it the students need to use a Web-browser, such as Netscape Navigator ^{TM} or Microsoft Internet Explorer ^{TM}. Since one of the aims of our course is to make the students familiar with graphics programming, it is important to provide them with sample programs to work with. Therefore, in addition to the instruction for each exercise a small programming example is provided. Since all these components of the course are integrated into a common interface, permanent switching between the theoretical background information, the description of the exercises, and the source code of the latter is possible and greatly supports the students during the completion of their programming tasks.

2.3 Course Summary

The described course environment increases the learning success of students through a common interface integrating lectures, programs, programming exercises, user support, and related literature references, thus optimizing the coordination among these basic parts of a course. It realizes a graphical system that contains all the basic functionality that modern 3D graphics system share, yet staying simple enough so that the basic concepts and mechanisms can still be easily understood by the students. It enables students to deepen the different contents of the lecture and explore the different algorithms.
The course provides different approaches: either to start with the theory using the script and to complete it with examples and programs or to start and motivate with examples and then take a closer look on the theoretical background. Its object-oriented design and implementation provides a simple and modern programming concept. Furthermore, the use of Java as programming language assures platform-independence.
Using our course teachers and students are enabled to theoretically and practically prepare, catch up on, and deepen the lectured course. There is no need to provide for and install a variety of software packages to be able to run the practical examples at home. Moreover, interested students are able to extend the examples.

3 Extending and modifying the course: The Challenges

3.1 Connection between course text and the applets

The current course contains about 70 highly sophisticated applets covering all topics of our graphic course. A drawback of the current situation is that a single applet provides to much functionality. For example the applets on BSpline-Curves contains the BSpline curves itself, the BSpline basis-functions and the knot-vectors. Reading the part about BSpline-basis functions and invoking the corresponding link the student get the whole applet. Instead of being focused to the basis functions the student is distracted by that functionality of the applet which is irrelevant in the current context. To get more focused references, also the small components of our applets must be provided as autonomous applications.

On the other hand extending the framework of a course the teacher should be able to use already existing components to generate new applets in a easy and fast manner.

3.2 Generating new applets

The strict object oriented design of our Java-applets simplifies the programming of new applets and classes. Many of the existing classes can be reused and extended. Nevertheless, to generate new applets still requires low-level programming. Students or teachers not familiar with the existing classes have to wade one's way through the jungle of hierarchical APIs, instead of concentrating on the structure and concepts of the algorithms. As already shown by a number of authors visual programming greatly aids in developing and debugging code [Wernert 1997, Lotufo & Jordan 1994].

3.3 The programming exercises

Since the low-level programming is too time consuming without visual programming our students only complete already existing applets. The drawback of this kind of programming exercises is, that most of the students are not able to understand the overall structure of the program. Although they successfully implement the missing parts there remains a bad feeling. Again, this problems can be solved using a visual application builder in combination with low level programming and studies of existing code.

4 The construction kit

4.1 The hypertext

The ingredients for the hypertext were the course text as Latex source with images, the applets and the exercises. In the first step we manually created an applet resource file containing all information necessary to automatically generate all hypertext environment of an applet. This includes the applets' documentation and keywords used to generate hyperlinks into the course text. The actual pages containing all HTML-tags for the applet (header, hyperlinks to the documentation or course text and applet parameters) are then automatically generated by a Perl script. This guarantees an easy-to-modify and unified outlook of all applets and saves an immense amount of time in the design of these pages.

Subsequently those applet resource files are used by a further Perl-script to automatically generate an index of all applets. Aside from hyperlinks to the applets this index page contains their titles, introductions and motivating images.

In an independent step the original Latex source was modified. As a first step links to the different applets are placed into the course text. As a second step anchor points named by the headers of sections and subsections of the course text were automatically inserted. This anchor points are later on referred by hyperlinks of the corresponding applet pages. The names of the anchor points are copied into the corresponding applet resource files. After these two steps we used the program `Latex2html` [Drakos 94] to convert the course text into an HTML format, which still contains the unprocessed anchor tags. These tags are processed in a further step by an additional Perl-script which generates the special course text structure developed for our course. This structure allow for folding and unfolding the hierarchy of the chapters. For each text page on the lowest level of the hierarchy automatically links to the previous and next text page as well as links to all predecessors in the hierarchy.

4.2 The applets

In the realization we put special emphasis to a common, easy-to-use interface of the applets. This is especially necessary as the whole course contain a variety of different topics and the functionality of the applets differs greatly. Some of the techniques we use are *same colors for the same context, same outlook of labels and control elements with identical meaning and same mouse control.* Very important for the design of the applets for teaching purposes is a *clear structuring* of the visible information. At a first glance the student must be able to recognize the topic of the applet, the key elements of the teaching content and the connectivity between them. Therefore, the visual part of the applet containing these information must attract his attention more than special control elements to steer certain parameters. Otherwise, the applet would overwhelm the student by a forest of equivalent choices.

4.3 The Beans

As stated in its specification [Hamilton 1997] a JavaBean is a reusable software component that can be manipulated visually in a builder tool. The components can either be an object with or without graphical interface. Typical beans in our course are

- interface components that extend the standard Java AWT.
- mathematical and geometrical utility components like vectors, matrices, triangles, spheres etc.
- 2D- and 3D canvases also extending the standard Java components.
- 2D- and 3D scene graph for high-level graphics primitives and scene descriptions
- already programmed 'high-level' beans like image filters, function parsers, editable curves, etc.

Due to the strict object-oriented design of the Java classes used in our course, their conversion into Java beans was straight forward.

4.3.1 Examples

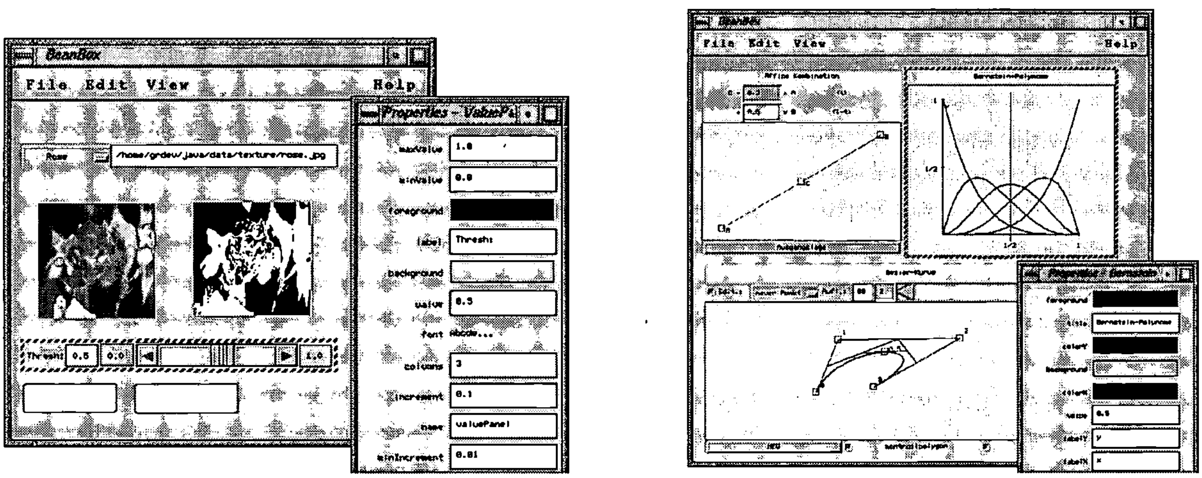

Figure 2: Left: Building a simple applet demonstrating black white image filter in the Bean Box. Unfortunately, the current version of the BeanBox does not display the already established links between the components. Right: Composing three beans into a new applet demonstrating Bézier Curves together with affin combinations and Bernstein polynomials.

Like in a visual data-flow language beans can be visually composed into new customized applets. The left side of Figure 2 shows the generation of a simple applet that demonstrates the conversion of a gray-value image to a black-white image. The user can define the threshold value. To generate the applet the image loader, two image beans for input and output image, the value panel and the black-white filter are loaded into the application builder. In this example the data-flow is defined by so called property changed events. The property changed event of the original picture (invoked by loading it) is propagated to the black-white filter that expects a reference to the input image and resolves an property changed event with an reference to the output image. Last but not least the property changed event of the value panel changes propagates the threshold value to the black-white filter and invokes it. After designing the applet in the application builder it can be compiled into a new applet.
The right side of Figure 2 shows the construction of a more complex applet demonstrating Bézier curves. Its main building blocks are three simpler beans, one realizing affin combinations between two points in 2D, one bean displaying the Bernstein polynomials, and one bean containing the B'ezier curve itself. Each bean already implements all basic interaction to manipulate their contents. Several interface components link the beans together. In such a way the functionality of data-flow languages are available to build up new Java applications. Using this paradigm teachers and students can easily develop their own new beans and integrate them into the course using

already existing components. Nevertheless, there are still cases like the implementation of new filters in which new beans must be implemented in the traditional way.

4.3.2 Discussion of design problems

One of the design problems of data-flow languages is how to manage the complexity of program networks. In our approach this problem can in most cases easily be solved by grouping several beans into new ones and customizing their appearance within the builder tool. We made use of these techniques throughout the whole course. The problem of propagating data through the network that is inherent to most other systems based on the data-flow concept does not occur, since different modules may share the same data in memory.

5 Conclusions

In this paper we briefly describe our WEB-based computer graphics course. This course contains various Java-applets allowing the students to explore different topics in computer graphics. We presented a new approach based on JavaBeans to design new applets using existing components in a visual builder tool. These high-level approach is of advantage for both, the teachers extending the course and students in doing their programming exercises. Due to the strict object oriented design of the Java classes used in our course, their conversion into Java beans was straight forward.

The advantage of this approach is that it combines the power of visual programming and of the data flow concept with the platform independence of Java. The resulting programs are not stand alone applications but may be integrated into hypertext. In addition all development components are available for free.

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Geometry and Education in the Internet Age

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Abstract: Interactive Geometry is a major tool in modern geometry education and various software tools are available. We discuss the requirements of such tools and how they can be fulfilled. We also explain how a geometry tool can benefit from the Internet and present Cinderella's Café, which is an internet-aware geometry tool with a high mathematical background.

1. What is interactive Geometry?

In all modern secondary school curriculae geometry plays a major role. Besides its drawing skill training purposes it is used as a tool for teaching mathematical and logical reasoning. Unluckily, the second, much more important goal, is sacrificed for the first, since accurate drawings are needed for correct reasoning.

As an example, let us consider the well-known statement that the three altitudes of *any* triangle meet in a point. In order to convince himself of the validity of this simple statement a student has to draw an example of it. Unfortunately, in most practical cases the three lines will *not* meet in a single point. Due to little drawing inaccuracies the altitudes will miss each other slightly. This is not very instructive; even worse, it confuses instead.

A high level of discipline and practice is necessary to benefit from the understanding a correct drawing can serve. A computer drawing program that supports access to *geometric constructions* can help. It can serve as a *geometric pocket calculator* and relieve the student from the routine work. Such a program helps to achieve the second goal that was mentioned above: the thought-stimulating effect of geometry.

2. Key features of Interactive Geometry Systems

Interactive Geometry Systems (IGSs) differ from usual computer aided drawing (CAD) software. In contrast to CAD Systems (which are well suited to produce a single static picture) Interactive Geometry Systems consider a drawing as a dynamic entity. They provide not only access to geometric objects like the intersections of lines or perpendiculars to given lines. They, in addition, memorize all *construction steps* that led to a final picture.

As a first application you can use an IGS to produce drawings that are exact with respect to the restrictions a pixel oriented display or printer bears. But in fact you gain a lot more than exactness: Since the IGS keeps track of the whole construction sequence, it can redo the construction for another set of starting points, so you can actually move single points and watch the influence on the rest of your drawing. Going back to our example you are able to verify the fact that the three altitudes meet in any triangle not only for one, but for a large set of triangles. Let us summarize the key features of IGSs.

2.1 Dragging Objects

The "draggability" of complete constructions stresses the most important, because most interactive part of Interactive Geometry Systems. This is more than a tool for getting a "feel for geometry" — which is already significant —, this is even a method for *proving* geometric theorems. A conjectured theorem (like the altitude theorem for triangles) can be explored by moving the free objects (in our case the vertices of the triangle). If the theorem "seems to be true" (that is, it is true for every single drawing one creates), it is generally true with an extremely high probability. Here "high" means, that it is much more likely that the computer fails during execution of the program (due to hardware or software failures), than that the theorem is false. This theoretical background of this method is currently under development by the authors and uses tools from randomized polynomial checking [Kortenkamp & Richter-Gebert 98b, Ibarra & Moran 83, Schwartz 80]. In addition, under certain conditions a low number of examples (a so called *test set*) is already sufficient to prove the conjectured theorem in general, without depending on randomized proving [Hong 86b, Hong 86a, Deng et al. 90].

2.2 Macro Operations

In order to facilitate constructions IGSs offer the definition of macro operations. Repetitive tasks like constructing the perpendicular bisector using two circles and their intersections can be bound to a macro that issues the necessary steps automatically. This leads to concepts like *geometric programming languages*. Unfortunately, this also brings up new theoretical problems inherent to this, like the ambiguity of *the* intersection of two circles [Laborde 97], or, even worse, the intersection of two conics, which has not been resolved satisfactorily yet [Kortenkamp 98].

2.3 Loci

While macro operations are a constructional tool, tracing the movement (*locus*) of a point while moving a free object is a more investigative tool. How Loci are offered to the users differs a lot among the currently available IGSs (as of now, there are two major systems offering Loci, *Cabri II* [Laborde & Bellemain 97] and *Geometer's Sketchpad* [Jackiw 97], as well as some minor ones.) The spectrum ranges from simple point position recording, which gets erased whenever a new point is moved, along more sophisticated techniques that offer connect-the-dot-algorithms and are able to be viewed under different additional motions, up to almost fully automatic, high-speed drawing routines, that try to find the complete range of positions a dependent object can take. As in the case of macro operations, several ambiguities arise, and to be resolved they require a solid mathematical theory.

2.4 Additional requirements for IGSs

The described features alone are not sufficient for a geometric tool to be applicable in education and research. Let us mention a few additional requirements, which should make a good IGS, but are not available throughout all IGSs.

To use the constructions in publications one needs high-quality output in any resolution (e.g. Postscript) and the possibility to use different colors and styles for the construction elements. When used with presentations (for example with a beamer as a "geometric blackboard"), the screen output must be configurable to give a good visualization of the construction (points must be big enough to be seen!).

On the user interface side the creation of constructions and macros has to be very simple. A *magnetic mode* that automatically detects incidences between points and lines or conics should support the user. The interface has to be configurable; if a teacher wants to allow circle and ruler only as construction tools, nothing else should be available.

And finally, a text-based output and input of the construction sequence should be available. This gives the opportunity to check a construction and to fully understand it. The value of this text-based I/O is indisputable, but nevertheless there is no support for it in most IGSs.

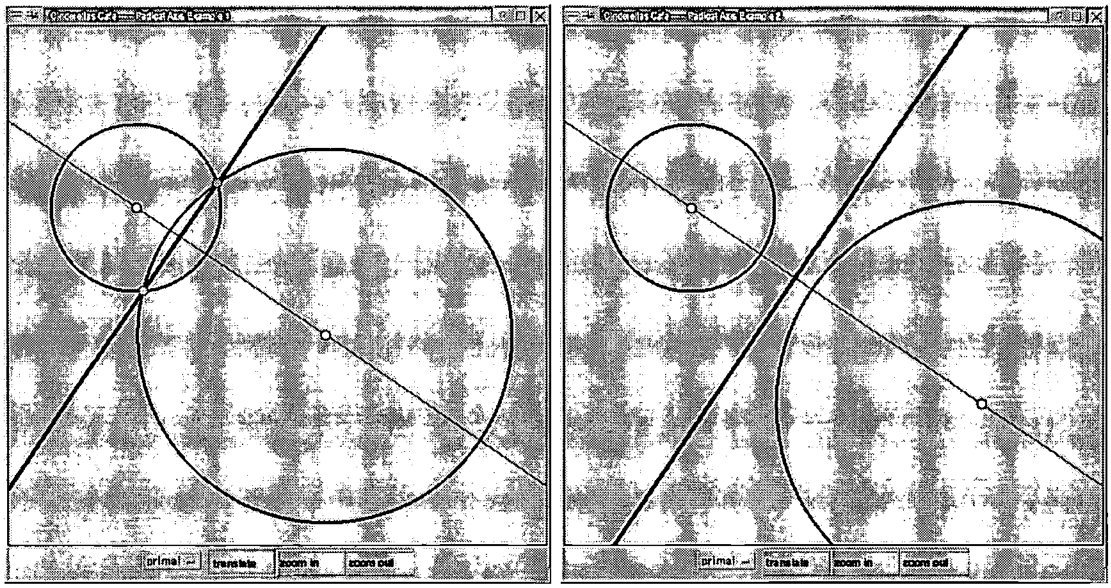

Figure 1: Correct behavior of the radical axis: The line defined by the two intersections of two circles is still real, even if the two intersections are complex ("vanish").

3. Cinderella's Café

Cinderella's Café is a new IGS we would like to present in this context. It features all the necessary components of an IGS mentioned above, and adds some other features that have not been available before.

3.1 Using most general approaches to geometry

A key component in every geometry system is the mathematics used, e.g. how the dependent objects are calculated. By using the most general approaches possible (as shown below) Cinderella's Café becomes a more general, simpler and consistent tool for doing geometry on a computer. A general approach to powerful mathematical concepts is the systematic elimination of special cases. This opens the possibility of more user interaction, makes programs more reliable and robust by eliminating possibilities of programming mistakes ("bugs"), and allows higher execution speed. We would like to present two examples of this paradigm.

3.1.1 Complex Numbers

Consider the following situation: You draw two circles that intersect each other in two points. Next you join these two intersection points by a line [Fig. 1], the so-called *radical axis* of the two circles. By moving the circles you can move this line. It will always be perpendicular to the line connecting the centers of the circles and at a distance to each center that reflects the ratio between the radii. But: What should happen in an IGS if you move the circles apart? The two intersections disappear, and so does the radical axis? Or, even worse: You are not allowed to move the circles in this way?.*Check it out with your favorite IGS, and find out which approach it takes.*

From a mathematical point of view, one would rather expect the following behavior: *The radical axis, which is still defined for non-crossing circles [Coxeter & Greitzer 67], moves consistently and continuously the whole time.*

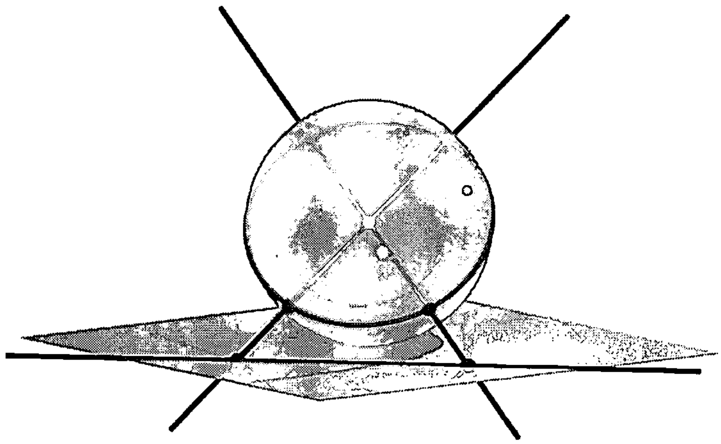

Figure 2: Central projection of points on the sphere onto the plane, giving a double-covering of the sphere by the projective plane. The preimages of points in the plane are pairs of points, while the preimages of lines are great circles.

This could be achieved by defining a basic operation "Radical Axis" which does a computation independent from the crossings. However, the desired behavior is inherent to the described construction. An IGS should be able to detect this without introducing additional concepts. Therefore Cinderella's Café takes the following approach: Recall that the two crossings are the common solutions of two quadratic polynomials, which happen to be real when there are two *visible* intersection points, and which are complex otherwise. Thus carrying out the calculations in the field of complex numbers always gives us two *complex intersections*, whose connecting line happens to be real (since the two solutions are conjugates of each other), and this is exactly the radical axis.

This small example shows that the introduction of complex number calculations greatly simplifies geometric constructions by eliminating "vanishing" intersections.

3.1.2 Geometric Calculations in Projective Geometry

In the Euclidean Plane almost all pairs of lines have an intersection. More precisely, two lines intersect if and only if they are not parallel. This becomes an issue when dealing with interactive geometry. Two lines which had an intersection might become parallel, when some objects of the construction are dragged. In Euclidean Geometry this introduces another problem: Whenever one calculates the intersection of two lines one has to check whether they are skew or not. But what happens to another line which is defined by this intersection and another point? The line should become a third parallel, but instead (if we stick to the paradigms of euclidean geometry) it disappears, because its defining points are not defined anymore. How can we avoid this dilemma?

Projective Geometry, a powerful theory that has been developed already a hundred years ago, helps us to solve the problem. By embedding the Euclidean Plane into the Projective Plane we add the "points at infinity" lying on the "line at infinity". First of all this eliminates the necessity of a special treatment parallels. In projective geometry *every* pair of lines has an intersection. When lines become parallel, their intersection lies on the introduced line at infinity. Moreover, the calculations that are needed to obtain the intersection are greatly simplified and unified (and not vice versa, as one could expect). For this we use homogeneous coordinates, i.e. we model the points of the Projective Plane by the one-dimensional linear subspaces of $\mathbb{R}^3$, represented by a spanning vector, and we

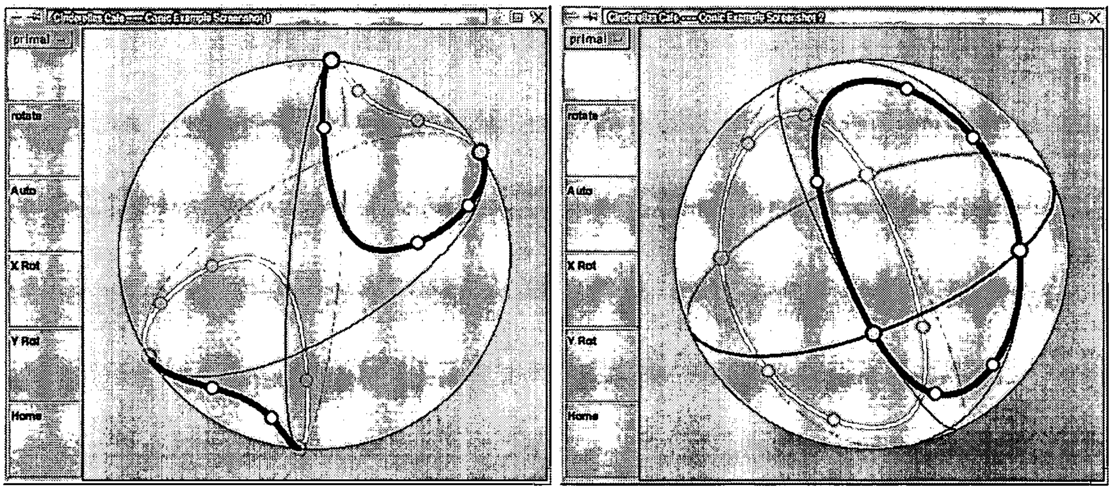

Figure 3: Exploring conic sections: Screenshot 1 shows a hyperbola projected onto the sphere, together with its asymptotes. Notice the two intersections of the asymptotes at infinity (which is the outermost circle). Screenshot 2 shows the same hyperbola, but now the sphere has been rotated to show that the hyperbola is projectively equivalent to an ellipsoid. For your convenience the line at infinity has been added to the picture.

model the lines by two-dimensional linear subspaces, represented by their normals. Note that scalar multiples of these representing vectors are identified [Fig. 2]. Now the calculation of the intersection of two lines reduces to calculating the cross product (or vector product) of two representing vectors in $\mathbb{R}^3$. The same holds for the calculation of the line connecting two points [Stolfi 91, Coxeter 92].

3.2 Multiple Views

We just sketched how to carry out calculations in the projective plane. How can one visualize the new, non-euclidean objects, or even input them? For this, Cinderella's Café offers the possibility to view a construction in a multitude of different Windows. So it is possible to have an overview of a scene and a detailed view of the same scene (zoom in) at the same time in different Windows. All windows are fully functional, that is, you can move or add elements in either window, and all windows are synchronized, that is, you can see the effects of one operation immediately in all windows.

Since it is not possible to zoom out so much that you can see the elements at infinity, another approach has been taken. It is possible to view a construction in a completely different model, for example, in the "spherical double-covering model of the projective plane". Here the Euclidean Plane can be imagined as being shifted to the $\{z = 1\}$-plane in 3-space. Then the complete scene is mapped onto the unit sphere by a central projection. Thus the points at infinity may be found at the equatorial circle at $z = 0$ on the sphere[1]. Cinderella's Café allows all the operations of the euclidean view also in the spherical view. The additional possibility of rotating the view of the sphere simplifies the exploration of geometric objects and constructions [Fig. 3].

[1]This is the same as identifying the linear subspaces by their intersections with the unit sphere

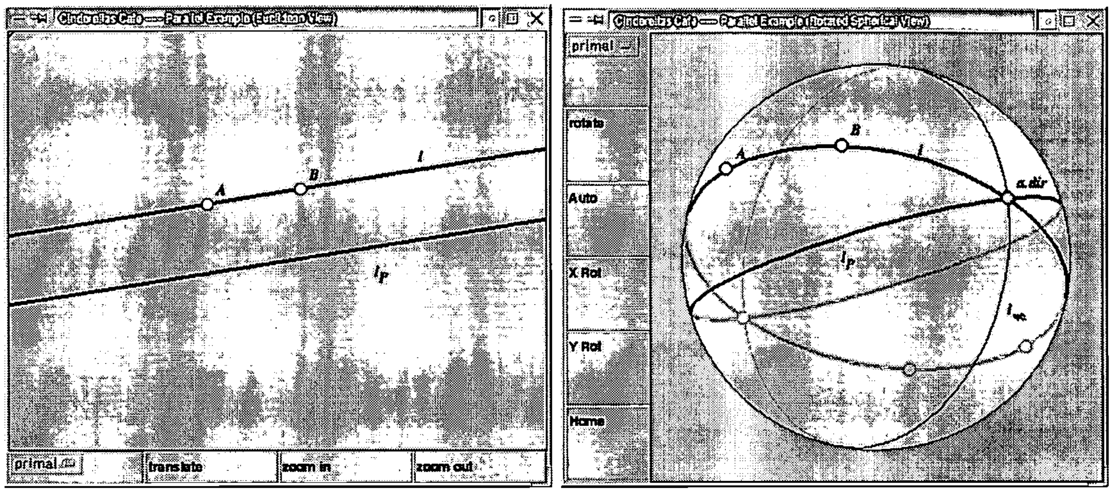

Figure 4: Constructing parallel lines: In the (rotated) spherical view you can see how the parallel in the left picture has been constructed. The sphere has been rotated to show the (thin) line at infinity. The intersection $a.dir$ of the line connecting $\boldsymbol{A}$ and $\boldsymbol{B}$ and the line at infinity has been constructed automatically by Cinderella's Café.

3.3 Euclidean Geometry support

Since most IGSs are to be used in secondary school teaching it is desirable to have a strong focus on Euclidean Geometry. In the last section we described how to avoid the pitfalls of Euclidean Geometry by using complex Projective Geometry. One might expect that by the introduction of the line at infinity and its associated points we lost the special role of infinity that is needed for "proper" Euclidean Geometry. This is not the case.

We just keep in mind (or in memory) that there is a special line — which does not need any special treatment —, and we can use it to do euclidean constructions. Let us take parallels as an example. When we like to construct a parallel ℓ_P to a given line ℓ we proceed as follows: Take the line at infinity ℓ_∞, calculate the meet of ℓ with ℓ_∞, and let ℓ_P be a line through this intersection, chosen specifically to the needed other properties of ℓ_P [Fig. 4]. We can carry out all the calculations in homogeneous coordinates without any care for special situations. The user is not bothered with these technical details, since all internal operations that are needed to construct the parallel are encapsulated within a macro.

Another example are circles. Since circles depend on euclidean measurements, one might expect that it is not possible to find a projective description of them. However a circle is a special conic, which can be defined by five points. A classical observation of Poincelet shows that all circles have two points in common — which have complex (!) coordinates. So our two mathematical concepts (Complex Coordinates and Projective Geometry) just do fine in modeling Euclidean Geometry [Klein 28].

3.4 Hyperbolic Geometry and beyond

Currently, most IGSs provide support for the Poincaré-model of Hyperbolic Geometry only via a sets of macro operations. The multi-view approach of Cinderella's Café allows for a "native" support of Hyperbolic Geometry. In the same way as with spherical views one can add a hyperbolic view that provides full functionality [Fig. 5]).

By this we can avoid the usual pitfalls in designing macros [Kortenkamp 98, Laborde 97]. But we are also given the opportunity to create new views, either traditional ones, or completely new ones. All views share a

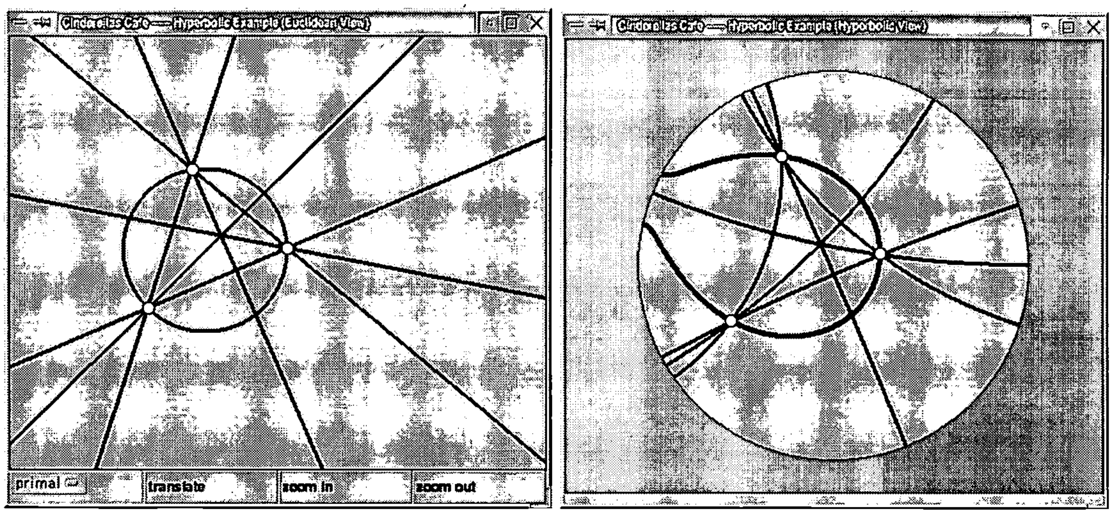

Figure 5: Hyperbolic geometry in Cinderella's Café: Observe that the statement about the heights in a triangle meeting in a point still holds for hyperbolic perpendiculars, while euclidean circles become strange.

common computational kernel, and one can concentrate on adding just the translation from abstract objects to their visualizations. The interface for this will be made public, so it is possible to share new views in the community.

3.5 Measurement of Angles and Distances

Since we mentioned circles, we have to discuss measurements as well. Despite the fact that the educational value of doing measurements within IGS is questioned [Kortenkamp 98], it is a feature desired by current curriculae.

Any measurement has to be carried out with respect to some scale. Here the point is not that it is possible to zoom into drawings while still having the correct distances. The situation is much worse: The definition of distance and angle is bound to the type of geometry we are using. Since projective geometry is a common basis for doing euclidean, spherical, and hyperbolic geometry (among others), we do not want to restrict ourselves to euclidean measurements. The unified approach to different measurements is Cayley-Klein geometry, as featured by Cinderella's Café.

Cayley-Klein geometry defines angles and distances as multiples of logarithms of certain cross ratios. These cross ratios are calculated with respect to certain fundamental conics, which are the defining conics of the geometry used [Coxeter 92]. So we have a "pluggable" measurement, which supports all our needs (and even more).

The same fundamental conics play a role when we define circles by a center and a point on the circle, or when we define perpendiculars. Both these objects come in different flavors, since they are heavily dependent on the measurement chosen.

While Cinderella's Café supports simple calculations to be performed with the measurements taken, it does not allow to mix different geometric units. So it is not possible to add an angle and a distance, or to assign the area of a triangle to the length of a segment. This is an intended restriction, since it would lead to results which do not reflect any geometric situation.

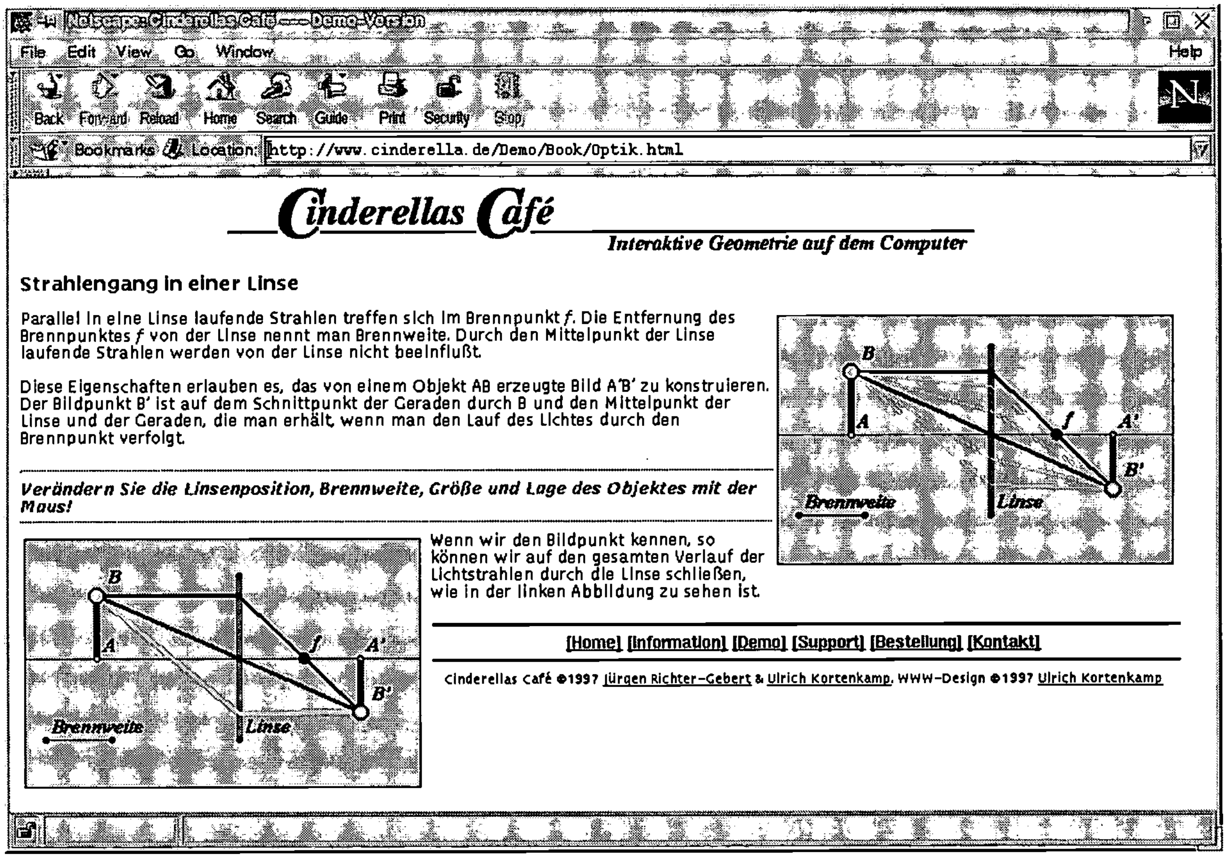

Figure 6: Example webpage showing the use of Cinderella's Café

4. Using the Internet in Education

These days there is a great effort to connect schools to the Internet. There are various arguments for that, but there are few high-quality Internet-aware educational tools. Having this in mind, Cinderella's Café has been designed to fill this gap.

4.1 Choosing the right language

Portability and simplicity have been the reasons for choosing JAVA as the development language of Cinderella's Café.

The program has to be highly portable across platforms in order to make it accessible on a wide range of systems, since it should be possible to use it with all the computer systems currently installed in schools, academic institutions, and at home. This has been made possible by using the language JAVA, developed by Sun Microsystems/Javasoft. This language is available on all major platforms, e.g. Windows 95, Mac OS, Solaris, and Linux.

The execution speed of JAVA was a major concern, but benchmarks showed that the performance is satisfactory even on Intel 486-based systems.

4.2 Instant availability

As an additional benefit we get instant availability of Cinderella's Café via the World-Wide-Web. It is possible to enhance webpages with interactive geometric content without having the user to install any software besides a JAVA-enabled browser. At our website [Kortenkamp & Richter-Gebert 97] you may find some examples [Fig. 6] as well as a complete demo-version.

Users of Cinderella's Café are able to create examples and export them directly into their own webpages. So everybody might use Cinderella's Café to enhance their webpages, which may be (interactively) viewed by anyone having access to the Internet. The visitor does not have to install any software for this, and there is no royalty fee.

4.3 Example databases

Currently there is work in progress to build up example databases which reflect the different curriculae. Thus in the near future a teacher or student may benefit from ready-made constructions. This underlines that it makes sense to provide connectivity to schools and other academic institutions, if you have software like Cinderella's Café that uses the additional possibilities one encounters.

4.4 Interactive exercises

Another new and exciting feature of Cinderella's Café is the possibility to prepare exercises for geometric constructions. The teacher can construct a sample configuration and mark the set of starting objects and the desired object to be constructed. Then he or she can export the exercise together with a restricted set of tools. For instance, one can imagine to give the exercise to construct the perpendicular bisector with a ruler and a compass. You only need one construction with Cinderella's Café in order to create an interactive exercise sheet.

The solution of the construction exercise is checked automatically by Cinderella's Café. This non-trivial task, which has not been available in any IGS before, is done via a new randomized theorem prover developed by the authors [Kortenkamp & Richter-Gebert 98b, Richter-Gebert 95]. So the student is not tied to the particular construction the teacher had in mind, but is free to find any construction that leads to the desired result. So the program can be used as an educational tool without restrictions on the creativity of the student.

5. Conclusion

We presented Cinderella's Café, which is a new IGS with a *high mathematical background*. It supports *highly consistent interactive manipulation* of geometric constructions. This is achieved using the *most general mathematical models* whenever possible, in order to avoid the necessity of special treatment of degenerate cases.

The software package is very well applicable in education and presentation since a lot of features not known to other IGSs is included. Since the program is written entirely in JAVA, it is *highly portable* and *Internet-aware*. The additional possibilities of the network are used to enhance the software by offering direct *export into webpages* and the creation of *interactive exercises*. Thus it gives the Internet the necessary content to make it suited for educational purposes.

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In this article we explore some of the possibilities of multimedia technology and networked learning environments. To illustrate our position, we argue with a sample online course on Distributed Software Engineering [Krämer 97a]. In our discussion we focus on two issues: Section 2 sketches our approach to the design of this course and reports on lessons we learned during its evaluation. Section 3 describes our approach to use a shared workspace system to support joint work of distributed project teams and learner groups. We conclude with some general observations we made at FernUniversität during two test runs of a preliminary version of a comprehensive online teaching platform with a limited community of students.

2 An Interactive Online Course on Distributed Software Engineering

The course "Distributed Software Engineering" is the second part of a two-semester course on software engineering issues. It is particularly dedicated to three characteristics of many computer-based process control applications: *reactivity*, *distribution*, and *safety*. The course introduces new terms and requirements specific to distributed software that is embedded in technical applications and has to satisfy high dependability requirements. Sample applications include computer-controlled manufacturing systems, industrial control systems, process automation, (mobile) communication systems, and pipeline-control software in petrol industry.

To illustrate the different steps of software development, a simple production cell serves as a general case study [Fig. 1]. The production cell includes electro-mechanical actuators and sensors that monitored and controlled by a distributed program. Major course objectives are to confront students with the intricacies of distributed and non-sequential software systems and endow them with the capability to recognize realistic abstractions and modeling ideas for given development tasks. We also want to teach them suitable specification, design, programming, and validation techniques and raise their awareness to scrutinize correctness and adequacy of specifications and programs with rigorous means. Further pedagogical aspects of this course are described in more detail in [Krämer 97a].

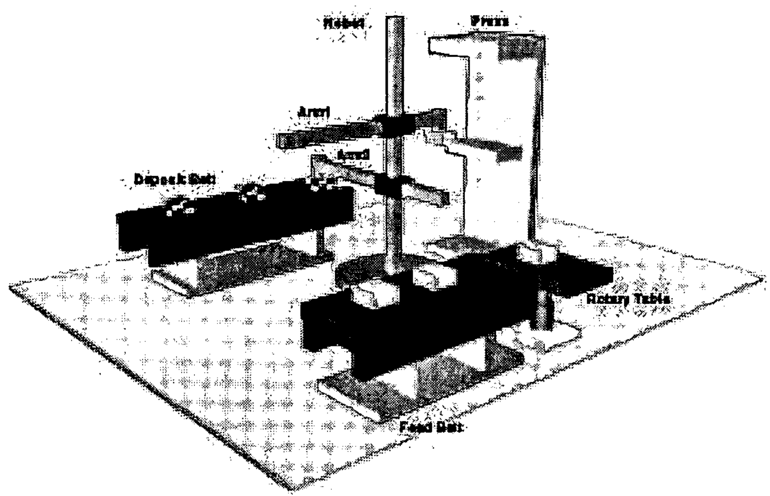

Figure 1: A virtual production cell

2.1 Structure and Design of the Online Course

The online version of the course is a structured program of study whose skeleton consists of a hyperlinked set of HTML pages. These pages include interactive animations, simulation packages, videos, and light weight software tools. The course consists of the following teaching units:

Introduction to Distributed Software Systems. In this lesson we develop main concepts of distributed application programs such as concurrency, resource contention, synchronization, or deadlock with different use cases. These use cases are visualized in terms of a distributed virtual book store. We chose the HM-Card authoring system [Maurer & Scherbakov 96] to integrate animation, text, sound, and interactive user input in this unit. The didactic method used is guided discovery and exploration [Khan & Yip 96].

Case Study and Safety Analysis. The introduction of our general case study includes a short video showing a real production cell in action. This cell operates under strong safety constraints in a German metal factory. Throughout the course we use an interactive 3D-model of that production cell [Fig. 1]. The virtual production cell was developed in VRML and Java and is operational under a VRML 2.0 browser plugin like SGI's Cosmo player.

This virtual production cell serves for several purposes: a) students can study the behavior of each individual machine and understand the synchronized interplay of neighboring machines with the help of a panel controlling the cell's actuators individually. b) As software safety is of primary concern to that course, the students then have to find eight different sequences of production steps leading into eight different hazardous situations. A typical example is a robot arm being extended and directed towards the press. Any attempt to move the cheek of the press in that situation would lead to the destruction of both press and robot. The student's attempts to find such sequences are recorded, normalized and compared with a predefined set of correct answers to provide positive and corrective feedback. During our study days held on campus at the end of the course, we develop hazard analysis models using fault tree analysis and state machine hazard analysis [Leveson 95]. We use selected student solutions of the distributed cell controller to analyze their flexibility in coping with possible hardware failures that were revealed during this post-development system safety analysis. c) An automatic mode shows the virtual production cell in correct action. It demonstrates the behavior of a correct solution that avoids all hazardous situations and exploits the maximum of concurrency in all production steps. d) After having developed their distributed control program towards the end of the course, the students can link their program with the control interface of the virtual production cell to get visual feedback on the behavior of their own solution. All kinds of safety violations that may happen now are visualized and recorded.

Requirements Analysis and Specification. The students' insight into the problems gained through manual interaction with the virtual cell machinery and the detection of hazardous situations provides the ground for the formalization of behavioral requirements and safety constraints.

Design. A light version of a Petri net editor written in Java allows them to edit and symbolically execute their Petri net design of the machine controllers' intended behaviors at home. A model checker, a tool for reachability analysis, and other verification tools for Petri net designs operational on our Unix server can be accessed remotely through CGI-Interfaces. We are currently working on a interface between the net tool and the virtual production cell by which the transitions of the student's net design are synchronized with the execution of corresponding operations (e.g., `extend-arm(L)`) at the control interface of the virtual cell. This mechanism would allow them to get visual feedback on the behavior of their solution early at the design level.

Distributed Programming. Distributed programming is centered around a Java version of the graphical design tool for Darwin [Ng et al. 96]. Program development starts with the transformation of the student's design into a course program architecture which is then developed into a hierarchy of interacting program components. The students finally have to develop Java code for the leaf components of their architecture to obtain an operational solution. This code controls and surveys the actuators and sensors of the virtual production cell, respectively.

Further subjects of this course topic are concepts of distributed programming languages, synchronization and communication mechanisms, and middleware standards and platforms. Remote procedure call, marshalling, message brokering and other core mechanisms of current middleware systems are visualized and animated by means of an interactive introduction to CORBA. Students can learn the different steps of a CORBA-based programming methodology by working through predefined and guided examples. In addition, they can define their own problems, design corresponding interface specifications and develop code by accessing our CORBA environment remotely.

2.2 Evaluation

This and a previous version of the online course have been tested with a small population of students. During summer semester 1997 an evaluation study was undertaken. The study served to measure the effectiveness of the use of new technologies including the Internet, the World Wide Web and multimedia. The hypothesis we started with was that teaching/learning effectiveness can be influenced by a number of independent factors including:

- design and presentation of the course material;
- degree of the students' previous experience with computers;
- time spent by students online.

In the sequel we sketch the conceptual framework used for the evaluation and summarize major results.

Method. During course development prototype solutions were regularly presented to peer colleagues to receive early feedback on the quality of the online course material. During the test run of the online course with students a summative evaluation relying on pre- and post-test [Calder 95] was performed. Two kinds of questionnaires were handed out the students. The first one for the pre-test aimed at identifying the students' expectations of the new teaching model. The post-test questionnaire helped to determine their overall judgment and criticism. The twelve questions contained in the first questionnaires were replicated in the post-test questionnaire. In the latter further standardized and open-ended questions were added to allow the evaluation of specific issues on the course design, the human-computer interaction, or understandability. The standardized part of the questionnaire was analyzed by means of statistical analysis, while the open-ended part was analyzed using qualitative content analysis.

Results. Due to the relatively small number of students that participated in the user trails, we can only draw tentative conclusions from this first evaluation. All students found the online, interactive teaching model attractive and challenging. Most participants expressed the feel that the new mode helped them increase their skills and knowledge on the subject matter of the course. The correlation of effectiveness as a measured variable and several other measured variables including design of multimedia courseware, preferred mode of study, or time spent working online revealed that the effectiveness was mostly influenced by the design of the material. Conversely, the students' time spent working online added very little to the effectiveness variance.

The qualitative content analysis of the open-ended questions showed the students' preferences and dislikes concerning the use of multimedia courses. It also generated a number of suggestions for enhancements. A great majority of students found that the new learning model had positively affected their study patterns as they were actively involved in the acquisition and development of knowledge. In particular, students liked the possibility to put hands on things in animations and simulations. The search and navigation facilities and the availability of course material were also found useful. Requests for enhancements included the demand for: more interactivity, exercises, animations, simulations, and video clips. Also an improved, more professional layout, more visualizations of self test examples, and less online text material ended up high on the students' wish-lists.

Measurements of students' access behavior revealed that the lengths of online sessions were disappointingly short. We assume that this is particularly due to relatively high telecom fees in Germany and many other European countries. Therefore we decided to distribute heavy course material, especially video clips, sound files, software tools and utilities, on CD-ROMs, while those components that are like to change more often and are smaller in file size are maintained on our Web servers.

3 Synchronous Collaboration Support

Software engineering is a subject that should not be studied merely theoretically. An important asset of such a course is practical training in teamwork with small but realistic projects. In the past we had to constrain such experiences to the short period of practice days students spent together in our labs. Today, the Internet enhanced with suitable cooperation technology allows us to extend the time of collaboration and support distributed learning groups.

Collaboration in distance learning shares many features with groupware, also called computer supported collaborative work (CSCW). As a first step in the direction of collaboration support between remote students, we defined distributed project teams and set up a shared workspace for each team using GMD's BSCW platform [http://bscw.gmd.de/]. The team members were asked to use the functionality of BSCW to prepare joint specifications and designs prior to attending the practice days. To some extent this experiment failed, largely for two reasons: At the beginning CSCW seems to impose an additional burden on its users as it requires quite some discipline of documentation and communication. Usually it takes a while until the advantages of a disciplined team work are recognized. A real deficit of the platform in its current state is, however, the lack of synchronous collaboration support. Students had liked be be able to discuss properties of shared design objects or clarifying difficult passages of course materials through synchronous communication.

Whiteboards and chat tools were of lesser help here because they assume a poorly structured material as typically encountered in initial brain-storming sessions. The course material, requirement specifications, designs or programs, however, are well-structured documents bearing a potential for controlled navigation and small-grain annotation of individual document parts. Whiteboards and chat tools also suffer from insufficient concurrence control. For example, one participant might start to sketch an architectural design of a software solution, while, all of a sudden, someone else changes the context by scrolling the page on zooming into some detail of another object presented.

To diminish these problems, we borrowed structures and methods from both database research and current multi-media course development in the design of mechanisms supporting communication through gesturing at a shared drawing, images, pieces of text, animations or simulations [Krämer & Wegner 97]. Their intended advantage was that proposed changes would be made easily visible, evaluated and further developed in give-and-take discussions over technical media.

A sample collaboration scenario may illustrate our approach: Mary, John and Barbara have teamed up to form a distributed project team during the course Distributed Software Engineering. The problem our three students are currently concerned with is the development of a design solution for the safe control of the behavior of a robot used as a transport component of the production cell [Fig. 1]. The behavioral design of the robot controller is supposed to be delivered in terms of Petri nets. Mary has produced a preliminary design she wants to discuss with her peers [Fig. 2]. Hence she initiates an online team meeting. As the common work context she has been setting up her design solution and the course unit introducing the case study.

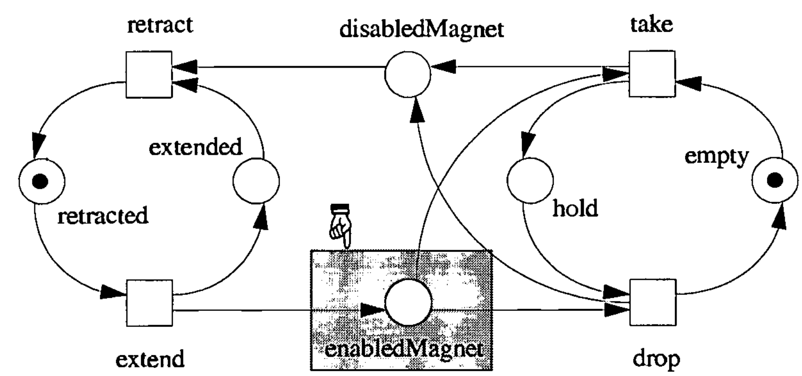

Figure 2: Finger on the Petri net design of the arm controller

John's first reaction is that he has difficulties to understand the essentials of Mary's proposal finding it overly complex. To clarify the issue, Mary sets a logical finger on the relevant part of the problem description in the corresponding course unit. In addition she also points to the place `enabledMagnet` in the net and explains that this place served exactly the purpose to ensure that pieces held by this arm can only be dropped by the gripper of an arm if that arm was extended. Obviously this place could only be set by an occurrence of transition extend. While saying this she moves the finger to the left lower transition of the net. In this moment Barbara jumps in and says: Do you remember the specification of the safety constraints we developed four weeks ago to formalize the safety requirements?". She opens another window and puts a new finger on the appropriate predicate in the premise of the formula presented in the new window and continues: These two subexpressions correspond to the case in which the places `out`, `hold` and `enabledMagnet` are marked and transition drop is enabled. John's reaction is: Ah, now

I got it. Let's keep these relationships in our records so that we can easily reconstruct them. He pushes a key combination to materialize the pointers (fingers) as links in the team database.

4 Conclusions

We strongly believe that distance learning can be improved with the help of new technologies. But, as we have argued, the traditional distance education model is not without shortcomings. Personal communication via phone, fax, and e-mail are no substitute for an eye-to-eye discourse. Students lose the opportunity to scrutinize facts or processes through extended conversations with tutors and peers. Remote teachers find it hard to verify that a student has actually learned the subject in, say, the same way traditional teachers can gauge progress and clear up misunderstandings. There is little regular hands-on experimentation and no access to physical objects, models, simulations, and instruments in computer and engineering labs. There is little support for cooperative learning and joint problem solving.

As one of the many examples aimed to improve that situation, we outlined the design of an interactive online course taught at FernUniversität Hagen. This course exploits various possibilities of multimedia technology to convey knowledge about the challenges, principles, techniques and tools for building distributed software systems. We provided preliminary evidence that our hypothesis holds true from a systematic quantitative and qualitative evaluation of this and other courses that was pursued in the context of a European project on open and distance learning. We then identified requirements needed to have shared pointing to objects in distributed work scenarios besides the typical functionality of CSCW systems. We sketched an approach to provide cursors, here called fingers, that can be positioned on logical objects rather than on their display representations. A simple use scenario served to illustrate the basic idea. Technical details of its implementation are described in [Krämer & Wegner 97]. A prototype implementation is currently in work.

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Improved Visual Navigation in Web-Documents

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Abstract: Reading a hypertext document differs from reading a book in many ways. The most important difference is the non-linearity of the hypertext document. Non-linearity means that the pages do not appear in a clear order but in an order that is controlled by the reader. Therein lies a big advantage of hypertext against linear media [Jones 87]. But the non-linearity causes one of the biggest problems of hypertext, too. The phenomenon of „getting lost in hyperspace", as Jeff Conklin named the readers disorientation in [Conklin 87], and the growing cognitive load are wellknown problems which were often discussed and are still not completely solved. This text shows an approach to solve both problems for internet based HTML hypertexts by providing an automatic generated visual document map to the reader. The map itself can be adapted to the readers needs very flexible, enables the reader to actively navigate in the document structure and reduces the cognitive load by giving preview information about the referenced pages.

1. Introduction

Two problems remain still unsolved for large hypertext documents:

- The reader still looses orientation when browsing the document. The pages appear from „nowhere" and disappear to there again after reading. The underlying structure is not transparent to the reader. A cross-reference in the text can lead a beginner in one step to the last pages of the documents where he hardly understands any of the experts knowledge given by the author. Another question is, whether the reader really did read all pages or if he only scratched at the top of the iceberg.
- Non-linearity is said to be a big advantage of hypertext against traditional books because the reader can explore the knowledge space individually by deciding himself which page to read next. The problem with this advantage is that it also means an huge cognitive load for the reader. Before he can really decide which should be the next page, he has to read all available pages first, keep everything in mind and afterwards decide which page was the most interesting.

Approaches were made to prevend the reader form the named problems. Against cognitive load typed hyperlinks were suggested in [Trigg 83], implemented in the Intermedia System [Yankelovich et al. 88] [Utting et al.89] [DeRose 89] and ported in a more flexible way to HTML and the Internet in [Kreutz et al. 97]. The link types show the kind of relation between the current page and the referenced page and thereby reduce the number of pages that have to be visited by the reader, because he can leave out the pages which do not match his own interest. A preview information suggested in [Kreutz et al. 97] as well helps to reduce the cognitive load, too, because the reader does not have to leave the current page to get information about the referenced page anymore. He just clicks on the link and gets an information window that displays a brief abstract about the destination.

Document maps are suitable to improve the readers orientation within the document, because they display the whole structure of the document. On the other hand very large and complex documents are hard to display and the diagrams are normally not very readable [Brandenburg 88] [Batini 85]. Maps are implemented in HTML documents very rarely so far. The maps implemented in Web based hypertext documents are mostly limited in size and detail depth. In [Kreutz 94] a visual navigation tool was introduced for ToolBook based hypertexts, that solved the problems of displaying even very huge structures and keeping the display flexible to readers adjustments at the same time. It also enabled the reader to actively navigate within the document structure. This approach proved to be useful in [Buchner95] which constists of approximatly 2,000 pages and 10,000 links.

The next chapters show a way to provide a visual navigation tool within Internet based hypertext documents that is adjustable to the readers interests, easy to generate and maintain, and that includes the benefits of preview information, too.

2. Visual Navigation: An Overview

2.1. Index

Indices can be found in some documents today. They are implemented in two ways. Either as a central page that is referenced from each document page or as part of the browsers display where the index stayes constantly visible. In most cases the latter approach makes use of Netscape's Frame-Concept. Because the display space of the browser is limited this approach leads to a limitation of the index itself, too. The first approach doesn't lack this limitation but is on the other hand not as elegant as the latter. The reader has to leave the current page and by this his context to get to the index page which then doesn't tell him were he was. He has to use the browsers Back-Button to get back to the originally page.

2.2. Maps

Maps are nothing more than a visual index. They too suffer the limited space of the browser display but their readability is in most cases better than the one of textual indices. Because maps are more graphically oriented they contain more graphical elements such as boxes and arrows. Therefor they need more space, too. To take the advantage of a better readable graphical display without taking the disadvantage of high space requirements, maps are often limited in width, depth or both. But the main disadvantage of maps is the lack of flexibility and the problem of maintenance. Huge graphics may show the complete structure and all links between all pages but they do not meet much of the requirements for good readablitiy of graphs as described in [Batini 85]. Smaller graphs that do focus on special structure views support the reader better and are more readable but demand higher costs for maintenance to keep the graphics conform to an evolving document. Experiments showed further, that graphics that were called „good" and „readable" were in most cases those that were edited by hand. From this it follows that if the author wants to provide good assistance to the reader he can not rely on automatic graph layouts only. This again leads to higher editing costs.

2.3. Fish-Eye

The Fish-Eye view tries to reduce the space needed to display the complete structure. Therefor it shows the nodes representing the current page and its direct neighbours larger then nodes representing pages further away. Indeed it saves space but because of the changing sizes of the displayed nodes, the reader has problems with recognizing the documents common structure in the different presentations.

2.4. Wall

The Wall view [Lechner 94] (p. 53) is not implementable for Internet based documents. It shows the current page centered and compressed presentations of the precessor and the successor page. The problem is that in highly linked documents normally one can't tell which will be the next page. To give a pre- and postview might be helpful but it is questionable that a user can recognize the compressed page presentation. We prever textual previews as introduced in [Kreutz et al. 97]. Such a textual preview is shown in [Hierarchical View].

3. Improved Visual Navigation

Our approach as maps and Fish Eye view tries to save space, too, but uses another way to achieve this goal. Instead of presenting one universal display we provide many different views on the document structure meeting the different readers intentions in looking at a document.

3.1. Complexity of Graph Algorithms

As described above producing good maps is a timeconsuming process. The maps then are not adjustable to the users needs. On the other hand automatic generation of maps does not lead to very readable maps or requires algorithms that are at least NP-hard [Sugiyama et al. 81]. The advantage of automatic automated maps is a by far higher flexibility. Therefor the first aim is to reduce the complexity of the algorithm or the complexity of the problem. [Kreutz 94] showed that efficient algorithms with linear complexity can be found by distinguishing different link types. We are sure that in all hypertext documents a main hierarchic structure can be found and with this at least two link types can be distinguished: hierarchical links and crossreferences. (A technique to introduce more link types into HTML based hypertexts is mentioned in [Kreutz et al. 97].) With the information about the link types more specialized algorithms can be used which enable us to provide views that can be adapted to the user's needs and that can be updated after an user interaction within less than one second.

3.2. User Adapted Views

If the reader wants to know, where he is in the document, he needs a hierarchical view that shows all needed information and hides all unneeded. If he wants to know which pages he can reach directly from the current page (which pages are directly related to the current page), he needs a map of all direct neighbours. Then again the reader might want to know where he had traveled so far through the structure, which pages he had already visited or which he hadn't visited so far. For each of these different questions he needs a special view.

All these views are specialisations of the same underlying one structure. Each of these specialisations itself is controlled by parameters by which the view can be individually adjusted to the readers needs. Because each view focuses on one specific question the algorithm to create the presentation does not have to cover all intentions of looking at a document. Therefor one can optimize it that much that the resulting presentation is good enough to be used in a document. This way we achive a „good“ and „readable“ presentation at low maintenance costs that behaves flexible to user needs.

4. Implementation

4.1. Goals

In our approach we focused on maximal flexibility in adjusting the display to the readers needs and interests and heavy performance. Each presentation has to be computed at runtime taking in consideration the readers adjustments. At the same time the implementation has to be platform independend as the documents themselfs.

4.2. Language

To meet this last goal Java [Flanagan 97] was chosen as the implementation language. Building browser plugins in C/C++ would have lead to much more browser specific programming which eventually had to be adjusted with every browser update and which would had to be compiled and shipped for every platform each browser supports. With Java we are able to implement the display tool without having to bother about platform dependencies. The command set of Java is sufficient to force browser actions. The Java based concept to achive preview informations which was introduced in [Kreutz et al. 97] could be adopted in this work.

4.3. Interface

To meet the first goal (flexibility) the design was kept very simple. It provides just an interface between the Web-Browser and the display tool [Figure 1]. Through this interface data is exchanged to specify the current document and the current document page in the one direction. In the opposit direction the request for a new page is transferred to the browser. The kind of view (visual graph presentation) is specified by the user through the user interface of the graph viewer itself.

The simplicity of the interface and the specialisation of views also guarantee the performance to achive goal two (computation at runtime). Algorithms with linear complexity for computing the graph layout were discussed and implemented in [Kreutz 94]. They are used in this approach, too.

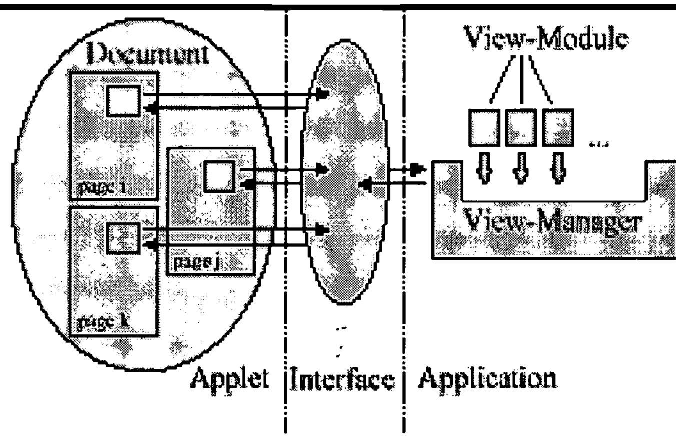

Figure 1: Applet and Application communicate via a common interface

4.4. Browser / Display - Communication

A communication between browser and graph viewer is necessary to synchronize the user interactions with the displays. If the user moves to another page using the browser, the graph viewer needs to get informed about this and the graph layout has to be updated. On the other hand the browser has to move to another page if the user clicks on a node within the graph viewer. This communication [Figure 1] is initiated by a Java applet that is included in each document page. It is answered by the Java application that manages the structure display.

4.5. View-Modules

Different intentions to look at a document demand different presentations. Those presentations are computed by view moduls at runtime, which can be docked to the graph viewer. The number of view moduls is unlimited and each module holds methods for adjusting the display parameters to the readers needs. The modules communicate with a View-Manager and share one global representation of the documents structure in common.

5. Results

The Clinic for Diagnostic Radiology at the RWTH Aachen developes an HTML based Script for their medicine students where our View-Manager is included. The document consists of approximatly 300 pages and 1,500 Links. The underlying structure is rather deep with up to 7 chapter levels. Two views are implemented. One to show the hierarchical structure of the document and one to visualize the neighboured pages to the current page. Both are discribed further below.

The inclusion of the applets into a document's pages is done within a few seconds by the author. Futher steps are not necessary. The applet itself can be downsized to one single pixel. This way it doesn't even appear visible inside the document.

The View-Manager is started automatically as soon as the first page of the document is loaded and stays visible as long as the document is browsed. The current page appears marked in the view window. By clicking on a chapter node with the right mouse button an extra window pops up that gives a brief description of the corresponding page. Clicking the chapter with the left mouse button loads the corresponding page into the browser.

5.1. Hierarchical View

The hierarchical view [Figure 2] presents the hierarchical structure of the document. It is a tree where the root represents the starting page of the document (i.e. an index page). This view subpresses all non hierarchical links like all kinds of crossreferences.

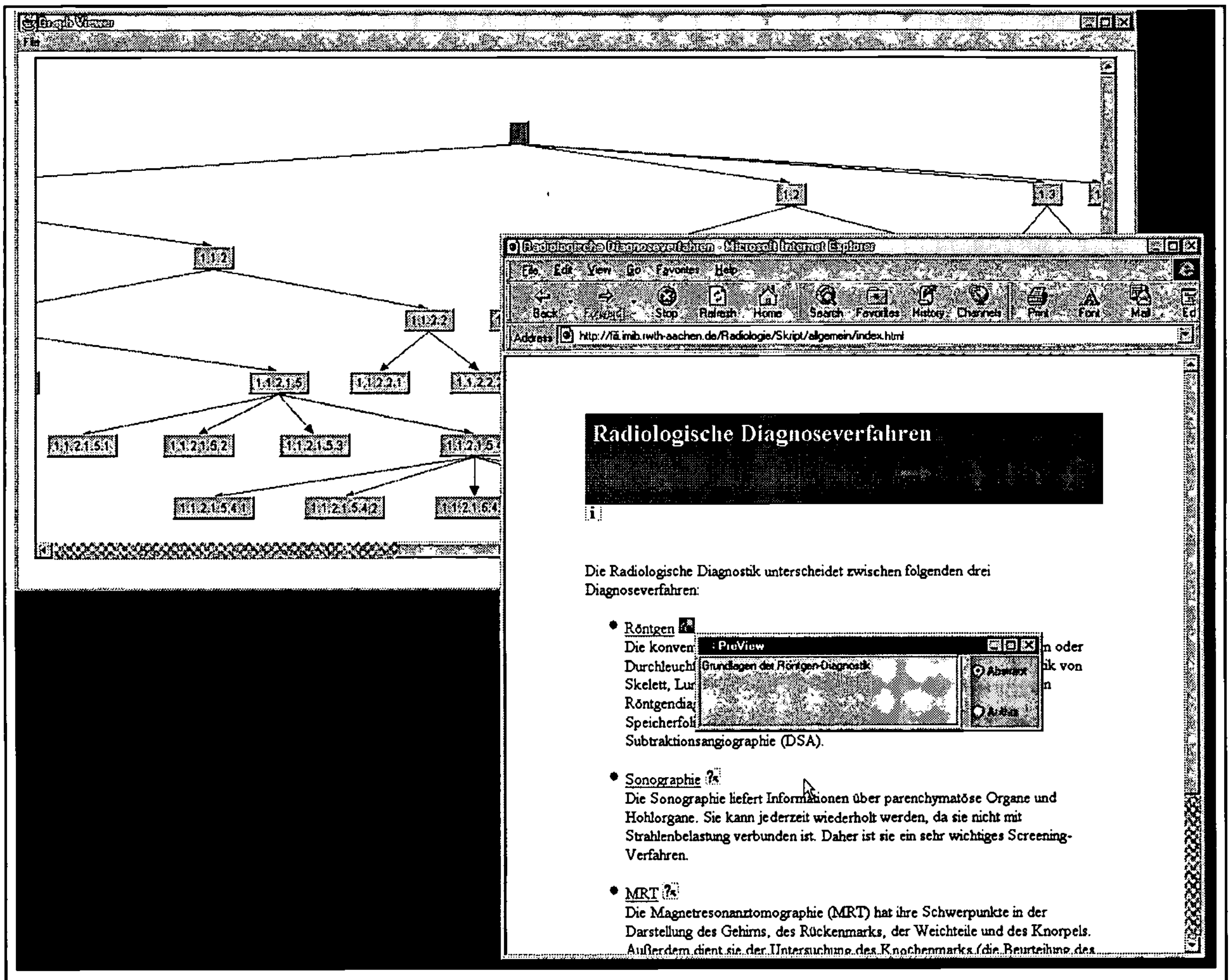

Figure 2: The current chapter appears marked in the view window

This simplified view enables the user to quickly overlook, where he is. It also enables him to get fast access to a specific page. Without having to wander a special route from page to page to finally reach the intended destination page he just clicks on the displayed corresponding node and gets there immediately. If the reader is not absolutely sure if the page is the one he wanted, he takes a look at the preview information that is presented also by clicking on the displayed node. This preview information gives an brief abstract about the referenced page. The abstract text is edited once by the author. It is then accessable from any other page within and outside the document via the above mentioned applet or application.

The view can be adjusted to the readers interest in some ways at runtime. For example the hierarchical depth can be limited to a specified niveau, or each chapter and subchapter can be either collpased or expanded. This way the structure's dimension is reduced in size which again increases the readability of the displayed graph.

5.2. Neighbourhood View

The neighbourhood view focuses on another readers intention. Here the question is not „Where am I?" but „Where can I go from here?". The view generates the N-Context - the set of pages, that can be reached from the current page within N or less moves - and displays it in a cyclic order.

This view is also adjustable to the readers intrests. The reader can specify how extensive the N-Context should be. An N with value two or three has pooved useful as they give some furthergoing information than an One-Context but do not include almost every node in the document like a Five-Context or Ten-Context does. The reader can also specify if only the shortest routes to the N-Context pages should be displayed, or all of them (A page may be reachable from the current page on different routes with i.e. two and three moves). If he decides to filter out the longer routes, the displayed graph gets a bit more readable and the reader sees the shortest ways to get to specific pages. If he decides the other way round, all links are displayed which enables him to overlook the general connectivity of one chapter / page with the other chapters / pages. This general connectivity reflects contextual relationships between the pages / chapters and is therefor of some interest.

5.3. Other Views

Three more views are planned for implementation. One in which the question is „Where do I come from ?", „Where did I go so far ?" and one that varies the hierarchic view into a Directory Tree which is wellknown from file select dialogs in many operating systems. The third view displays the reading history in a hierarchiy way.

Further studies will show if there is a need for even more views. Considering that different hypertexts are based on different structures a need of more views seems to be justified.

6. Conclusion and Future Works

We believe that the Internet with HTML as its publishing standard will supersede the platform dependend publishing systems in the long run. Universities should make intense use of the hypertext medium to improve the quality of teaching and reduce costs at the same time. A good reader support is essential for a growth in acceptance of Web based hypertexts - exspecially for those with educational intentions. The text showed a solution to the two problems disorientation („lost in hyperspace") and cognitive overload that existed in Web based hypertexts so far. The shown solution is currently included into a hypertext for medicine students.

To measure the benefits of the visual navigation to the reader an evaluation is planned. We are very confident that the visual navigation increases the usability of Internet based hypertexts and that it will become more commonly used in hypertext documents in the future.

Further improvements such as reader modelling and context dependend navigation were mentioned in [Kreutz et al. 97]. Future works will include these topics into the visual navigation, too. To support the author during the definition of the document structure currently an authoring system is under development. In the near future more View-Modules will be developed and docked to the View-Manager.

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Automatic Generation Of Questions For A Comprehension Test In English Learning

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Abstract: This paper describes the automatic generation of questions for the Comprehension Test component of HELEN (Hypermedia Environment for Learning ENglish). The test is one of intelligent learning functions, and the test module converses with learners about the contents of sentences. Aims of the test are roughly classified into three categories: first, to train the use of grammatical knowledge; second, to confirm the understanding states of content; and third, to correct errors. A question generation module in the test generates questions according to the aims by using syntactic and semantic information, semantic structure of sentences, and a student model. For example the module generates questions which make learners use new words; which ask time and space relationships; and which use grammatical knowledge that the learner previously used incorrectly.

1. Introduction

In this paper, we describe 1) educational targets of the Comprehension Test in which a learner and a computer converse about the contents of English sentences, and 2) an architecture of automated question generation which reflects the educational targets.

The Comprehension Test is one of the intelligent learning parts which realize the learning functions of HELEN (Hypermedia Environment for Learning ENglish) [Kunichika et al. 95a]. HELEN is an authoring system for intelligent learning environments for English Learning. The aim of HELEN is to give authors who are not good at programming, a programming-less authoring environment. The authors can easily make up learning environments according to their educational intentions by selecting necessary learning parts from a prepared learning parts library.

The Comprehension Test gives a learner questions about the contents of sentences in a textbook. This kind of test is popular in language learning environments. However many of these systems provide quite limited answering capabilities such as selecting from choices or filling blanks; e.g. MARPLE [Teutsch & Vivet 93] and Dynamic English [DynED 97]. And even if systems allow learners to input answers freely, questions are prepared beforehand in almost all the systems; e.g. MARPLE and ALICE-chan [Levin & Evans 95]. Furthermore in the situation using the Comprehension Test in HELEN, learning is proceeded on learners' initiative fundamentally, so what the learners have studied vary, and it is necessary to generate questions automatically by considering both semantics of the sentences and the learner's understanding states about syntactic knowledge and the semantics. Moreover when systems generate questions, they should reflect authors' educational intentions.

In the second section, we classify educational targets of the Comprehension Test. Then in the third section, we describe the outline of its architecture such as the knowledge and processing flow of the Comprehension Test. Next, we explain how to reflect educational intentions. Finally we present our conclusions.

2. Aims Of The Comprehension Test

Learning by using a learning environment created with HELEN proceeds on a learner's initiative fundamentally, so the learner can select how and what to learn. The test is designed to use after the learner has studied the contents of sentences by using the other learning functions.

The educational targets of the Comprehension Test are as follows.

(1) To master the use of grammatical knowledge

In general, each lesson in textbooks for novice learners has learning targets about grammatical knowledge. To confirm whether the targets are achieved, the Comprehension Test module makes questions which use particular grammatical knowledge such as new words or sentence structures, or questions which ask words used in a particular case.

(2) To acquire the ability to exchange information

This target means giving and taking information by using hearing, reading, writing and speaking skills. Note that HELEN does not support the speaking skill at present because to recognize speech in any situation is very difficult in present information processing technology. The Comprehension Test requires learners to use reading, hearing and writing skills; that is to say, the learners read sentences, hear questions and write answers. To achieve the target, the test function gives the learners questions which have moderate difficulty and ask about the contents of sentences. It is desirable to construct questions and answers by such a process as replacing words and phrases or summarizing of sentences, instead of using only words in textbooks. For example the questions which use synonyms of words in a textbook or ask the contents of some sentences are useful.

(3) To correct errors

Learners sometimes make errors syntactically or semantically. When a learner makes errors, rather than giving the correct information immediately, it is important that she corrects the errors by herself through dialogs designed to recall the correct knowledge. The errors are classified into two categories; one is past errors and the other is present errors. For correcting the past errors, especially frequent ones, systems should make questions which assess the knowledge the learner has learned from those errors frequently, and for correcting the present errors, systems should support correcting the errors immediately. To achieve this target, the Comprehension Test module makes questions by referring to a student model.

3. The Outline Of The Comprehension Test Module

In this section, we explain the information used for automated question generation and processing flow.

3.1 Information For Question Generation

The question generation module uses 1) syntactic and 2) semantic information, 3) semantic structure of sentences and 4) a student model. 1)-3) are extracted in the authoring stage, and 4) is generated in the learning stage. In this section we describe each information.

Syntactic information consists of a syntactic tree which expresses parts of speech and modification relationships of words and phrases, and the feature structure which expresses both grammatical functions of words and phrases and grammatical information such as sentence structure and idioms.

Semantic information consists of time and space information and the information about verbs, nouns and modifiers. [Fig. 1] shows the semantic information of the four sentences placed on the upper left-hand corner. One of the features of this expression is that each piece of information is stored separately and relationships of correspondence are expressed by links shown as arrows, so the module can easily use contexts to make questions which ask the contents of some sentences such as referring relationships by pronouns, or the time order of some events.

The structure of sentences is expressed as a semantic hierarchy, and it expresses the context such as changing topics and scenes. Experiments have been done to divide sentences automatically by considering topics, time and space information, and to make up a semantic hierarchy automatically by con-think carefully.

4. Mechanisms Of Question Generation For Each Aim

The question generation module in the Comprehension Test treats the following three kinds of query forms.

(1) Questions using interrogative pronouns

This type of question is high level because a learner must understand the context such as referring relationships between words and time-space relationships, and have the necessary writing skill to construct an answer sentence.

(2) Alternative questions

This type is easier than (1) because if an answer follows "No", a learner must have writing skill but she can construct an answer by referring to the question.

(3) Questions asking a leaner to point out errors

A learner reads a sentence describing the contents of the textbook, and then she answers whether the meaning of the sentence corresponds with the contents or not. This type is the easiest because the learner needs not construct a sentence.

To ask questions of types (2) and (3), the module should automatically generate sentences which are semantically incorrect. We have implemented the following methods.

(a) To use an opposite word

(b) To exchange the order of cause and effect or time relationships

(c) To replace an instance of a noun or a modifier in the semantic information

The methods of (b) and (c), especially, are quite natural and useful because these methods use information taken from sentences in the textbook.

Note that we are discussing difficulties of questions by considering the query forms and what and how to ask, and we will describe them in a future paper.

In the following part of this chapter, we describe how to form questions from the information described above in [Information For Question Generation] along with the authors' educational intentions.

4.1 To Master The Use Of Grammatical Knowledge

To confirm understanding states of particular grammatical knowledge such as new words and phrases and new interrogative pronouns, the question generation module makes a question of one sentence as follows [Kunichika et al. 95b].

(1) Using new words and phrases

"Words and phrases" include words, idioms and sentence structure. The module has information about the places where new words and phrases appear in each textbook. Using this information, the module transforms statements into questions which include new words and phrases. For example the module generates "Did John have breakfast at eight this morning?" when we assume a new word in the sentences in [Fig. 1] is "breakfast".

(2) Using interrogative pronouns

For conversation training using particular interrogative pronouns, the module makes such questions by referring to semantic categories and functions of words stored in semantic information. For example to train dialog using "Who", the module selects the agent "he" of the third sentence as the query part, and then generates "Who sat on a white bench in the park?".

4.2 To Confirm Understanding States Of Contents Of Sentences

To achieve the target the module makes questions which confirm whether or not the learner is able to answer questions even if they use synonyms, or is able to grasp the context.

First to make questions by replacing words, the module uses dictionaries of synonyms and antonyms. At present the module has information about synonyms and antonyms of verbs, nouns, modifiers, and prepositions and conjunctions used for expression of time or space information. For example by replacing "then" in the second sentence in [Fig. 1] with "after" and combining the first sentence with the second sentence, the module makes a question "What did John do after he had breakfast at eight this morning?".

Next to make questions which ask the context of sentences the module can use the following ways.

(1) Using sentences of textbooks

The module uses interrogative sentences in a textbook. But if the sentences have pronouns, the module replaces them with referred words by tracing links in semantic information. For example we suppose an interrogative sentence "Do you like skiing?" is in a textbook and "you" in the sentence means "Tom". The module makes questions such as "Does Tom like skiing?" by replacing "you" and selecting the suitable verb "does", and "Does Tom dislike skiing?" by using the antonym "dislike" moreover.

(2) Using referring relationships of words and phrases

Referring relationships by determiners and pronouns are expressed as links in semantic information. To confirm whether a learner understands to what words and phrases refer, the question generation module uses the links. For example the module generates "Who went to West Park?" which asks for the word referred to by the pronoun of the second sentence of [Fig. 1].

(3) Using attributes of nouns

Semantic information of nouns is expressed separately for each noun. For example in [Fig. 1] two bicycles: one is the blue bicycle described in the second sentence, and the other is the red bicycle in the fourth sentence. They are not the same object, but they are stored into one entry as different instances. The word "bench" which first it appears in the third sentence and next in the fourth sentence, is the same object, so its attributes are stored into the same instance as shown in [Fig. 1]. Because modifiers which appear in various sentences are stored in one instance, the question generation module can make questions related to some sentences. For example by using modifiers of "bench" in [Fig. 1], the module makes "Did John sit on a small white bench in West Park?". By using a modifier of another instance of "bicycle", the module makes a semantically incorrect question "Did John go to West Park on a red bicycle?".

(4) Using relative pronouns

The question generation module makes questions which use relative pronouns in the following order. First, the module selects both a main sentence and a subordinate sentence. Next, the module selects a relative pronoun by considering both the role of an antecedent in the subordinate sentence and a semantic category of the antecedent. And then the module inserts the antecedent, the relative pronoun and the subordinate clause into the main sentence. Finally, the module makes a question from the sentence. For example by using the third and fourth sentence in [Fig. 1], the module makes "What was there near the small bench which John sat on?".

(5) Using time and space relationships

Time and space information are expressed as hierarchies as shown in [Fig. 1]. Inclusion relationship information is expressed, vertically, and partial ordering in time information and positional relationships in space information, horizontally. The module makes questions which ask relationships between nodes in the information. For example the module makes "When did John go to West Park?" which asks when the phenomenon in the second sentence in [Fig. 1] happens.

(6) Using information about transitions of scenes

To make questions which ask the transitions of scenes, symbolized by changes of topics, time and space, the question generation module uses semantic hierarchies of sentences as described in [Information For Question Generation]. As a hierarchy indicates in [Fig. 3], sentences in [Fig. 2] are divided between the second and third sentences. Furthermore by using information about continuance of words which express topic, time and space, the module decides the topics of the opening two sentences are "king", "queen" and "have" which appear in the both sentences: appearing includes referring pronouns. For example the module generates "What did a king and a queen have?" by using the semantic reason for dividing, and "Who liked the baby girl?" to confirm whether a learner grasps a story by assuming the first sentence of a divided group describes the change of a scene.

4.3 To Correct Errors

This category has two meanings; one is to confirm whether a learner has correctly acquired knowledge mistaken in the past, the other is to correct errors in the previous answer. In this section, we describe the ways to make questions for the two types of errors.

(1) For incorrect knowledge in the past

To confirm the knowledge about words and sentence structure, which was mistaken in some test functions, the module makes questions which make a learner use the knowledge in an answer by referring to a student model. Grammatical information in the student model consists of understanding states of both words identified in a word test, and grammatical knowledge identified in the Comprehension Test. The natural language understanding module can identify 61 types of grammatical errors in the following two ways [Kunichika et al. 95b]. One is to use extra conditions in grammatical rules for natural language analysis, and this way is used for identifying word transformations. The other is to use buggy rules, and this way is used for identifying word order. As a result, the identified error type and concrete grammatical information are stored in a student model.

For example to confirm whether a learner who has made the error "countable noun with no article" uses an article for the countable noun "bicycle", the module generates "What was there near the small bench?" from the fourth sentence in [Fig. 1].

(2) For incorrect knowledge in the present time

When a learner inputs an incorrect answer, the module supports the learner from the viewpoint that the module makes the learner think carefully. As parents correct syntactic and semantic errors made by their children immediately, it is important for the module to support correcting errors immediately.

The module corrects syntactic and semantic errors as follows in the Comprehension Test: First, to correct syntactic errors, the module helps the learner in the following order: (a1) Telling the learner where she makes errors. (a2) Showing a correct example sentence. (a3) Showing the incorrect part of the answer and telling about the errors concretely. (a4) Explaining correct knowledge. (a5) Giving an example of a correct answer as the final way. Next, to correct semantic errors, the module supports in the following order: (b1) Telling the learner "Your answer is incorrect.," and giving the same question again. (b2) Giving the same message and a simplified question. (b3) Showing sentences of a textbook, which includes the answer, and giving the same simplified question. (b4) Giving an example of answers as the final way.

5. Conclusion

In this paper we described the targets of using a question and answer facility in the context of education, the kinds of questions to achieve the targets, and the methods of automated generation of them.

A short-term target of our research is to implement the question generation module which generates various kinds of questions automatically. We have already implemented a way of question generation from time and space information, and we are now implementing the other kinds of ways. After we have implemented them, we will evaluate a rate of both generated correct sentences in syntactically and semantically, and generated useful questions in educational use. The next step is to research educational use of the question generation module, that is how and what to ask in what order.

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An Internet-based Journal System for Learning

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Abstract: An emerging model of learning as situated in social practice is challenging traditional methods of education that tend to isolate the student and abstract the learning processes and outcomes from the social and cultural practices that give them meaning. Approaches to learning and professional development are increasingly turning toward models of induction and apprenticeship. For teaching and learning processes these models emphasize learning from experience and the development of expertise as a process of progressive problem-solving and movement past present levels of competence. This paper describes an Internet-based journal system to provide access, support and sharing for the processes of learning to become a teacher.

Educators and learning scientists are coming to understand that learning is not a discrete process which can be abstracted out of social and cultural experiences, but rather that learning is a part of each human experience. Further, learning from experiences can best be understood when it is seen as situated in a community of practice [Brown, Collins, and Duguid 1989] [Lave and Wenger 1991]. The models of induction and apprenticeship are also aligned with a view of the professional as a reflective practitioner engaged in life-long learning. Donald Schon [Schon 1983] described professional practice as being engaged in a reflective conversation with an uncertain situation, taking stances, experimenting, and learning from the back-talk of the situation.

Following from these emerging understandings of professional education the College of Education (COE) at the University of Missouri-Columbia designed a new undergraduate teacher development program. The new program emphasizes:

1. learning from field experience (i.e. a substantial part of the program is situated in K-12 classrooms),
2. becoming a reflective practitioner (i.e., being challenged to articulate one's experience and learn from the backtalk of the situation.), and
3. induction into a learning community of educators (progressively more challenging responsibilities in teaching, developing habits and strategies for life long learning, and contributing to a knowledge-base of teaching and learning to teach.

Technology infrastructure

The COE envisioned a technology infrastructure connecting students to a common knowledge base and support structure even when dispersed throughout various school systems in the State of Missouri. Students would participate in field experiences in remote schools, communicating about those experiences, being supported as they made sense of the experiences, and building an appreciation and capacity to use a network of resources (human and archived) for engaging in reflective conversations with uncertain situations.

The three key elements for the initial implementation of the technology infrastructure are access, support, and a sharing service. *Access* was made possible by providing Macintosh Powerbook 1400's to all 290 freshmen students in the class of 2000 and approximately 30 faculty who would guide their first year curriculum experience. The Powerbooks have both ethernet and modem capabilities for making connections to network services. *Support* issues are handled by multiple training session about using the technology, a special troubleshooting team created to address technical problems, and a newly designed physical space, called the reflector, for shared resources such as desktop systems, printers and check out for audio-video devices. The current paper describes the Interactive Shared Journal System (ISJS) designed, developed and implemented to support the *sharing* service for the new processes of teaching and learning.

ISJS is implemented on a Macintosh client and Silicon Graphics Indy servers. The clients and servers communicate over the internet using TCP/IP connections. Anyone who has access to the internet via a direct connection or a SLIP or PPP connection is able to participate, thus students can connect from any home or school location in Missouri and beyond. In addition the software supports the creation and editing of journal entries off-line for later upload when a connection is available. A custom server was created for connecting and maintaining a login to the journal system. The server provides communication between the client and an Oracle database. ISJS is a flexible system for the development and support of learning communities, but in the context of the undergraduate teacher development program it can best be understood as enabling three key processes: access to Internet-based resources, capturing experiences, and sharing experiences. These processes are undertaken in the context of a community made up of four roles:

- administrators, who are responsible for the system;
- mentors, who are responsible for instruction and modeling;
- students, who are responsible for articulation of experiences; and
- guests, who have limited access to public information

Access to Resources

When a student logs into ISJS with an id and password they connect to an intranet of information and communication services. Figure 1 shows the tools menu that greets users once they have successfully logged into ISJS. Users have access to an internal email system that allows for posting mail to internet-based accounts, but also enables an internal mail system for sending messages to other ISJS users via their ISJS login id. This feature will be especially valuable for K-12 students who do not have email addresses. Users can also invoke the Netscape browser from the Tools window. The News button and Resources button take the user to custom news readers and web pages. These features allow the faculty to craft special discussion or HTML environments for their students and their curriculum and have them directly available within ISJS. The inclusion of these first four services in the tools panel is primarily to organize and integrate these features in a single environment for the faculty and student.

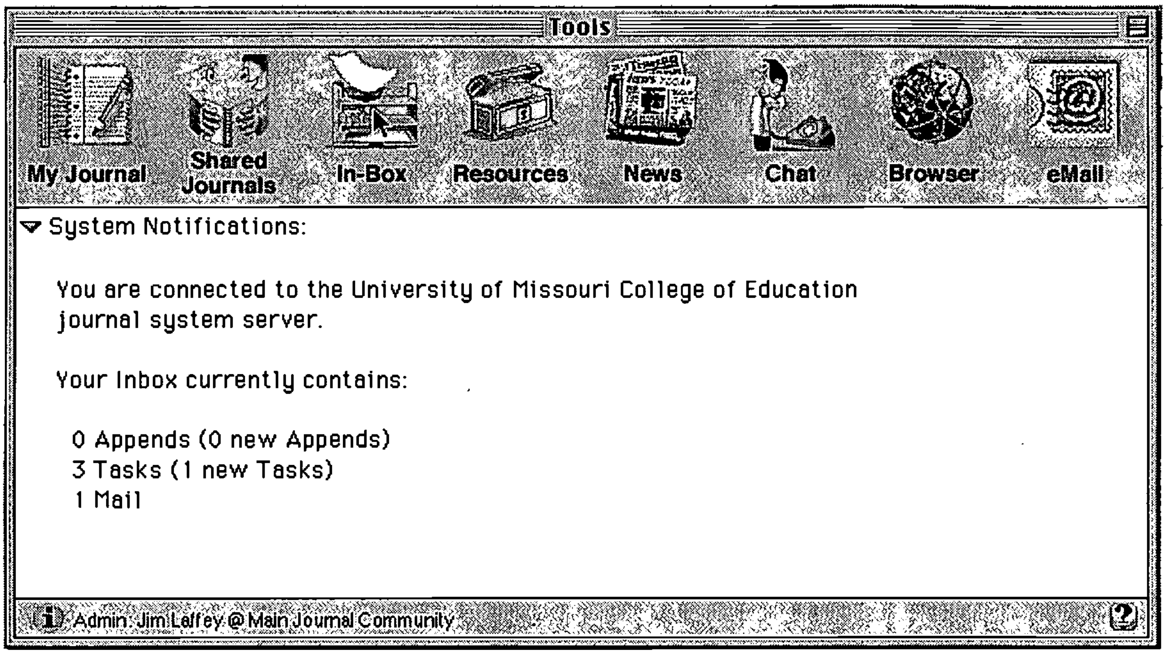

Figure 1: Tools window provides access to shared services.

Capture Experience

When a student selects "My Journal" from the Tools window they open a list of existing journal entries. Figure 2 shows four types journal entries: Journal, Append, Source Task and Task. The Journal entry is used to represent an experience or reflection. An Append is a personal journal entry that is attached to another persons journal entry. For example, a mentor or other user might be reading a journal entry from a student. The reader can click the append button that allows for a new entry to be created and attaches it to the open entry. Source Tasks are created by Mentors as assignments and can be distributed to students and then monitored for progress. A Task is what the student receives from the mentor. The sections of the task created by the mentor cannot be modified by the student. The student can, however, insert his or her response to the assignment and indicate level of progress. The journal entries are organized by folders for the various groups that a user has joined or can be sorted by alphabetic title or by date. When entries are created or updated the author can set access privileges to be private, public or by group membership. Figure 2 shows the symbols for each of the four types of entries and illustrates that entries can be either public or private. In addition public entries can be organized by groups of users (not shown in figure).

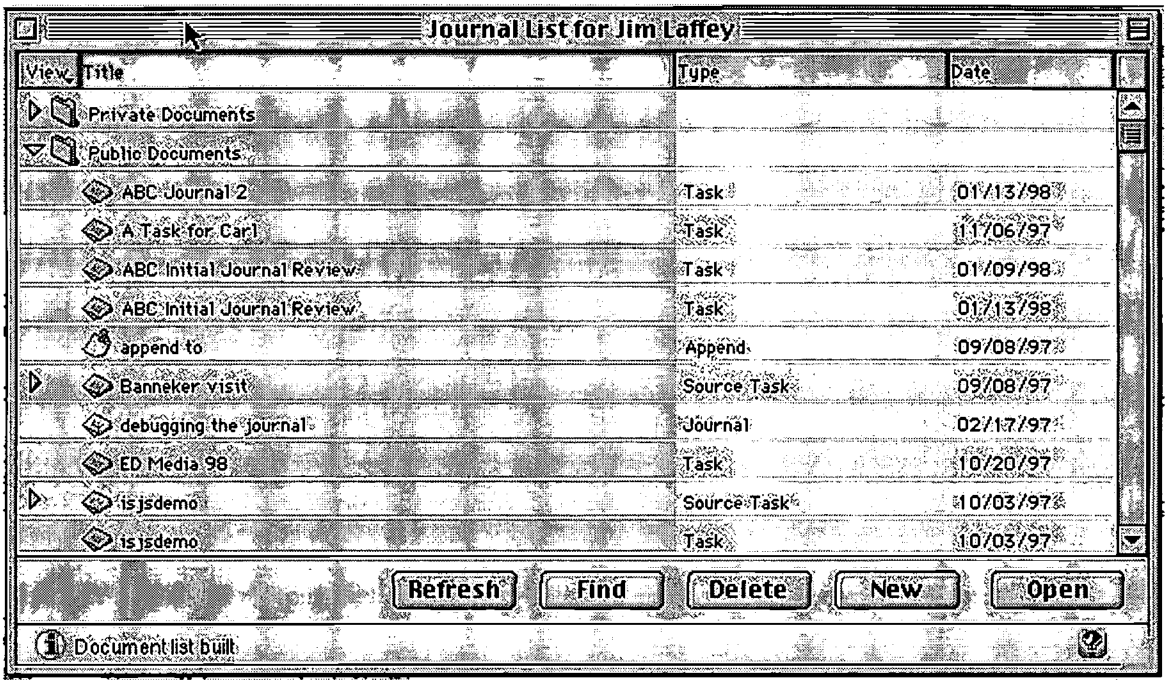

Figure 2: List of entries in My Journal

A user can create a journal entry with the New button on the list window or directly from the File menu. A standard entry has several elements: a title, keywords, access privileges, an author, a body, and it may have appends. A source task has a distribution list, and a task has a progress status. A key design goal of ISJS was to enable mentors and students to express themselves with as much representation power as possible in order to facilitate articulation and communication. To this end we have created a journal entry as a set of media and link objects. Figure 3 shows a journal entry that includes text fields, a link to a web page, a link to another journal entry, an image, and a sound object.

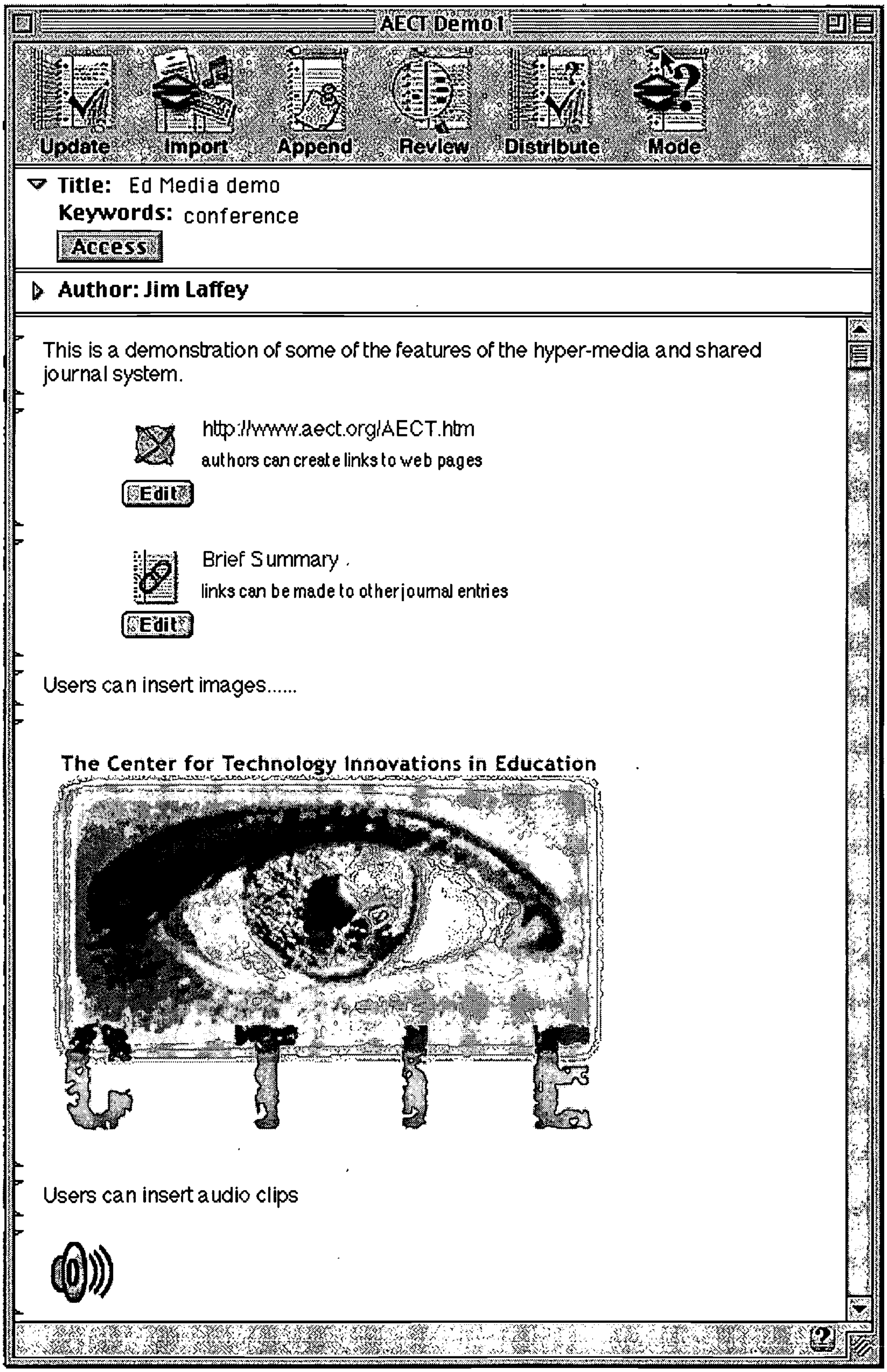

Figure 3: Journal entry showing text, links, an image and a sound.

In addition entries can include attached binary files (e.g., an excel spreadsheet or video clip).The media objects can be imported into an entry through cut and paste from an open document or through a file access dialog if they reside as a file in computer storage. Objects can also be acquired on the fly by selecting an open web page or journal entry, or by using a media control panel for capturing sound through a microphone, a video still from a camera, or an image from a scanner. The object rich journal entry form can facilitate the student as they capture their experience and as they represent it. For example, a student on a classroom visit can capture images of the seating arrangement or bulletin boards, record audio of students reading text passages, or include links to web sites the students found or developed during class assignments. Fellow students or the instructor can not only review the students text descriptions of the experience, but can have a mediated tour of the experience, facilitating understanding and discussion.

Sharing Experience

The idea of capturing experiences can be extended by enabling the student situated in the experience to call up journal entries of classmates who have undertaken similar assignments. By comparing one's "findings" with those of others, our student can "make better sense" of the experience. In this way, by allowing access to a dynamic community memory, ISJS scaffolds students as they take on progressively more challenging tasks in the community of educators.

ISJS is an archive of experiences, richly presented, that can facilitate being successful on challenging tasks, thus enabling the curriculum to provide progressively richer experiences for the student. Based on research undertaken at Apple Computer, electronic systems can augment the processes of taking on new challenges, sharing resources, and being guided to successful performance. [Laffey 1995] articulated the characteristics of a dynamic support system as the ability to change with experience, to be updated and adjusted by the performer, and to augment other resources found in the performer's community. The archived experiences can become especially valuable when enriched by appends from faculty, peers, or practicing teachers.

To build a learning community ISJS was designed to represent both users and their archived experiences. The system enables each user to create a personal profile that represents a type of business card from which other users can connect via email, view a personal web page, enter one's journal or solicit a chat session. Figure 4 shows a profile window for a system user.

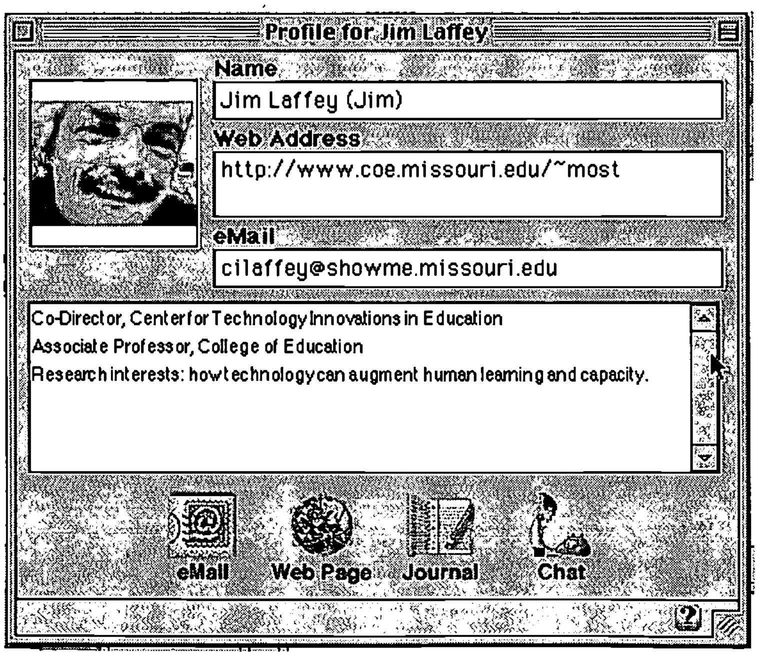

Figure 4: A profile window for a system user.

In addition to archived representations of experiences ISJS affords a live chat intranet. A faculty member or student for that matter could invite students to a chat session in the evening following a set of field experiences. Similarly a chat session could be invoked amidst a field experience to seek suggestions or help make sense of an observation. Users of the system can see who is on-line by asking for a list of people on-line. On-line users can be sent notes asking to meet in a private or open chat room.

Another form of sharing is for the faculty or mentor to structure an experience for a student. Instructors can create object rich source tasks that can be distributed to individual students or groups. Figure 2 shows a journal entry that a mentor has turned into a Source Task. Once an entry becomes a Source Task the mentor can use the Distribute button to assign the task to members of the community and the Review button to monitor progress in the completion of the assignment. A student receives the task in "My Journal", but a pointer to the task is also placed in the "In-Box" to facilitate the students attending to the task. The In-Box also holds system email and shows when someone has created an append in one of your journal entries. Upon opening the task the student can report about the work they undertook to complete the task and also use a slider bar to mark their progress on a 0 to 100 scale. When the mentor reopens the source task he or she can review student progress and directly open the student task entry.

Conclusion.

ISJS provides an electronic support environment for many of the teaching and learning processes of learning from field experiences, of supporting reflective practice, and of sharing within a learning community. Our experience is showing that learning communities can be augmented by a technology infrastructure that emphasizes access, networking, and shared services. The pilot year of implementation with freshmen students in the undergraduate teacher education program has provided several markers of progress. Representing learning experiences in an electronic journal supports the articulation and sharing of experiences and the ability of faculty and students to derive benefit from field-based learning. ISJS also enables connections to resources and learning experiences that are otherwise inaccessible. For example, we have a cohort of practicing math and science teachers using ISJS with their students as the students undertake project based learning. ISJS is being used to help the preservice teachers "observe" project based learning via reading journals, and is beginning to be used to facilitate a conversation between the preservice teachers and the high school students so as to support the work of learning from their projects. Given some good beginnings, the pilot year has also shown that traditional methods are slow to yield to new approaches in a college of education and that many challenges remain to be overcome. One example of the strength of existing practices is that although ISJS affords the opportunity for a network model of sharing (e.g., communication among peers), almost all instances of ISJS usage of appends show a hierarchical model of sharing (e.g., students provide entries for review by faculty who then use appends to provide comments)

The coming year represents several advances in system use and utility. The freshman and sophomore classes of the teacher education program, including faculty, for a number of about 600 will use ISJS. A key system enhancement is to develop a second client based on the use of a web browser and Java scripting. This client will enable cross-platform use of ISJS. ISJS is a continuing effort to match innovations and advances in technology to the communication and sharing needs of a learning community.

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Attitudes of University Students to Computing: An Australian Perspective

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Abstract: This study reports on the results of a study investigating attitude to computing for a large group of students undertaking an introductory information systems course in an Australian university. The focus of this study is to determine whether the following factors: age, gender, previous computing background and computer knowledge, influence attitude of university students to computing. Our results show that age and gender do not appear to significantly influence attitudes to computing. However previous computing background and level of computer knowledge do significantly influence attitudes to computing.

1. Introduction

The purpose of this study is to determine the attitude of university students to computing. We are interested in the following questions: "do age, gender, previous computing background and level of computer knowledge influence attitude to computing?"

With the above aims, the following four null hypotheses were formulated for this study:

1. There is no significant relationship between age and attitude to computing.
2. There is no significant relationship between gender and attitude to computing.
3. There is no significant relationship between previous computing background and attitude to computing.
4. There is no significant relationship between the level of computer knowledge and attitude to computing.

2. Methodology

A survey was conducted during the first class for students enrolled in an introductory information systems course in March 1997. The course teaches computer-based information systems in business organizations and practical hands-on lessons on word-processing and spreadsheet software.

The questionnaire is divided into two parts, A and B. Questions in part A are related to gender, previous computing background and level of computer knowledge. Previous computing background is measured in terms of number of years a student has used a computer. There are four categories: not at all, less than a year, between one and two years and more than two years. In this study, level of computer knowledge is defined as overall knowledge in word processing, spreadsheet and database software as well as programming skill. For each type of software and programming skill, students are asked to indicate what they believe to be their level of expertise in terms of none, basic, intermediate and advanced, each carrying weights of 1, 2, 3 and 4 respectively. The mean score, rounded to the nearest whole number, for these four questions is calculated to indicate the overall level of individual student's computer knowledge. A mean score of 1 indicates no computer knowledge at all, 2, 3 and 4 indicate basic, intermediate and advanced levels of expertise respectively. Part a also consists of other questions such as age (less than twenty years old, equal to or more than twenty years old), faculty which the student enrols in (Commerce, Informatics and others), year of study (first, second, third and above) and mode of study (full-time or part-time).

Part B of the questionnaire consists of twenty-four questions related to attitude to computing. These questions (see Table 1) were adopted from [Francis, 1993]. A five-point Likert scale, ranging from "strongly agree", "agree", "not sure", "disagree", "strongly disagree" was used. The question can be either a positive or negative statement. For example: "I feel at ease when I am around computers" is regarded as a positive statement, whereas "computers make me feel uncomfortable" is a negative statement. Questions relating to negative statements are coded in reverse order to those relating to positive statements. In this study, a positive statement is coded as 5 for "strongly agree", 4 for "agree", 3 for "not sure", 2 for "disagree" and 1 for "strongly disagree". On the other hand, a negative statement is coded in the reverse order (for example 1 for "strongly agree"). The attitude of each student is determined by calculating the mean score of the twenty four questions presented in Table 1. A student is considered to have a positive attitude if he or she has a mean score of 3 or more. Otherwise he or she is considered to have a negative attitude to computing.

1.	I feel at ease when I am around computers.
2.	I feel comfortable when a conversation turns to computers.
3.	Learning about computers is boring to me.*
4.	I like learning on a computer.
5.	Working with a computer would make me very nervous.*
6.	I feel aggressive and hostile toward computers.*
7.	Computers make me feel uncomfortable.*
8.	I get a sinking feeling when I think of trying to use a computer.*
9.	I would feel comfortable working with a computer.
10.	Computers make me feel uneasy and confused.*
11.	I am not the type to do well with computers.*
12.	I would like working with computers.
13.	The challenge of solving problems with computers does not appeal to me.*
14.	I think working with computers would be enjoyable and simulating.
15.	I do not enjoy talking with others about computers.*
16.	Learning about computers is interesting.
17.	I enjoy using a computer.
18.	Computers are boring.*
19.	Learning about computers is something I can do without.*
20.	Computers are not exciting.*
21.	Studying about computers is a waste of time.*
22.	It is fun to figure out how computers work.
23.	Learning about the different uses of computers is interesting.
24.	I enjoy learning how computers are used in our daily lives.

Table 1: Twenty-four questions on attitude to computing (*indicates negative statements)

3. Results

As the study involves bi-variate correlational problems, chi-square analysis is used.

3.1 Profile of Respondents

Five hundred and nine responses were collected, of which two hundred and seventy-eight were from male students and two hundred and thirty-one were from female students. There were four hundred and sixty-three full-time students and forty-six part-time students. There were three hundred and eighty-nine respondents enrolled in the faculty of commerce, whereas seventy-nine respondents enrolled in faculty of Informatics and forty respondents were from other faculties in the university. In addition, there were four hundred and thirty-two respondents who were first-year students, sixty-one respondents were second-year students, sixteen respondents were third- and fourth-year students. In terms of age category, there were three hundred and forty-five respondents who were less than twenty years old and one hundred and sixty-four respondents fell into the age category of equal to or more than twenty years old.

There were forty-five respondents with no computing experience at all, sixty-two respondents had less than one year of previous computing experience, ninety-four respondents had between one and two years of previous computing experience and three hundred and eight respondents had more than two years of previous computer experience. In terms of level of computer knowledge, one hundred and nine students considered themselves did not have any computer knowledge, two hundred and forty-three students were perceived to have basic level of computer knowledge, one hundred and thirty-two students were identified as having intermediate level of computer knowledge and twenty-five students had advanced computer knowledge. Figures 1 and 2 show breakdown of age in relation to previous computing background and level of computer knowledge respectively. Figures 3 and 4 show breakdown of gender in relation to previous computing background and level of computer knowledge respectively.

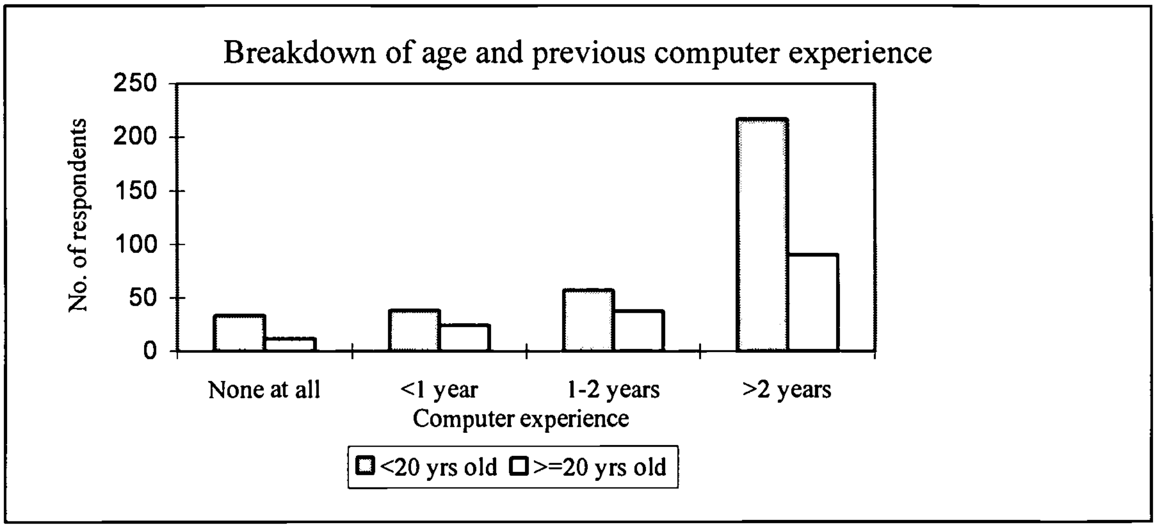

Figure 1: Breakdown of age in relation to previous computer experience

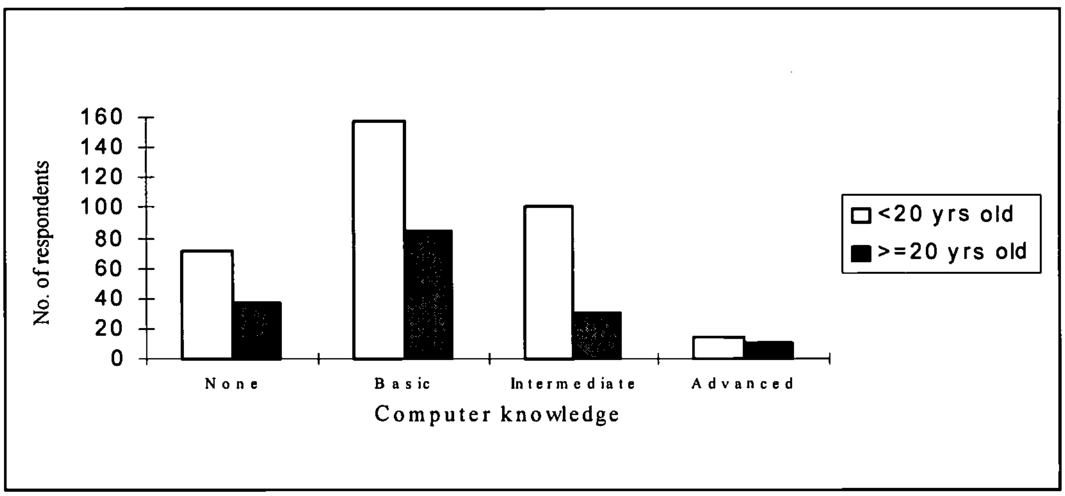

Figure 2: Breakdown of age in relation to level of computer knowledge

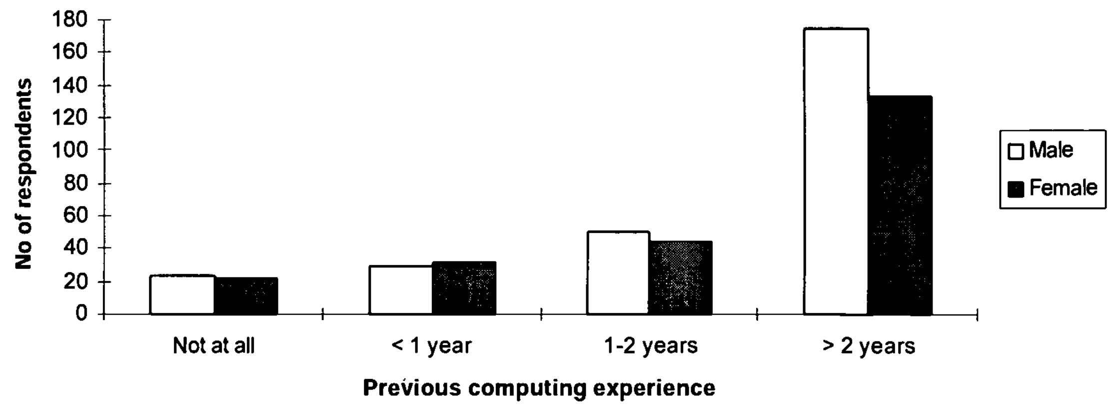

Figure 3: Breakdown of gender in relation to previous computing background

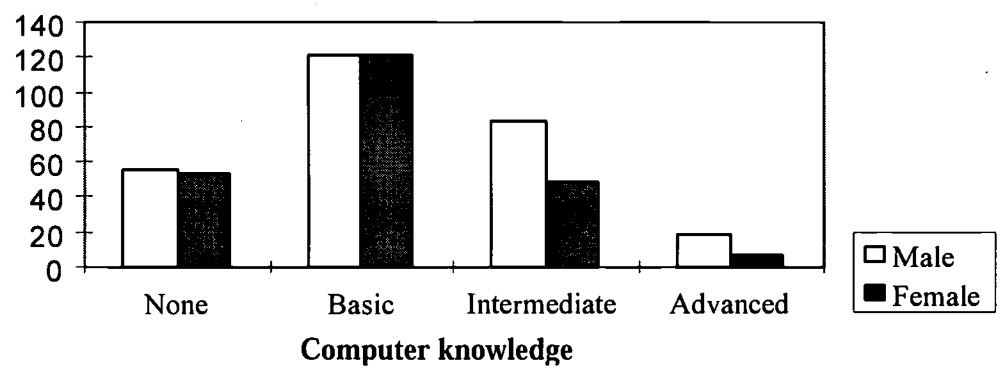

Figure 4: Breakdown of gender in relation to level of computer knowledge

3.2 Chi-square Results

Table 2 shows observed Chi-square values from comparisons between attitude and age, gender, previous computing background and level of computer knowledge. We conclude that there is no significant relationship between attitude to computing and age, and, attitude to computing and gender. However there are significant relationships between attitude to computing and previous computing background and, attitude to computing and level of computer knowledge.

Variables	Observed chi-square values
Age	0.4928
Gender	0.5734
Previous computing background	45.62*
Level of computer knowledge	32.79*

Table 2: Observed Chi-square values (* results significant at α=0.01 level)

4. Discussions

In this study, it is found that age has no significant relationship with attitude to computing. Studies have shown that although older students had less computing experience compared to younger students, they were less computer anxious. Older students also believe that they could benefit from computer technology and viewed acquisition of computer knowledge as desirable and favorable. On the other hand, younger students are more likely to use computers earlier in life than their older counterparts and therefore they are more likely to show positive attitudes to computers. It is suggested that although older students have less computer experience than younger students and they may be less confidence with computer, however they demonstrate positive liking for computer. Confidence with computers is often a result of computer knowledge and familiarity with the technology, thus age should not be a factor in influencing one's attitude to computing. Attitude can change as a result of computer knowledge and experience with computer. Our results which show age does not influence attitude to computing is consistent with that reported by [Anderson, 1996].

Our results also show that gender does not significantly influence attitude to computing. This result is encouraging as female students are no longer perceived to have a less positive attitude to computing. In a previous study conducted by the authors in 1994 [Lau et al, 1995], gender was found to significantly influence attitudes to computing. The result presented here is consistent with studies conducted for undergraduate students undertaking introductory course in information systems or computing [see Anderson, 1996; Houle, 1996] in which gender factor was found to be not influencing attitude to computing. Thus it is encouraging to note that the result presented here together with others reported elsewhere may indicate that traditional gender stereotyping and attitude to computing no longer valid.

Our study shows that there are significant relationships between previous computing background and attitude to computing, and level of computer knowledge and attitude. These results are consistent with that reported in the literature as well as consistent with a prior study conducted by the authors in 1994 [Lau et al, 1995]. Evidence [see McInerney et al, 1994] suggests that increased computer experience diminishes computer anxiety. This is because computer anxiety and attitudes towards computers use are related [Bozionelos, 1997]. In another study [see Torkzadeh and Dwyer, 1994] also suggest that computer training increases user confidence. Confidence with computers can be attributed to familiarity and computer knowledge. Lack of computer knowledge results in high anxiety and negative attitudes. It has been shown that attitude to computing can be improved significantly with training. Thus in order to reduce the anxiety of students to computing, training may be an ideal way to overcome the negative attitude to computing. [Torkzadeh and Dwyer, 1994] show that computer user training does influence user satisfaction and user confidence. However it is worth noting that increased computer experience alone will reduce computer anxiety and thus ensure a more positive attitude to computing is a simplistic view [McInerney et al, 1994]. Further research in this area needs to be conducted to confirm this view.

6. Future research

There is no consistent view on whether attitude to computing change for better or worse after attending the computing course. [Barrier and Margavio, 1993] show that student's attitude to computing do become worsen after a one-semester computing course. However [Torkzadeh and Koufteros, 1993] do not show any change in attitudes upon completion of a computing course. It is important to investigate student's change in attitude to computing. As [Simon and Wilkes, 1997] point out having a good attitude will encourage a student to learn more. It is desirable that further research to be carried out to investigate whether students change their attitudes after completion of computer course. In this study students were asked to determine their perceived level of computer knowledge in terms of their capability in using application software (word processing, spreadsheet and database) and their programming skills. In order to obtain a more accurate measure of computer knowledge, a computing test should be administered to determine individual's level of computer knowledge. A set of multiple-choice questions on computer concepts and applications can be used for this purpose [see Oliver, 1993]. Thus to investigate the change of attitude after one semester course in computing, a pre-test needs to be conducted at the beginning of the semester and then a post-test can be carried out at the end of the semester using a structured instrument.

As information technology becomes an indispensable organizational resource, top management expects its employees to be conversant with computer technology and to use the technology in all aspects of planning, management and production operations. More and more organizations are also employing staff who are computer literate. Students from business and commerce courses are expected to be computer literate and proficient in computer software. It is not known whether professional expectation such as that described above plays a part in influencing attitude to computing. Future research should be carried out to investigate the relationship between professional motivation and attitude to computing.

7. Conclusions

In conclusion, our results show that there is no significant relationship between age and attitude to computing, and, gender and attitude to computing. However there are significant relationships between previous computing background and attitude to computing as well as between level of computer knowledge and attitude to computing.

Finally what can this study contribute to the educators, in particular educators who are involved in teaching introductory computer courses in tertiary education? As discussed previously with widespread introduction of computers in the workplace, a large number of organizations expect graduates they employed to be computer literate and be able to integrate their academic knowledge and computer technology into all aspects of their work. Universities have also included computer literacy as one of desirable attributes which students must possess when they graduate. Thus it is not surprising to see that introductory computing course has often become a compulsory unit in business degrees and programs. To this extent an introductory computing course often have large group of students with diverse background and computer skills. As indicated in this study, previous computer background and level of computer knowledge show significant influence on attitude to computing, thus educators should make deliberate efforts to find out if students possess any previous computer background. By finding out prior computer experience and level of computer knowledge, this can assist educators in planning the content, format of the course as well as assessment. As [Houle, 1996] points out that effective teaching requires detailed knowledge about the students as it impacts on students' motivation and desire to learn. It is hoped that by having detailed knowledge about students' previous computer background and level of computer knowledge and by planning a course which is appropriate to their level, it will improve students' motivation to learn more and to acquire computer skills which will be useful to them.

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Problems of teleteaching: a critical theory perspective

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Abstract: Telelearning is no longer a new phenomenon in educational practice. The emergence of the Web in the field of education has created a new teaching and learning discourse as well as a new discourse community. It provides teachers and learners with powerful facilities to interact and to explore the world of knowledge whose access is no longer restricted by time and locality. Educators of different academic specialisations have used the Web as a superhighway for extending and expanding education. However, it is not smooth surfing as teleteaching in a virtual context can bring with it serious problems, particularly in an intercultural context. As learning cannot be divorced from its cultural context, teaching via the Web needs to take into account the discourse of learning which is sensitive to cultural imperialism. The superhighway can create cultural conflicts between learners and course providers if it fails to recognise learners' cultural identities.

The question 'What is teleteaching?' was raised by Daunt [Daunt 1997] at a conference when she attempted to examine how teleteaching and traditional face-to-face teaching differ in the current context of computer technology. In her view, the most common factor for teleteaching is that it involves the use of communications technology to interact with students in 'real' time. She explains why teleteaching is introduced:

> Many educators are being thrust into the role of 'teleteacher'. This sometimes occurs because an organisation has investigated new and creative ways of delivering education to dispersed groups of learners. However, it often occurs because organisations must do more with less and teleteaching is seen as one way of achieving this. No matter what the motivating factor, teleteaching presents exciting new opportunities for teachers and students.
>
> [Daunt 1997, p.105]

As the prefix 'tele' means 'far' or 'over a distance' as in 'telephone', 'telegram', 'television' etc, teleteaching can be said to be in contrast with face-to-face teaching. The discussion in this paper will focus on teaching via the Internet, primarily the World Wide Web.

While the constant search for an effective and enlightening way of teaching in traditional education is explored, a different force which challenges the current educational practice has emerged as computer technology has powerfully permeated society as a whole and education cannot be immuned from the computer-led revolution. The Web is undoubtedly a powerful force which may tricker a paradigm shift. The popularity of this conference is a clear evidence of its recognition in educational theory and practice. Terms such as virtual class, virtual school, telelearning and courseware are no longer special jargons.

The Web has become a familiar educational context for alternative teaching, particularly in tertiary education. Terms such as courseware, teleteaching (Daunt 1997), virtual class, and Internet-based teaching represent a new paradigm shift from face-to-face teaching. As the context of teaching has changed due to the recent emergence of the Internet, the role of a modern teacher has also changed. Tella [Tella 1997] suggests that the teacher's role is likely to change from the 'Sage on the Stage' to the 'Guide on the Side'. Roberts [Roberts 1997] argues that higher education is experiencing a paradigm shift, which occurs worldwide but faster in some parts than others depending on availability of resources, existing infrastructure and the stage of development reached. Moran [Moran 1997] refers to the new paradigm as a cult as she points out that this cult has "its own esoteric language and rites, 'in' groups and 'out' groups, and above all faiths in the intrinsic value of electronic communications". The so-called paradigm shift brings along newly defined concepts such as flexible learning , independent learner, technologically-based learning style. For instance, according to Szewcow [Szewcow 1997] flexibility means 'being able to learn a course/subject any time, any place, any pace and leave when you have satisfied your needs'.

Courseware and semi-courseware have been introduced by tertiary education institutions to cater for on-campus as well as off-campus students. These are across subject areas. However, science and technology subjects tend to dominate the new technologically dominated domain [Linn 1992; Hedberg et al. 1994; Lê 1995; Gibert 1996; Newmarch 1997].

Though the Web has undoubtedly provided its users an extremely powerful tool for communicative interaction via the superhighway, it also brings along problems, clearly identified or mysteriously hidden in a human context as the superhighway has to run through a global village in which villagers of diverse cultures live. There are always cultural boundaries and demarcations which are invincible. In the discourse of education, while we may feel proud of the incredible speed and wide range of interaction the Web has brought to telelearning, it also brings many problems of the human kind. Access to a treasure of valuable information is one of the main aims of the Internet. However, the information superhighway cannot ignore the dynamic nature of different cultural contexts through which it travels. As the context of cultures determines the discourse of education, it is important to recognise that the cultural background of the learner can have a more profound effect on education than does a courseware itself. In traditional teaching as well as teleteaching, the commonly held assumption is that unless students can relate the application of what is taught to their own cultural backgrounds, their learning is likely to be less than effective. This is the reason why it is important to examine critically the new discourse brought about by the Web so that we can understand and appreciate its full contribution to education and intercultural understanding while taking notes of its potential problems and dangers. Andrews [Andrews 1997] has recently pointed out the needs for implementing global education using new computer technologies:

> The rapid uptake of telecommunications technologies is having a profound impact on the nature of teaching and learning at a local, national and international level. While expanding and enabling the globalisation of teaching and learning this globalisation has considerable implications for educational establishments. The challenge lies in providing a quality education to a client base that is not only geographically dispersed but also diverse in terms of age, culture, access, educational experience, expectations about learning and exposure to a range of teaching and learning methodologies and modes of delivery.
>
> [Andrews 1997, p.5]

The issue of 'taking for granted' in society and education has re-emerged with great interest. This is partly due to new developments in discourse analysis and critical pedagogy. Recently, educators , particularly those who adopt the critical theory, have questioned current educational practices which reflect the dominance of certain ideologies implanted in the curriculum and most importantly their powerful control of the educational discourse. On this tenet, the hidden curriculum needs to be systematically exposed and critically examined in terms of coercion, social inequity and ideology imposition. It is argued that this is crucial as the Web with its own powerful superhighway travels through a vast land of diverse cultures. As learners' cultural backgrounds cannot be ignored in intercultural education, any telelearning involving learners of diverse cultures needs to tackle seriously curriculum issues in a Web-based teaching context. Teleteaching in an intercultural discourse needs to be culturally sensitive as it may create cultural conflicts between course providers and learners. Factors such as cultural assumption and definition, cultural norms in social interaction, learning styles and cultural attitudes to education tec. need to be in the consciousness of courseware providers. Failing to take all these factors into consideration, the superhighway will lose its educational mission as it can lead to educational conflict, particularly when the cultural gap between the educational provider and the receiver is wide and in many cases no conventional bridging can fill the gap. As the paradigm shift moves away from the focus on teaching and learners are no longer passive knowledge receivers, there have been various attempts in educational theory and practice to introduce innovative curriculum ideas to schools to improve learning conditions and teaching methodologies. A quick glance at papers presented at this conference shows abundant use of curriculum concepts such as constructivism, learner-centred, negotiated curriculum, humanistic approach to learning, learner empowerment etc. This is a fascinating direction in educational multimedia.

The popularity of the Web has brought various parts of the world together. Gradually it has created its own culture. From the educational viewpoint, learning interaction is no more restricted to a few classmates in a corner of a classroom. The interaction has widened to include those from different geographical and cultural backgrounds. Teachers are no longer the only powerful source of knowledge and the library is no longer a building with many isolating walls and concrete boxes. In other words, the virtual world almost becomes a reality, not just an imagination. Teaching and learning via the Web present a different dynamicity in a different discourse. The new discourse of teaching and learning via the Web creates a different meaning making process which cannot be derived from the face-to-face tradition. The new discourse requires new ways of thinking, interacting, expressing etc. If educators seriously want to meaningfully embark on a new paradigm and accept a paradigm shift, they need a new consciousness.

To maintain meaningful intercultural education, particularly via the Web, it is important to take into critical consideration the meanings and assumptions that people in different cultures hold on fundamental concepts such as learning, teaching, curriculum, knowledge and relevancy etc. since these concepts are culturally specific. The reality facing a virtual class is that it cannot treat students as virtual learners. They exist in context and bring to the learning environment, whether it is face-to-face or via the Internet, a complex socio-cultural background which interferes with their learning and becomes a determining factor for their educational achievement. The fact that they are not visible in a face-to-face teaching does not mean that they do not exist. We cannot expect these students leave all their cultural backgrounds behind when they undertake a course delivered on the Internet. As stated, learning is embodied in culture. According to [Andrews 1997], not only students, teaching staff are struggling with the changes brought about by globalisation and the accompanying diversity of the student body. She points that while it is generally acknowledged that learners have different learning styles and expectations and teaching students from other cultures can be an ordeal for some staff and misunderstandings concerning cultural differences are not uncommon.

It has been argued in this paper that the real question facing Web-based education is that different cultures see issues differently and people engage in discussing those issues are culturally constrained. Therefore courseware developers need to take into account the cultural reality of a virtual class. Learners bring to learning their cultural identity which can strongly dictate teaching and learning styles, perception of the role of a learner and teacher and most importantly the classroom discourse. Thus, teaching cannot be treated as culturally independent.

The Web has provided distance education learners and teachers with an extremely powerful tool for sharing information in teleteaching. It also brings along problems in a human context. In education, there are curriculum issues in internet-based teaching which need to be dealt with, particularly from the intercultural perspective. Like face-to-face teaching, virtual classroom teaching in intercultural education needs to be culturally sensitive as it may create cultural conflicts between course designers, teachers and learners. Factors such as cultural stereotyping, cultural norms in social interaction, learning styles and cultural attitudes to education need to be taken into consideration. Otherwise the superhighway can lead to educational conflict, particularly when the cultural gap between the educational provider and the receiver is very wide. Davison [Davison 1997] is critical of the way in which the concept 'globalisation' is (mis)applied in intercultural education. He says:

> The importance of personal knowledge of the people involved in any open, distance and flexible learning is sometimes lost in a context of 'globalisation' trends and a techno-idolatry often associated with it. And yet all education is a moral activity. It is concerned with people significantly affecting the lives of others and educators have a moral obligation to consider how their individual actions in the teaching/learning nexus might significantly affect the lives of those immersed in it.
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> [Davison 1997, p.113]

The serious problem facing Internet-based teaching is that different cultures see issues differently and people engage in discussing those issues are culturally constrained. In one culture, talking about sexual behaviour is encouraged in education while in other cultures, it is censored partially or totally banned. It is the question that Internet-based courseware developers have to take into account; otherwise a 'virtual classroom' in one cultural context may become a villainous classroom in another.

Ideology plays a crucial role in the development of critical theory as a central feature of the work of critical theorists is therefore ideology-critique. Ideology is therefore an important feature for critical theorists to expose the social imbalance of the society. Interest in ideology leads to the understanding and sympathy for the culture of the oppressed. Critical theory operates by freeing people from coercion of ideology through enabling them to recognise the reality of their situation and thereby giving them more control over their own lives. In the critical theory viewpoint, educational practices are not themselves ideologically neutral. It reveals a context of cultural and political imposition. As Comber [Comber 1994] points out in literacy education:

Literacy practices are not in themselves neutral, but work culturally and politically to privilege particular kinds of literacies and therefore particular kinds of literate students.

[Comber 1994, p 26]

From the critical theory perspective, education should seek to overcome false consciousness as individuals are caught up in a social context in which they are blind to inequities of their situation and can be exploited by the dominant class. It is interesting to apply the concept of hegemony from critical theory to the context of Internet-based teleteaching, particularly in relation to the multicultural education. Hegemony can be defined as "the whole body of practices and expectations: our assignments of energy, ordinary understanding of man and his (sic) world. It is a set of meanings and values which as they are experienced as practices appear as reciprocally confirming. It thus constitutes a reality for most people in society, a sense of absolute because experienced reality beyond which it is very difficult for most members of society to move in most areas of their lives" [Phillipson 1996]. In this way, there is a close link between hegemony and discourse community. The relationship of these two concepts is metaphorically seen as the mind and body matter. According to [Phillipson 1996], hegemony reveals 'the relations of domination and subordination, in their forms as practical consciousness, as in effect a saturation of the whole process of living - not only of political and economic activities, nor only of manifest social activity, but of the whole substance of lived identities and relationship, to such a depth that the pressures and limits of what can ultimately be seen as a specific economic, political, and cultural system seem to most of us the pressures and limits of simple experience and commonsense [Phillipson 1996]. As pointed out previously, the Web produces a new culture of learning and teaching and obviously it can create its own hegemony.

There is now a strong belief in Web-based teleteaching that teaching is not the process of acquiring new knowledge but fundamentally to make sense of knowledge and even to challenge it. Postmodernism encourages learners to question how the master narratives become constructed and how they influence their thinking and living experience. In addition the regime of knowledge should be challenged as it is 'there' in the curriculum because it is part of power. In Foucault's view, power and knowledge cannot be separated. Weedon [Weedon 1987] points out that social structures and processes are organised through institutions and practices such as the law, the political system, the church, the family, the education system and the media, each of which is located in and structured by a particular discussive field. If all those issues are ignored due to financially-driven principles and pure excitement with the magic of the Web, the culturally ill-perceived educational superhighway could lead to ideology imposition and cultural conflicts. It is not always easy to draw a line between imperialism and education.

Conclusion

We have just examined some moral dilemmas in telelearning, particularly in the context of intercultural education. The Web has permeated the field of education at various levels, ranging from primary to tertiary education and covering themes across subjects and specialisations. Internationally, the Web as a superhighway has brought people of different cultural backgrounds together and this conference is a good example of its achievement. However, how powerful this superhighway is, it is still so vulnerable in its teleteaching mission.

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Advanced Technologies, Achievement, and Migrant Students

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Abstract The purpose of the MECHA project is to develop, implement, and evaluate a comprehensive model for 1) promoting greater continuity of instruction for migrant students as they are served in different school districts and 2) assisting migrant students to achieve high academic standards through innovative uses of technology to enhance teaching and learning. Web based instruction, email, and two-way interactive technologies are used to provide instruction and feedback as students migrate so that each student has a seamless academic year. This project serves as a model for collaboration between government, school districts, universities, and industry partners.

The Migrant Education Consortium for Higher Achievement (MECHA) project is a collaboration between Barry University, Miami-Dade County Public Schools, Florida Public Schools' Migrant Education Program, public television, telecommunications industry partners, and school districts serving migrant children and youth in five states along the migrant stream of the eastern coast of the United States. This project is funded by the U.S. Department of Education, Barry University, DCPS, and industry partners.

The purpose of the MECHA project is to develop, implement, and evaluate a comprehensive model for 1) promoting greater continuity of instruction for migrant students as they are served in different school districts and 2) assisting migrant students to achieve high academic standards through innovative uses of technology to enhance teaching and learning.

The objectives of the MECHA project are:

- to develop a model for providing and monitoring a student's individualized learning plan regardless of time or place.
- to implement the model over a 5 year period and evaluate its effectiveness.
- to provide relevant and meaningful instruction which will result in higher achievement in the core subjects at all grade levels and reduce dropout rates for secondary migrant students.
- to expose migrant students and their families to a number of career options available to them.
- to disseminate information about the model to state and local agencies serving migrant families.

Dade County is located at the tip of the Florida peninsula. Because of its idyllic climate and long growing seasons, it is the site of many large farms and other agricultural-related industries. Dade County is the home base for approximately 1,089 migrant families and 2,787 school-age migrant children and youth [Florida Department of Education 1996]. The typical migration patterns for these farm workers is from Mexico to South Florida, Georgia, South Carolina, North Carolina, Pennsylvania, Virginia and back to Dade County. The pattern varies little from year to year, depending on weather, availability of housing and work, and educational opportunities.

Migrant students at all grade levels have been identified by M-DCPS as being at risk for school failure for a number of reasons: 1) inability to communicate effectively in English, the language common to American schools, 2) socioeconomic factors, and 3) disruption of education due to migration.

The problems associated with migration are obvious:

- disruption of and lack of consistency in educational services.
- isolation of students from their peers.
- lack of educational materials.

- back-tracking (students have to be re-assessed at every new school due to lack of timely receipt or transfer of educational records).
- lack of time to complete school assignments due to the students' need to work or provide child care.
- lack of knowledge of systems and opportunities.
- the inability of migrant parents to support their children's educational progress due to time constraints and limited English proficiency.

Advanced telecommunications technologies afford students and school districts a way to bridge many of the barriers to educational progress found in the migrant community. These technologies allow any learner to take advantage of educational opportunities regardless of time or place. Our vision for the MECHA project is that migrant students can be involved in a consistent, individualized learning program regardless of where the student and his/her family are located, provided that appropriate supports are available and utilized. Innovative technologies have been built into the MECHA model in hopes that they will prove to be a prototypical approach to migrant education in other locations. The MECHA model was designed to address the critical concerns of educational programs in migrant communities as described in Table 1.

Problem	MECHA Solution
Lack of consistency in educational program	Each student will co-develop, with the MEP teacher, an individualized learning plan; the same teacher will mentor the same group of students over the school year using telecommunications technologies and instructional TV to monitor progress towards the goals of each plan.
Students' lack of time to complete school assignments due to work or child care duties	Offer instruction that is independent of time or place so that students can attend virtual classrooms, conduct activities and submit assignments asynchronously.
Lack of teaching/learning materials	Teaching/learning materials and resources can be accessed online.
Lack of parental support for the educational process	Using the same technologies as the school age children, parents participate in parent education opportunities.
Sense of isolation of migrant families from the mainstream and from each other	Email technologies promote communication between teachers and students as well as students with their peers.
Frequent back-tracking due to lack of records of educational progress	One teacher will be responsible for the individualized learning plan of students throughout the school year regardless of time or place.

Table 1: Critical Concerns of Migrant Education and MECHA Solutions

Description of the MECHA model

Key elements of the MECHA model include:

- centralized coordination of instruction, monitoring, and reporting at Barry University.
- use of telecommunications technologies for instructional delivery, technical assistance, dissemination of information, teacher/student/parent support, monitoring, and reporting.
- collaboration with critical businesses, districts, agencies, and departments to provide comprehensive educational services to migrant families.
- parent education and support via instructional TV and telecommunications technologies.
- implementation of "best practice" in education applied to the distance learning environment.

The MECHA project is housed in Barry University's School of Education. The director of the MECHA project is responsible for coordinating all components of the MECHA program including:

- parent education
- student and teacher training
- instructional delivery
- technical assistance
- monitoring and reporting of student progress
- coordination of services with other agencies
- development and maintenance of online learning environments
- curriculum development for migrant students

Five migrant teachers were selected by the M-DCPS Migrant Education Program and are housed in South Dade in order to facilitate the planning and delivery of distance learning. The migrant teachers:

- were trained by the MECHA project staff in the use of telecommunications for the development and delivery of instruction using distance learning technologies.
- were assigned 20 families each to mentor throughout the entire academic school year and the summer (their community) in conjunction with undergraduate teacher interns from Barry University.
- will deliver instruction to the mainstream or migrant resource teachers at the remote sites via one or two way internactive video (live) technologies.
- coordinated the curriculum development component of the model to integrate educational technology in authentic and transparent ways.
- co-developed individualized learning plans (ILPs) for each of the migrant students in their community.
- collaborated with other MECHA staff in the delivery of web-based instruction.
- coordinated and supervised undergraduate interns who will work directly with students as mentors.
- were responsible for monitoring the academic progress of each of the migrant students in their community.
- were responsible for referring migrant students and family members to other social service agencies when appropriate.

A dedicated web server was purchased using USDOE grant monies. Its function is to serve as the WWW information link to the migrant student's home-base teacher as well as the virtual (online) teacher's lounge where the home- base and remote teachers can interact privately via email to plan, discuss, and evaluate the effectiveness of the program, its curriculum, etc. In addition, the server is used as the home for web based instruction and student home pages.

A web master was hired to design the MECHA homepage (http://mecha.barry.edu), maintain the server web site, and to assist teachers in the development of web based curricula. In addition, the web master is responsible for the development of a secured area for storing information about each student in the migrant program which can only be accessed by means of a password. Two hourly records clerks input information from the cumulative folders of each student in order to establish a web based tracking system for all DCPS migrant students.

Equipment and network support for provision of two-way, interactive video were purchased through grant money and industry partnerships and set up at Barry University and in South Dade. One other district receiving migrant students will be randomly selected each year for testing the viability of "team teaching" using live, two-way interactive video between the remote site and the home based teacher. Two-way, interactive technologies will also be used to deliver parent education, teacher development activities, and progress reports on students.

Implementation of the MECHA Model

One hundred families were randomly selected from among the 1,089 migrant families identified in Dade County to pilot the on-line, distance learning component of the MECHA project in year one. Selected families received a WebTV interface with a remote, a small keyboard, and a carrying case. This device was chosen through industry partnerships to provide an inexpensive, portable means of accessing and interacting with the Internet using a standard TV set for the display of information and a built-in modem for access.

Prior to their departure from South Florida, migrant students and parents were taught by the home-based teachers to set up and use the WebTV interface to access the MECHA web site, to conduct research, and to send email to their teachers or other members of their community. All family members were also instructed on staying safe on the information highway.

When a migrant student leaves with his or her family to follow the migration route, the WebTV interface goes along too. Upon arrival in the new location, the device can be easily hooked up, and the student can dial a local number to access his or her account with the WebTV network. Once logged on, the student can then type in the address of the MECHA web site to access materials, assignments, and related resources on the web developed by his or her teacher. Assignments can be submitted by email back to the teacher or undergraduate intern.

Collaborative projects may be assigned by the home based teacher which require other migrant students within the neighborhood to interact via email in order to complete the requirements of the project. In any case, the opportunity to collaborate with both teachers and peers via email is available to the student wherever he or she goes and provides a motivating purpose for learning. All content area instruction includes a strand on career education to introduce students to alternative career choices based on their aptitudes.

Using the WebTV, students are able to work during the day and study at night, on weekends, or during bad weather. Instructional timelines will become asynchronous depending on the needs of the individuals and the neighborhoods (a "virtual" work-study program!).

If the student does not have access to a telephone line in his or her home, the MECHA partnerships at both the home based and remote sites go into action to ensure access either through directly supplying the necessary equipment and wiring or contracting the work. The coordination of these services is the responsibility of the MECHA director.

Other family members can use the WebTV interface as time allows. The MECHA web site has links to related Internet resources, parent education programs/activities in the home language, and resources for younger siblings in the home.

Each of the students collaborated with his/her teacher to develop an individualized learning plan (ILP) before leaving the home base. This learning plan included web-based communications and activities that address the student's specific needs and interests. The home based teacher keeps an electronic portfolio of all of the students in his or her community.

In addition to the WebTV interface, each migrant family received a "6 pack" of useful CD ROMs from industry partners such as electronic encyclopedias, etc. for use at the remote school site or at the public library.

Finally, each child in the selected family received a Scholastic Literacy Place kit to take with him/her to the remote site for enrichment and independent work. This particular curriculum is especially appropriate for second language learners due to the whole language approach to reading with extensive literature, writing, and technology connections. Additionally, each unit of study has a focus on career education.

When video-based components are necessary to introduce, teach or explain a concept, home based migrant teachers videotape an instructional segment at the district's TV studio, and a) broadcast the segment using 2-way interactive technologies or b) compress and digitize the video to be put on the web site. In this way, the student only has to click on the web link to view the video on his/her computer before, during, or after completing the assignment.

When the family has to move to a new location, the equipment goes along with the family. This equipment will change and/or be upgraded as new technologies develop during the 5-year grant period.

Evaluation of the Project

Formative and summative evaluation procedures are employed to assess the effectiveness of the MECHA project. An external evaluator works closely with project staff and migrant students and parents to document the program's activities, ensure effectiveness, and promote measurable gains in achievement of migrant students. The project's funding period of 5 years lends itself beautifully to longitudinal study of program impact.

Evaluation of the program's effectiveness can be assessed in the following ways:

- descriptive statistics on the numbers of migrant students and families served by the program.
- documentation of the implementation of the project and achievement of project goals
- evaluation of portfolio data and quality of products developed during the course of the program along with an analysis of the achievement of the goals of the ILP.
- standardized test scores given by the district in the spring of each academic year will be compared over as part of a multiple-measures model of ascertaining scholastic growth over time.
- standardized test score gains of participating students will be compared each year to the test's norm group gains (non-participating students).
- comparison of the drop out and teen pregnancy rates among participating students and a random sample of non-participating migrant students matched for age.
- focus group/interview data from participating teachers, parents, and students describing the most and least beneficial/effective components of the program.
- analysis of a sampling of email messages from students and parents; these thoughts and reflections should provide a rich source of anecdotal data.
- documentation of the types of parent education offered through the program and its impact
- level of dissemination of information about the model to state and local agencies serving migrant families

The central repository for information about the MECHA program, its implementation, effectiveness, and evaluation results is the MECHA web site. The information contained there can be updated daily. Student work can be published and displayed on the web site. Video data will also be collected throughout the entire program. This footage will be edited into a 1 hour documentary on the use of innovative technologies in migrant education to be broadcast on public television.

The collaboration between government, university, school districts, and industry partners has been crucial to the implementation and success of this project and serves as a model for other projects.

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Building a Dynamic Web-Database Interface for Business Curriculum

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Abstract: This paper explores various issues on building a Web-database gateway. The ease of the Web interface and the versatility of a relational database make the Web-database connectivity a potent vehicle for activities that require dynamic interactions including business environment. Web design, CGI programming, database design and "middleware" approach for Web-database connectivity are discussed. Some examples of Web-database interface are available online at: http://business.ship.edu/WebDB/.

1. Introduction

The World Wide Web is a particularly useful vehicle for learning activities for students, low-cost corporate training and customer service for small firms, and other situations that require a sophisticated level of interaction and user participation. The majority of Web sites today, however, is designed for one way communication and serves static documents. The Web, although an improvement over the past technology, requires additional development to make it truly interactive.

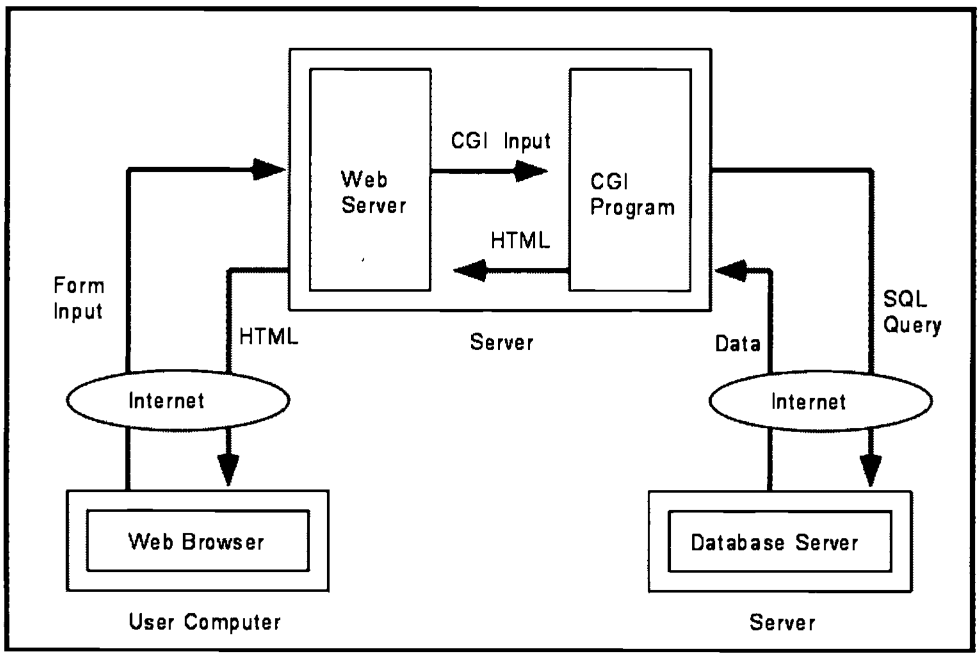
The marriage between the Web and a relational database can provide powerful interactive tools for academic as well as business users. One of the main issues in using a database is the problem of accessing the data. Many database management systems provide a programming interface for computer languages such as C or Fortran, but these can be cumbersome for ordinary users. A Graphical User Interface (GUI) can make database access easier, but the implementation of such interface also requires programming expertise specific to a hardware platform, and most database users should not be required to know how to implement a GUI. This is where the Web technology can play a significant role. Web browsers provide a GUI that can be used to access various informations, including a database. Users can access a database by simply filling a Web form and pressing a submit button. The Web server executes CGI (Common Gateway Interface) programs to access and retrieve desired data. The returned data are displayed in an easily readable format. Furthermore, the Web's cross-platform support allows users of different types of computers (Win, Mac, Unix, etc.) to access a database from anywhere in the world. Information can be disseminated with a minimum of time and effort, with no compatibility problems.

The purpose of this paper is to discuss various aspects of building a dynamic Web-database gateway that can be used in business curriculum for interactive teaching and learning, tutorials, and corporate training. The technology of building a Web interface to a relational database is on the cutting edge. While there are some applications available, they are rarely designed for educational or corporate training purposes. There is a need for Web-based database development that can be applied to business curriculum so that students may understand how the Web and relational database technologies can be integrated and apply them in the business environment.

2. Web-Database Gateway

For a majority of Web sites on the Internet today, five things normally happen when a user visits the site. First, the user's browser software decodes the first part of the Web address called Uniform Resource Locator (URL) and contacts the Web server. Second, the browser provides the rest of the URL to the server. Third, the server translates the URL into a path and file name. Fourth, the server sends the document file to the browser. Fifth, the browser displays the document. As stated earlier, these static Web documents can come alive through the use of Web forms, CGI programming and relational databases. The mechanisms for such Web-database interaction are shown schematically in Figure 1. There are five major stages in this interaction. First, the user fills the form using the browser, requesting pertinent information. Second, the browser submits the request to the Web server. Third, the server executes one or more CGI scripts, accessing and querying the database. Fourth, CGI retrieves or produces a document. Fifth, the Web server sends the result to the browser for display. The Web server and database server can be hosted in a single machine or two separate machines connected through the Internet [Lin, Danielson & Herrgott 1996; Healy 1996].

Figure 1. Schematic of Web-database Interaction



For purposes of Web-based instruction and training, this process can be repeated until the objective of the user is accomplished. The Web forms and CGI scripts provide mechanisms that record input, relate it to previous inputs, and to return desired results for the user's browsing. This structure of Web-based instruction even allows periodic evaluation of activities. For example, multiple choice questions can be presented in a Web form, which are answered by students and submitted to the server for evaluation. A database server (or program) stores the data. The CGI performs the evaluation using the data and sends the feedback to the students. This Web forms-CGI-database combination can be used in a variety of situations that require interaction and user participation.

To design an effective Web-gateway for a relational database, the three major design activities must be performed, including Web form design, CGI programming, and database development.

2.1 Web Forms

Web forms are created as a graphical user interface to link users to a relational database via the Web. These forms are designed by giving a number of data fields in which users can enter information and/or choose options. The action and method elements embedded in a form decide how the data are processed. For example, potential customers can key in order information in an order form. These order data are assigned to appropriate data fields. When finished, potential customers click a submit button to send information back to the server script. A script is a computer program that is written specifically for each form (or user interface). Scripts present flexibility by allowing users to interact with form documents instead of just reading and providing information. By writing scripts, results of data input in a form can be sent to an appropriate person or linking data to server applications.

2.2 CGI Programming

Traditionally, communications between Web server and database application are conducted through CGI scripts. The CGI programs can be written for a variety of purposes. For example, externally, a business organization might present its product information on a Web site. The corporate database might provide a link to the internal sales, supplies, inventory, and pricing database tables, allowing customers to check on their orders. All these linkages are realized through the CGI programming. One CGI program may handle customer search function for checking product availability in the product database stored in the Web server. Other CGI programs may process password verification, database security, table opening, record updating, field calculation, and data transmission. CGI programming makes it possible for the operations such as opening and updating appropriate database tables to link form objects to a database structure specified in the database design. Visual Basic and Perl are frequently used as the CGI programming tools for Web-database connectivity [Hermann 1996].

One weakness of using CGI programming for Web-database connectivity is that the interface seems to suffer in a production environment, since the Web server must load, execute, and terminate a new CGI script for each user access (Lazar & Holfelder 1997). Recently, Web "middleware" using server-side scripts is gaining popularity. Unlike the traditional CGI programming, this approach improves the performance of a Web-database interface by more tightly integrating the Web server and relational database. This "middleware" approach to Web-database gateway is briefly discussed in the following section.

2.3 Database Design

A database is a collection of information stored in files. A database management system is a program that stores, maintains and retrieves information in a database. A relational database (as opposed to hierarchical, network or object-oriented database) stores and retrieves information according to user-defined relationships. A relational database composed with rows (for records) and columns (for fields) in table format. Compared with a flat file structure, database approach has the advantages of minimal data redundancy, information sharing, and data consistency. For larger databases, a client/server relational database management system such as Oracle, Sybase, Informix or Illustra can be used. For smaller databases, a PC-based database system such as Microsoft Access, FoxPro or FileMaker Pro can be used.

Microsoft Access, for example, can be used to create a relational database for Web-database connectivity. Access is used for small and medium size database, but it is known to be a flexible and powerful relational database management system. Much of Access' strength lies in the fact that the database's design and management take full advantage of the Windows GUI environment (Jones 1995). By using Access, the creating and maintaining database become much simpler. By enforcing referential integrity, Access allows minimum data duplication and maximum data sharing and data consistencies among database tables. The newer version of Access provides a link between the database design and the Web. However, Web pages that are created with Access are still static. A static page reflects the state of the database when the page is created. Subsequent changes to the database information are not reflected in the Web page. Therefore, CGI programming or Web "middleware" applications are required to dynamically access and maintain a relational database via Web.

3. "Middleware" Approach for Web-Database Connectivity

While the traditional approach of using CGI programming to provide a Web-database connectivity has a pedagogic value and is preferred by some people, recently there have been a steady increase in the number of "middleware" developed by database vendors as well as individual programmers. A Web-database middleware is a programming tool for Web-database connectivity that reduces (or eliminates) CGI programming. These applicatoins also tend to improve the performance of a Web-database connection by more tightly integrating the Web server and database. Some of the middleware are commercial programs; others are shareware or freeware. They are available for all platforms, including Unix (NetDynamics, Sapphire/Web, Oracle WebServer, to name a few), PC (Cold Fusion, iHTML, DB Gateway, etc.) and Mac (Tango, DataWave, etc.). A partial list of Web-database middleware products can be found, for example, in (Letovsky 1998).

There are several factors to be considered in choosing a middleware tool for Web-database connectivity [Lazar & Holfelder 1997]. They include:

- Portability of the development tool across platforms
- Ease of installation
- Scalability
- Portability of the development tool across Web servers
- Reusability of components
- Performance
- Security

4. Design Issues of Web Database Interfaces

Although a Web gateway to a database can overcome many disadvantages of conventional client-server databases, there are several limitations in the Web-database implementation using the traditional CGI approach. First, there is lack of mechanism for locking a record in the database. With a conventional client-server database system, when a record is actively used by one user, the record is locked until the user is finished with editing the record. To get around this problem, a timestamp can be included in each record so that CGI program may detect conflicting updates by different users [Healy 1996]. "Cookies" are a new mechanism that allows the browser to keep "state" information between calls to CGI program. Second, the Web-database implementation lacks field-level validation found in conventional database system. For example, a user is not allowed to enter text into a Zip Code field in a traditional client-server database system. However, in the Web forms-database interface, all information is sent at once when the user clicks the submit button. CGI program must be designed to handle all errors at once. Third, as with many other Internet applications, the builder of a Web-database interface faces security issues [Knauss 1996]. User authentication is a challenging issue because most Web servers run CGI scripts under a low-privilege user name. Database access rights must be carefully implemented in order to avoid potential abuse and corruption of databases. Some middleware tools mentioned in the previous section do overcome some or all of these problems.

5. Web Database Interfaces for Business Curriculum

The Internet is changing the way companies conduct their business. Businesses of all sizes can lower the costs by using "electronic commerce" on the Internet. Electronic commerce can not only facilitate the selling and buying of goods and services but also improve customer relations by eliminating the constraints of time and space [Kosiur 1997]. Today's students would be better prepared for the business world by understanding how business transactions are conducted on the Internet.

5.1 Web-Database Applications in Business

The versatility of relational databases and the easy access of the Web provide companies with the capability of providing value-added services for their customers [Swank & Kittel 1996]. There are numerous situations in which businesses can take advantage of the Web-database connectivity. Among the uses of Web-database applications for businesses are:

- Electronic store with comprehensive catalog
- Easily accessible product information, specifications, and price information
- Technical support through searchable knowledge bases and troubleshooting information

- Improved and low-cost customer services through Web forms. (e.g., the package tracking service on the FedEx Web site)
- Online registration, record keeping for special events (conferences)
- Employment records, payroll records, inventory information, sales trends, customer demographics, transaction rules, schedules, other internal information sharing

5.2 Building a Web-Database Getaway: An Example

As a simple example of Web-database connectivity, let us consider a firm's database that includes customer information, order status, product information, sales representatives and shipment. First, a relational database needs to be designed and developed. Since a database can contain multiple tables, information can be organized in several different tables, establishing the necessary relationships between the tables. For example, using a desktop database system, we can create several tables for the firm, as shown in Figure 2.

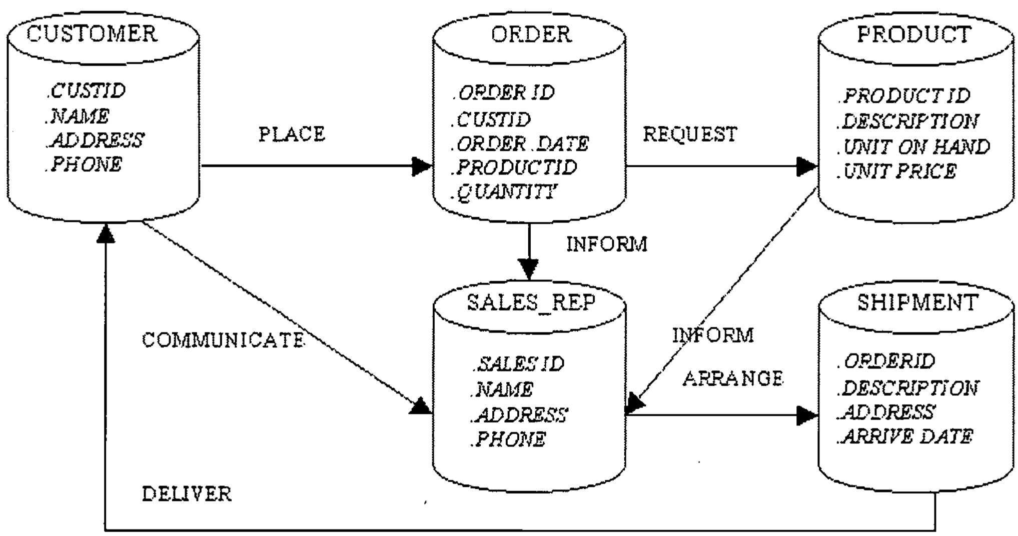


Figure 2. Database Relationships and Structures

Next, several CGI programs need to be written to provide the connection between the database and the Web-based user interface. Finally, Web-based user interface that includes various Web forms need to be designed to access and retrieve data, and to report database query results to the user. Again, these tasks can be minimized if a Web-database gateway product is utilized. The details of this example and other examples can be found online at **http://business.ship.edu/WebDB** /.

6. Concluding Remarks

A Web gateway to a relational database promises to provide a powerful interactive tool for both academic and business world. This paper discusses major issues involved in building a dynamic Web-database gateway to a database and how the new technology can be applied to academic environment, especially for business curriculum and corporate training. Three major components--Web forms, CGI scripts, and database design--are discussed.

Although a promising field, Web-database interfaces are not without limitations. For example, there exists no client-side validation for database work and handling simultaneous updates can be tricky, when the traditional CGI approach is used for Web-database interface. These and other issues including security presents challenges to Web-database developers. Perhaps such new technology as an object-oriented relational database or a client-side scripting language will provide answers to these challenges to enable a more robust implementation of Web-database interfaces.

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Imaging of A Virtual University

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Abstract: Current social systems are extremely unstable and educational systems based on the paradigm, in which people learn to prepare for their life during a certain period, can not function well anymore. People want and need education provided to themselves in their workplaces, home, or near learning centers. The current research discusses the image creation of virtual university as a new educational system. Above all, it describes the importance of image building based on stakeholders' shared values and ideas, as a preparation stage before an actual design stage. As a framework for image-building, Banathy's three-dimensional model is introduced. Then, an image of a virtual university is introduced as just one example. This image has been created based on the current researcher's values and ideas, by applying Banathy's framework.

I. Virtual University as a New Educational System

We as a society sit posed at the doorway to the 21st century. In this world, information and abilities will be shared globally through information and telecommunication technology, which weave educational consumers and providers together. We have to accept that the acceleration of social changes created by this technological change creates a new paradigm to which education should respond. According to Linda Harasim [Harasim 1995], we became to have a framework for time and space independent group interaction for the first time in the human history in new technology's favor. "With the emergence of ISDN-based electronic highways to our homes and workplaces, we are rapidly approaching technical readiness for the Distance Education Network - a virtual university, school, or training department in which learners anywhere can interact with teachers anywhere." [Moore & Kearsley 1996]. This technology supports a nation to overcome economic, cultural, physical barriers against learning; and to create a new system which allows just-in-time education promoting continuous human development [Baker & Gloster II 1994]. Simply stated, the most powerful tool for changing the old paradigm is education based on information technology and further a virtual university, a virtual school, and virtual training organization as the network of learners and instructors which are not limited at specific geographical location.

As the idea of a virtual university becomes more familiar, so does the amount of on-line educational opportunities provided by various universities increase. As access to multimedia information gets faster and easier, a virtual university primarily existing in a cyberspace as bits and bytes is considered the next logical stage for distance learning.

II. Framework for Imaging a Virtual University

Markley and Harman's research informs us that if old images from the old historical stage guide development when a new societal stage emerges, it hinders and delays societal development [Markley & Harman 1982]. In like manner, continued images in education also hinder the imaging of a newly designed education if we stay within the conceptual framework of the existing system and focus on the problems that the system has. We should now search for a new educational image that can lead our education for the 21st century. This image can be created based on the shared values and ideas of participants in the designing of this new educational system.

1. Importance of Value in Educational Systems Design

Designing of an educational system should be a transformation process based on 'values' rather than on 'goals' or 'purposes'. According to Checkland [Checkland 1981], value is the most important element of all societal systems' structures and processes, and shouldn't be ignored at the front-end of system design. This is due to the nature of values as 'preferred futures' that underlie visions and guide systems design inquiry. Therefore, any system design process must help stakeholders raise awareness of, articulate, and arrive at commonly shared institutional values. Values serve to guide and better the systems design process in education as follows [Lee 1995]:

Value as a collective sense: Clarified values enable stakeholders in educational systems design to understand each other so as to lead toward a collective sense of the purpose of a particular design effort. This might happen as clarified, shared core values reduce the disruptive potential of hidden agendas [Nadler 1981].

Values as a set of directions: Educational systems design is a dynamic and emerging process. As systems are continuously informed and re-informed by their environment, the designing of human activities is ongoing and never ending. In this complex process, values function as learned "principles and rules to help one choose between alternatives, resolve conflicts, and make decisions." [Rokeach 1973]. Accordingly, values guide in daily situations during the design of educational systems as "poles of attractions which give directions to whatever emerges"[Goulet & Dolbec 1991].

Values as standards and criteria: Any decision, performance, and behaviors in a system are based on values, that is perceptions and interpretations of what ought to be in the system. Therefore, values are standards and criteria [Rokeach 1973, Schlechty & Cole 1992, Reavis & Griffith 1992, Keeney 1992, Hechter 1993, Williams 1968] for judging a particular position, task, or behavior in an educational system and for deciding what should be measured and evaluated in organizations, as well as whether the system's actions are acceptable.

2. Framework for Creating Images of a Virtual University

When the design of a new educational image is created based on the clarification of values regarding a virtual university, its image can function as solid foundation in the actual 'design' stage. This research proposes Banathy's framework for creating images as a tool on which image options can be explored and synthesized in a holistic manner [Figure 1]. The following framework is constructed of three dimensions upon which we can reflect our values and ideas of a new image of an educational system [Banathy 1991]. "Which one of the options we select will depend upon our worldview and our view of the society, coupled with our perspectives on the societal functions of education, and our core ideas and values about education and human development."[Banathy 1991].

The Dimension of the Focus of the Inquiry

The focus of the inquiry provides the opportunity for designating the primary level of system design. The constituents of this dimension are (1) governance, (2) administration, (3) instruction, and (4) learning-experience. According to which level is selected as a primary level, there appears clearly different education models as described below:

If the learning-experience level is in focus, the learner is designated as the key entity and occupies the nucleus of the systems complex of education. The primary system function is the facilitation of learning. The primary system level is the learning-experience level, in support of which we design the other systems of the complex: the systems of instruction, administration, and governance. If the instructional level is in focus, administration and governance are to provide policies and resources for its support. The instructional system defines the content and method of instruction, and students are called upon to respond to it. If the administration level is in focus, it sets the goals of instruction, defines the instructional content and method, and provides indicators for the use of resources. Governance sets broad policies and is called upon to secure needed resources. The governance level is in focus when the purpose of education is indoctrination and enculturation. Top decision-makers (in the government or in religious institutions) define policies and regulations, and mandate uniform curriculum and instruction.

The Dimension of the Scope of the Inquiry

The constituents of the scope of inquiry provide four different options from a very limited scope and narrow boundaries toward an ever broader, widening, and extended scope and, consequently, enlarged boundaries.

(1) Limited by the boundaries of the existing system. In this case, the inquiry may explore issues surrounding management, organizational communication, instructional effectiveness, staff development, school climate, etc. This narrow scope is typical with the goals of making the existing system more efficient or more effective. (2) Broadened to consider certain issues in the environment. With this options, we broaden the scope and make some changes at the margin of the existing system, and extend the inquiry in order to consider issues in the environment to which education might respond. The inquiry might focus on such problems as dropouts, teenage pregnancy, students at risk, economic competitiveness, smoking, etc. (3) Extended to include the entire community as the domain of design. The involvement of a wide variety of societal systems, organizations, and agencies is explored that might provide resources, arrangements, and territories for learning. (4) Marking the larger society as the space of design -- with the broadest scope and within the most extended boundaries. In this scope, we extend our inquiry into the larger society and re-vision education and guide the design inquiry based on our understanding of the evolving major societal changes and transformations. We seek not only to respond to these massive changes and transformations, but also to create a new image of education by asserting that education has a special and unique responsibility today to participate in shaping societal development.

The Dimension of Patterns that Connect

Four patterns may be considered that the educational system interacts with other social systems that can offer situations, resources and opportunities for learning and human development. These are information exchange, cooperation, coordination, and integration.

(1) Information exchange between the educational system and its environment. It means the least amount of interaction. It projects exchange between the school and the community, by providing information about the community for use by the school. Information might be developed about resources in the community that could supplement instruction. This pattern of interaction is the most frequent today. (2) *Cooperation with external system that strengthen the social functions of education.* It implies a pattern of interaction between the school and other societal institutions and agencies for the purpose of attending to complementary goals or sharing some resources. Participants in cooperative arrangements still maintain their autonomy but may enter into mutually advantageous relationships. (3) *Coordination as inter-organizational arrangement among the organizations of education with other social and human systems.* It shares ownership of an educational enterprise, which is mutually beneficial to the participants. It also implies giving up some autonomy and indicates longer-lasting commitments. Formal organizational arraignments are created for the accomplishment of shared goals of education and human development. (4) *Integration in which all social and human service systems become a system complex based on education and human development.* If integration is considered, the entity currently called as schools will become a constituent of the total educational community, which pursues learning and human development. Such a system would be designed from the integration of systems of the public and private sectors, community organizations, and various agencies that have the potential to offer resources and arrangements for learning and human development. Participating systems would integrate a portion of their resources and services into a new entity that would assume the responsibility for designing and carrying out the societal function of education and human development.

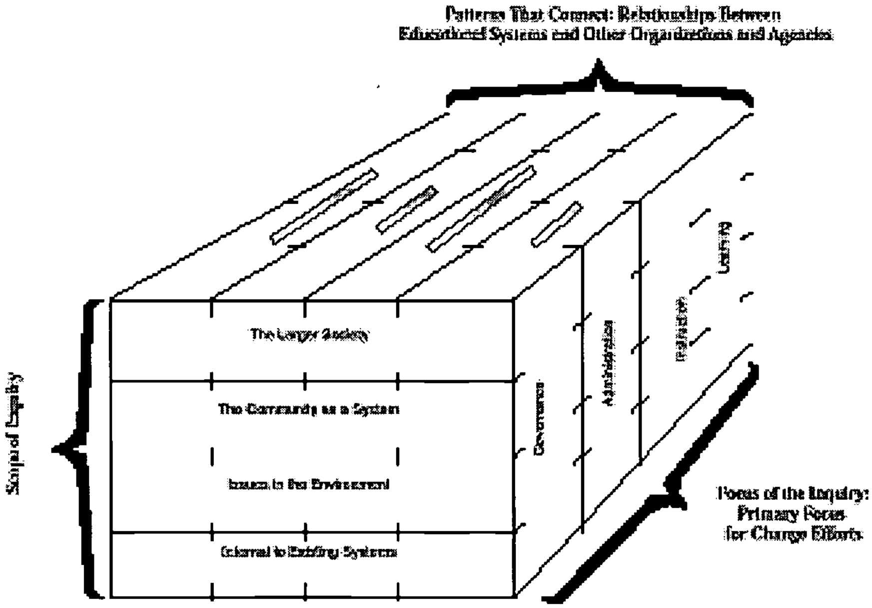

Figure 1: Framework for Creating Images

According to Banathy, the above framework enables us to accomplish the followings [Banathy 1991]: (1) Portray the image of the existing system as a 'base-line' against which to design or from which to depart. (2) Map the overall context within which to explore and create new images of education. (3) Consider and create various alternatives to the existing image of education, by creating alternative images. (4) Formulate criteria by which to select from the alternatives. (Criteria are formulated by considering the advantages and disadvantages of choices made of available options offered by the three dimensions and their constituents.) (5) Select from the various alternatives the most promising alternatives and describe it as the new images. Map the selected image into the framework. By so doing, we also define the boundaries of the system we intend to design.

III. An Image of a Virtual University

This research selects the following levels among various alternatives of the three dimensions of Banathy's framework as an option, which will enable us to create an image of a virtual university with the newest and largest perspectives:

1. The learning-experience level on the dimension of focus of inquiry
2. The overall societal context on the dimension of the scope of inquiry
3. Cooperation on the dimension of patterns of interaction

The image provided below reflects the current researcher's perspectives which were discussed in the preceding part of this paper. This image reflects the above mentioned levels in terms of a virtual university's relationship with the society, overall functions, the scope of learning experiences provided, the key organizational imperatives, types of intervention, and resources used. This image of a virtual university is introduced just as one example, based on the current researcher's perspectives. Arrangements and structures of a virtual university vary depending on stakeholders' perspectives of society, education and the human development of those participating in the system design.

1. A virtual university should be a 'purpose-seeking system'. A virtual university should derive its educational vision from its understanding of key emerging societal changes, define its policies and purposes by this vision, and constantly seek out new purposes and boundaries in its environment. This university system should be open, and can co-evolve as a partner to its environment. For this to be true, it should place value on organizational flexibility that can cope with the knowledge explosion. By organizational flexibility I mean its ability to perform organizational learning and continuous organizational redesign.

2. A virtual university should provide lifelong education through coordination and integration with various human service systems. If based on the image of learning-centered educational system, we can and must design a comprehensive social and human service system in order to nurture and enhance human and societal potentials. Education as a societal system, in the largest perspective, is a collective integration of human activity systems that include considerations, resources, opportunities for children and young people to learn and develop as well as for adults continuously to learn and develop.

When based on this large scope of perspective, a virtual university will seek for other systems in community and the society in order to input resources and opportunities for learning and human development. A virtual university extends its inquiry for creating our new educational system into the outside society by constructing itself with a larger resource base. It is designed by integrating public, private, community, and institutional systems that have the potential for resource and organizational arrangements appropriate for learning and human development. The entity currently called 'school' will become just one constituent of an entire educational community that pursues learning and human development.

3. A virtual university should be an open learning community based on learning information technology. A virtual university expands opportunities for people to receive higher education by employing the newest information technology based on distance communication and personal computers for delivering educational services. It should demonstrate innovative and cost-effective approaches. It should be established on a solid foundation through the partnership with existing various higher education institutes, other educational providers, information technology hardware and software providers.

In a virtual learning environment, individual learners have chances to be recognized in their own jobs and academic areas, overcoming the limitations of time and locations. Learners will be able to take courses in their convenience on campus, home, libraries, or workplaces and offices; and to finish courses and earn credits according to the most appropriate and flexible time schedules. In addition, learners can enjoy a globalized learning environment. Learners will take courses from virtual universities all over the world. This feature itself will add special dimension to learning, and ultimately quality learning activities will be supported in a global virtual space.

4. A virtual university should provide organizations and environments in which learning-experiences are centered and supported. Learners in a virtual university are located at the center of the system complex. That is, the foremost function of a virtual university is to facilitate learning. It should be designed to respond the learning-experience level and then the instruction, administration, and institutional system to support the learning-experience level. Learners and learning resources managers should make decisions related to learning-experience. Various learning resources in the society need to be identified and developed. The structures and environment are established in the manner of promoting easy access and utilization by learners

In a virtual university, wide and various learning styles and models such as self learning, peer learning, collaborative learning, social learning, and organizational learning are used and supported. In the meantime, a virtual university uses optimal and various tools according to individual conditions and needs. In this environment, learners are transformed from passive information consumers to active apprentices.

5. A virtual university should be humanized educational space. A virtual university should pursue the maximization of humanized educational spaces in which learners can enjoy a rich environment of learner-learner and learner-instructor interaction. Negative phenomena including a sense of isolation, lack of belonging, and "being out-of-control" occur more readily in a situation where learners are located at a distance to each other, than in traditional face-to-face or assembled education. In addition, the learning community is not a spontaneously occurring entity. Rather it is something, which requires planning and subsequent nurturing. We need special efforts on designing humanized, social interactions and organizational cultures. Through this, a virtual university can maintain learning communities of space that is accessible to, comfortable with, and provides what people want.

IV. Conclusion

The era of acceleration and dynamic social changes has introduced new thinking, perspectives, technology, and new scientific approach. This eventually demands breaking out from the old thinking frame that we have experienced in the current education sector and changes in the ways of educational practices. "We should jump out from the system, explore educational changes and renewal from the larger vistas of the transformed society, and envision a new design."[Banathy 1991]. Although there is not a commonly shared understanding of a virtual university's entity yet, there have been various efforts along with the perspective extension of its need. What we need to create are the ideal models of the new educational system called a virtual university. Its design process should be based on the ideas of the complete 'transformation' of education, and this means the re-formulation of education at the social level.

This paper identifies learning boundaries and resources of a virtual university centered on learning-experiences. It also pursues a new education system design through 'integration' among human social systems. Yet, I should make clear that there are alternatives of various levels depending on who the stakeholders participating in designing the system are. In addition, what values and ideas concerning society and education they hold are important parts of this education.

The 'preparation' stage of creating the image of a virtual university will be followed by the actual 'design' stage. This image of a virtual university based on shared values and ideas will function as a shared understanding, a set of directions, and design criteria in the process of specification and design. We, however, should understand shared images can be revisited, changed or improved as needed, rather than fixed, due to the circular nature of system design.

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MHEG based Distance Learning System on Information Superhighway

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Abstract : As need of distance learning grows more and more, requirements for development of high-speed network based real time distance learning system become spread. MHEG-5 is the fifth part of the MHEG standard and it defines a final-form representation for application interchange.
In this paper, we design and implement real-time distance learning system based on MHEG-5 standard. As we design that it contains session managing module to support multi user collaboration environments, it can provide real-time educational application such as videolecturing and distributed CAI. Also it can provide non real-time application such as bulletin board systems, video on demand, etc. And we can support effective student management using session managing mechanism for real-time user interaction handling.

1. Introduction

Distance learning is a new field that can overcome the limitation of previous education criteria[Campbell, Hurley, Jones and Stephens 1995, Dwyer, Barbeiri and Doerr 1995]. So requirements for development of high-speed network based real time distance learning system become spread. But, representing and exchanging educational multimedia contents are too difficult[Lockyer and Badham 1995]. MHEG-5 is the fifth part of the MHEG standard suite[ISO 1997]. The standard defines a final-form representation for application interchange so that the application only has to be developed one time. In this paper, we design real-time distance learning system on information superhighways based on MHEG-5 standard.
As we design the system contains session managing module to support multi user collaboration environments, it can provide real-time educational application such as videoconferencing and distributed CAI. Also it can provide non real-time application such as bulletin board systems, video on demand, etc. We design the MHEG-5 engine using MHEG-5 encoding/decoding class library[Lee and Wang 97a], so it can be easily modified when some modification needed. We can support effective student management using session managing mechanism for real-time user interaction handling.

2. Related Works

MHEG is an ISO/IEC and ITU standard for the interchange representation of multimedia/hypermedia information objects[ISO 1994]. Approved by ISO in 1995, MHEG currently receives very strong interest from most major actor in the interactive TV market, as the standard for set-top-unit high-level API. The developers can implement interoperable multimedia systems and information providers can implement open multimedia applications, using the MHEG standard[Hofrichter and Bitzer 1996, Cossmann et al 1995, Steinmets and Nahstedt 1995]
MHEG-5 is the fifth part of the MHEG standard suite[ISO 1997, Joseph 1995]. It was developed to support the

distribution of interactive multimedia applications in a client/server architecture across platforms of different types and brands. The standard defines a final-form representation for application interchange so that the application only has to be developed one time. [Fig. 1] shows MHEG-5 class hierarchy.

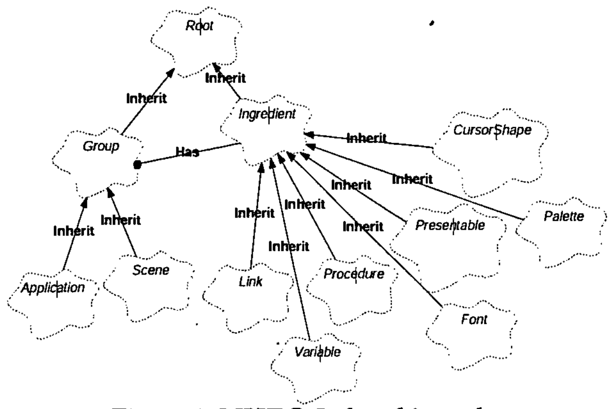

Figure 1: MHEG-5 class hierarchy

3. System Design & Implementation

In this paper, we use some session-specific mechanisms such as centralized controlling, multicasting, collaborating. We implement this system at 100base-T ethernet and Pentium-pro™ 200MHz Server as hardware environment. We use MS Windows NTTM 4.0 as operating system and MS Visual C++TM 5.0, Win32 SDK, MHEG-5 encoding/decoding class library as development tools.

3.1 Overview

[Fig. 2] shows overall system configuration.

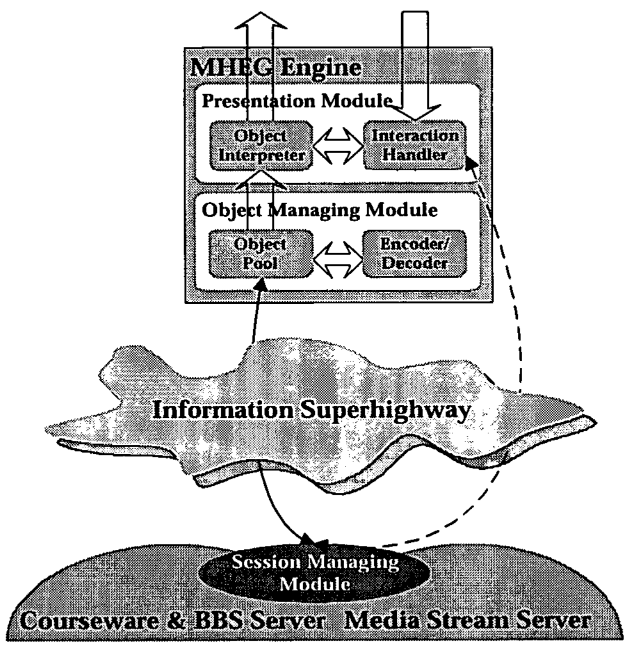

Figure 2: Configuration of system

3.2 MHEG Engine

In client side, MHEG-5 engine contains object managing module and presentation module. Object managing module has encoding/decoding module for MHEG-5 objects. Presentation module has object interpreter and interaction handler. Object managing module fills a role of interpreting and converting between MHEG-5 objects and internal objects. In presentation module, object interpreter reorganizes internal objects from object pool, and interaction handler processes link and action operations. We use MHEG-5 engine in [Lee and Wang 1996, Lee and Wang 97a].

3.3 Session Managing Module

In server side, session managing module has group managing module and event handler[Manthe and Mamuye 1996, Rodden and Blair 1992]. [Fig. 3] shows architecture of session managing module.

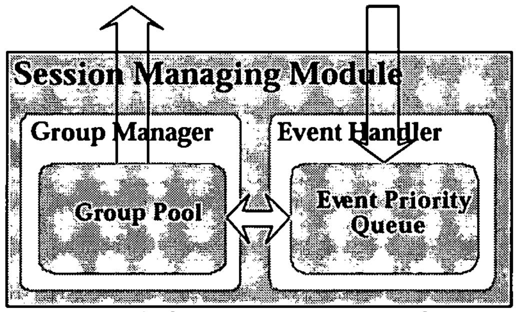

Figure 3: Session managing module

Group managing module operates as gateway. It authenticates and manages participated users. Event handler processes events that occur in each group. Group managing module creates appropriate group for user requirement, and manages those using group pool. Once event occurs, interaction handler catches that. If it cannot be handled, interaction handler sends it to event handler. Event handler processed that using group managing interfaces. Events handled by event handler require group-related operations such as create, destroy, join, and leave.

3.4 Servers

Courseware and BBS server has educational materials. We store courseware as MHEG-5 object representation form using MhegDitor[Leroy and Charbonnel 1997]. Students can browse these materials using MHEG-5 engine and presentation system. It appeared to students as tree-liked form, so students may select any content in a view. If there are some questions about materials, students may use bulletin board system or E-mail. For videolecturing and video on demand, media stream server stores movie files and supplies stream-related service. Using MHEG-5 representation form, movie files can be used during courseware browsing or videolecturing.

4. Learning Senarios

In this chapter, we describe two learning scenarios that can be occurred when students use this system. The first case is using videolecturing feature of our system. The other case is using courseware-browsing feature.

In order to testify the student administration ability in group, we designed the class with one lecturer and four student. And in order to testify functions of real-time application, we used MHED objects for videolecturing. These MHEG objects were made by MhegDitor 1.3 and edited by encoding/decoding class library for MHEG-5 objects[Lee and Wang 97a]. [Fig. 4] represents MHEG objects used by lecturer.

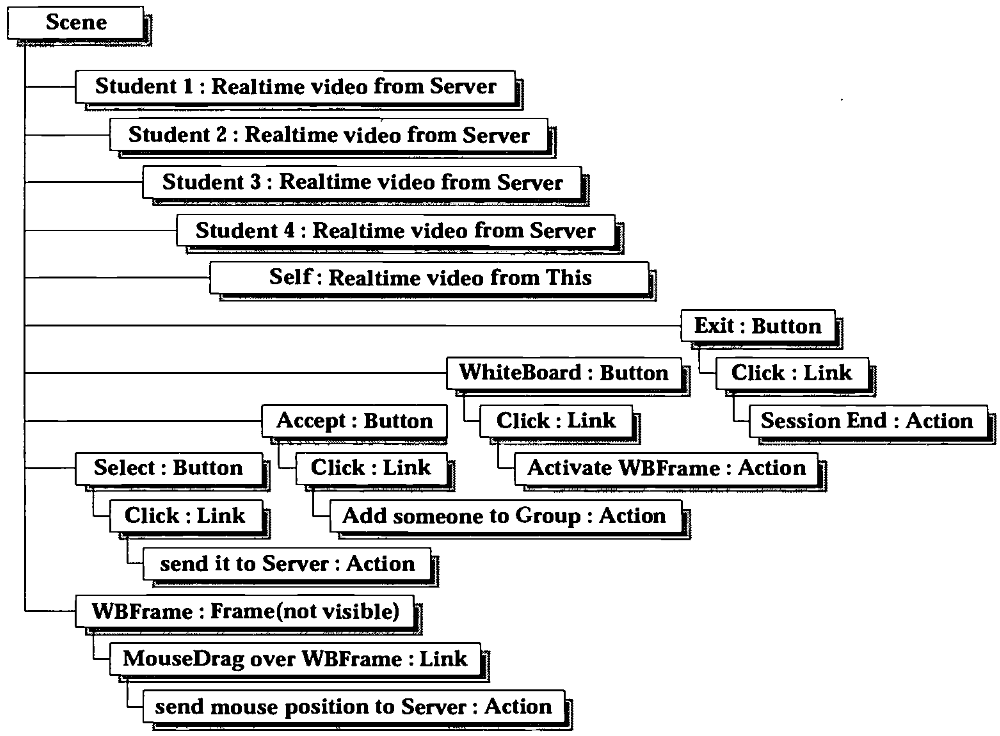

Figure 4: MHEG object used by test

4.1 VideoLecturing

A student executes a client application to connect media stream server. Then login dialog appears, and the students inputs username and password. After login process, a session view appears to and the students. Then he/she selects a group that he takes interests in.

When and the students participation succeeds, his/her participation is notified other students and lecturer in that group. Then, and the students can view lecturer's video stream and whiteboard. During videolecturing, lecturer can monitor participated students. Lecturer selects certain student to give token as the right of speech. The student who has that token speaks his/her opinion. After student's speech, lecturer owns that token for next right of speech. Also, a student requires token for his/her own right of speech. When lecturer draws some figures on whiteboard, these figures are shown to all participated students.

4.2 Courseware Browsing

A student executes a client application to connect media stream server. Then login dialog appears, and he/she inputs username and password. After login process, a group view appears to him/her. Then he/she selects a group that he takes interests in. When his/her participation succeeds, his/her participation is notified other students and lecturer in that group. Then, he/she can view lecturer's video stream and whiteboard.

During video lecturing, lecturer can monitor participated students. Lecturer selects certain student to give token as the right of speech. The student who has that token speaks his/her opinion. After student's speech, lecturer owns that token for next right of speech. Also, a student requires token for his/her own right of speech. When lecturer draws some figures on whiteboard, these figures are shown to all participated students. [Fig. 5] shows client application in lecturer side.

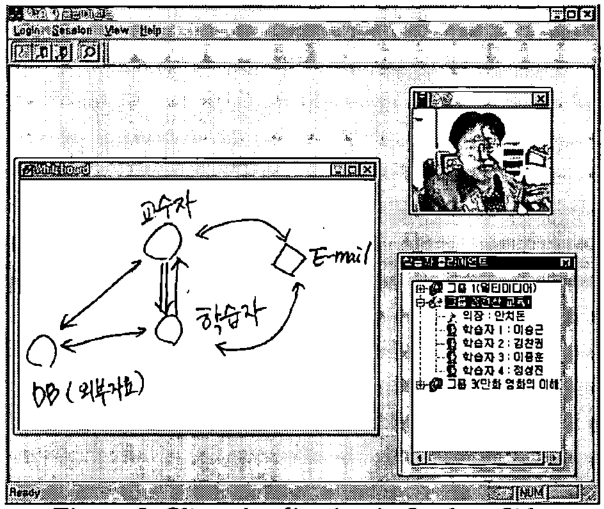

Figure 5: Client Application in Student Side

[Fig. 6] shows the example that lecturer sent additional information to students using whiteboard. These types of Session management facilities are enough to control the participated students. In this experimentation, we show that the designed framework can be used for applications that require efficient group management and control, and it can support to handle user interaction in real time environments.

Figure 6: Client Application in Lecturer Side

In this case, a student also executes a client application to connect courseware and BBS server. Then login dialog appears, and he/she inputs username and password. After login process, a courseware view appears to him/her. Courseware view is represented by tree-liked form. Then he/she selects a topic that he takes interests in. Selected topic is provided as MHEG-5 application object. That has several or a number of scenes that compose of various multimedia presentations. Browsing courseware is same as hypermedia navigation. Students may have some questions about courseware when browsing. Then they can use both bulletin board system and E-mail. When a question registered, lecturer would read and reply answer to student for that question.

5. Conclusion & Future Works

Implemented system has several advantages. It can provide effective presentation and management for multimedia information using MHEG standard. And we can use its user management facilities for real-time multimedia applications that should support real-time user interaction. Also encoding/decoding class library applies to various MHEG-5 based applications.

There is an important feature to enhance educational values of this system. Currently, we cannot provide student-evaluating facilities. We plan to implement integrated distance learning system that contains intelligent tutoring features[Lee and Wang 97b].

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Meta-Freedom in Hypertext:
The Freedom to Limit Your Own Freedom

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Abstract: Hypertext is fast replacing traditional linear text in many environments and documents, such as the World Wide Web and the on-line documentation packages supplied with many current software applications. Much of the discussion on the merits of hypertext, as well as its drawbacks, revolves around the extra freedom it affords the user compared to linear text documents such as books. In this paper we offer an analysis of some factors influencing how much freedom may be desirable for a given user in a given context and, in some cases, suggest a solution to the problem of too much freedom. Our guiding principle is not to limit users' freedom in any authoritarian and predetermined way, but rather to offer them one more level of freedom, called meta-freedom: The freedom to choose for themselves the amount of freedom vs. the amount of guidance for a given context.

Introduction

Hypertext is fast replacing traditional linear text in many environments and documents, such as the World Wide Web and the on-line documentation packages supplied with many current software applications [1]. Much of the discussion on the merits of hypertext, as well as its drawbacks, revolves around the extra *freedom* it affords the user compared to linear text documents such as books.

On the one hand, the user of hypertext is free to choose the *order* of traversing the various text modules, as well as the *degree of detail* in reading the material. For example, if a long and complex document is arranged in hypertext as a hierarchy of short modules, users are free to choose the order of traversing the hierarchy, as well as how many levels deep they wish to go. A closely related set of ideas – the advantages of hierarchical modular design and presentation – are elaborated in computer science in relation to structured programming [Dijkstra 1972] and in mathematics in relation to structured proofs [Leron 1983, Leron 1985].

On the other hand, users are often overwhelmed by the amount of freedom they have in traversing the various nodes in a complex hypertext document, and may wish for more guidance. In other words, users are sometimes willing to surrender the total freedom (and concomitant confusion) and hand over some control to an outside agency. Here is Romiszowski's (1997, p. 32) description of the problem of too much freedom:

> One major user problem in many currently available hypertext systems is described as "lost in the hyperspace" effect [Edwards & Hardman 1989; Yankelovich *et al.* 1988]. The readers navigate in a non-linear pattern from one "node" of information to another, following potentially interesting or relevant "links," and soon lose their bearings, as if in a maze, unclear as to where they have arrived in the domain of study and why they are there.

[1] Much of what we say is equally applicable to hypermedia in general, but for simplicity we will stick to hypertext.

In this paper we offer an analysis of some factors influencing how much freedom may be desirable for a given user in a given context and, in some cases, suggest a simple solution to the problem of too much freedom. Our guiding principle is not to limit users' freedom in any authoritarian and predetermined way (that would be defeating the very spirit of hypertext and the web), but rather to offer them one more level of freedom, called **meta-freedom**: *The freedom to choose the amount of freedom vs. the amount of guidance in a given context*. In the talk we will discuss in addition how this facility could be implemented in practice and give some examples from our own practice in web-based instruction. Meta-freedom, if properly implemented, is empowering rather than limiting the user, since it offers more choices rather than less. There is a seeming paradox here: How can we deal with the confusion due to too many choices by adding even more choices? However, the answer is implicit in the above definition of meta-freedom: the new choices are *control* choices, allowing users to set the optimal amount of guidance in accordance to their own preferences.

The price of freedom: The need to make control decisions

Let us consider the allocation of mental resources (time, energy, attention, memory, etc.) of a user reading – and trying to make sense of – a complex document. We'd like to compare the allocation of these resources when the document is organized in hypertext vs. linear form. We note that while concepts, ideas and mental structures in general are structured in non-linear webs [e.g., Minsky 1985], the activity of reading *is* largely linear. Thus in the process of communication through text, writers and readers must go through some linear representation of their target ideas. Since there are many ways to linearize a complex structure, the relevant questions for us here are what is an optimal linearization for a particular individual in a particular context, and who is in charge of making the decisions involved in the linearization process (called *control decisions*).

In the case of books, the author has made for the reader all the control decisions regarding the level of expertise and detail, and the order in which the material should be followed. True, readers often skip and skim, but this happens despite the linear nature of the medium, not because of it; the structure of the medium carries the default expectation (which, however, is seldom obeyed), of reading sequentially and fully from the beginning to the end.

The idea of hypertext, in contrast, is exactly to leave all the control decisions to the reader, hence the glorified extra freedom. The great idea behind hypertext is that there is no single best linearization, and each reader should be free to decide what's best for him or her. "Because each individual's knowledge structure is unique, based on his or her unique set of experiences and capabilities, the way that each would prefer to access, interact with, and interrelate knowledge is also distinct. [...] Therefore, readers should be encouraged by the hypertext to jump around and even alter the text in order to make it more personally meaningful" [Jonassen 1986, p. 270]. But this freedom comes with a price: the need to make many control decisions and to constantly hold in memory one's place in the complex structure, in order to be able to return to the "highways" of the hypertext. This may in times cost the user heavily in terms of available mental resources: mental resources that would otherwise be available for learning the contents of the document, must now be allocated to dealing with control issues. This is as it should be, since control issues are always important in learning in general and in problem solving in particular [Schoenfeld 1985]; but, again, the question before us is how to optimize the allocation of mental resources between learning the material on the one hand, and the *management* of the learning process on the other hand.

Factors influencing the allocation of mental resources

The issues discussed in this section require much empirical research. Here we can only offer some tentative observations based on theoretical considerations and reflection on practice (our own and others').

There are two kinds of guidance which may be desirable for the user in order to facilitate the navigation of a complex hypertext structure. One, *global* guidance on the structure of the entire document and on suggested ways for traversing it. Two, *local* guidance on substructures – small, coherent and relatively independent clusters of modules in the document. The first kind is well known and is (to some degree) taken care of in the first few pages presented to the user. Here we will limit ourselves to dealing with the second kind.

We have identified in our experience one typical situation in which people have usually preferred to be guided sequentially rather than having to jump back and forth through the hypertext links. Here is an example taken from Microsoft Word 7 Help (abb. MSWH). Suppose one wishes to design a page in MS Word which includes the logo of one's company and some additional information, such as regular and email addresses, phone and fax numbers, URL, etc. In other words, one needs to learn how to design a new *template* – a fixed-format page with "slots" for adding variable information. For this purpose MSWH is indeed helpful. After some selecting and clicking (in fact, Help/Microsoft Word Help Topics/Contents/Formatting/Setting Default Formatting with Templates) one gets to the templates "contents page". Here are listed the actual 12 short help pages on the various aspects of templates, such as creating, editing, saving, etc. Now it is quite likely that one might want to get an overview of templates by quickly scanning the 12 short pages sequentially (this might typically take about 10-15 minutes). However, MSWH does not provide the user with this option (at least not as of Word 7). Rather, the user must skip back and forth between the individual help pages and the contents page.

The example of help on templates is typical of what we have called a *compact subdocument*, which is a cluster of modules satisfying the following three conditions:

One)the cluster in itself forms a well-defined complete entity which is of independent interest.
Two)it may be desirable to read the cluster in its entirety.
Three)the total length of the text in the cluster's modules is relatively short and can be reasonably read in one stretch.

These conditions are clearly relative: they express a relationship between the given document and a particular person at a particular time. That is, whether a particular cluster forms a compact subdocument or not may change from one person to another and even for the same person at different times. Still, some clusters are more obvious candidates than others.

Our main observation is that *when encountering a compact subdocument, users often prefer to read it sequentially*. We were first clued to this observation when we had noted our own relief during web surfing, upon discovering that 10 links to subsections of some document pointing to different locations on the same long page. Oh good, we'd say to ourselves, now we can simply read the whole thing from beginning to end, rather than skipping back and forth through the contents page. Indeed, when you come to think of it, being forced to go to the contents page is a bit of a nuisance if all you want to do is move on to the next page, and the nuisance turns to annoyance if you are forced to do it 12 times for one topic!

What this means in practice is that when designers of a hypertext document encounter a likely candidate for a compact substructure, they should offer the user a *choice* of reading the entire substructure sequentially, while of course retaining the standard option of clicking on the individual links. This choice should suggest itself clearly and naturally by an appropriate user-interface. We will discuss below some ways of actually implementing this idea and will add some more at the conference talk. Note that this is a typical example of what we have called meta-freedom, since the user is in effect choosing the degree of freedom (or, conversely, the degree of guidance) he or she wants. Note too that it is good enough that the designer can only *guess* at whether a particular cluster of modules would be a compact substructure for a "typical" user, since what the user gets is just an additional option (of following the cluster sequentially), which the user may freely ignore.

Implementing Meta-Freedom

We recall that a hypertext document is made up of "pages" (individual text files or other chunks of information) and links between them. It may happen that a particular page will contain several sections with their own headings, and will consequently be relatively long. For example, one often encounters a page consisting of 10 subsections, each taking up about one screen or less. The Setting Default Formatting with Template MSWH topic mentioned above could be such an example, had the designers chosen to implement it as one long page (they didn't). In such cases it is customary to start the page with a "contents" opening screen, containing the list of subsections headings as links. Such links, which point at different sections of the same page where they appear, are to be distinguished from "genuine" links, which point to different pages. However, these two kinds of links are usually represented by the same symbol (an icon or underlined phrase in a particular color), and are rarely distinguished so that the user could know in advance which is which.

In light of the discussion in the previous sections, it is suggested that *the features of a subdocument be made explicit via a suitable interface design*, such as:

- that the cluster in question has been explicitly designated a compact subdocument;
- that the user has a choice, in addition to the standard use of links, of perusing the subdocument sequentially, e.g., by scrolling (if it is in one long page) or by clicking on a "next" button;
- that some measure of the length of the subdocument is given (say, 5 sections, each one-screen long, or some similar measure).

Incidentally, and independently of the above recommendations, one may wonder whether it is advantageous to design a compact subdocument as one long page (as is often done), rather than making each module into a separate page. It seems to us that the logical structure of the document is represented more faithfully and clearly by the latter, but for technical reasons designers at present often prefer the former. One reason is that with present communication technology, clicking a link to a location within the same page may get a much faster response than clicking a genuine link.

Clearly, following these suggestions will give users the meta-freedom we have been talking about, since they would be able to determine whether they prefer to be totally guided by the designer of the document (following the subdocument sequentially), keep their total freedom of control (ignoring the linear order, using the buttons as they wish), or any combination thereof. They will also be given enough prior information to be able to make their meta-decision wisely.[2]

We conclude with a few thoughts on implementing the meta-freedom user-interface.

- Links to locations within the same page may be distinguished from genuine links, e.g., by using different colors for the underlined phrases.
- Individual buttons pointing to the subsections may be inscribed in a large super-button. Clicking on the super-button will bring up the subdocument as one long page. Clicking on a regular button leads to a specific item. Figure 1 demonstrates how the two options are provided: Clicking on the circumscribing ellipse give us the compact document entirely as one page. At the same time one can still choose to go to individual subsections by clicking on one of the small buttons.

[2] Since hypertext documents are constantly being updated (especially when they are on the Internet), editors should have the facility to automatically update this prior information when the document is changed. This is especially relevant to the third item on our list (the length of the page), but may apply to additional items that may be added to the list.

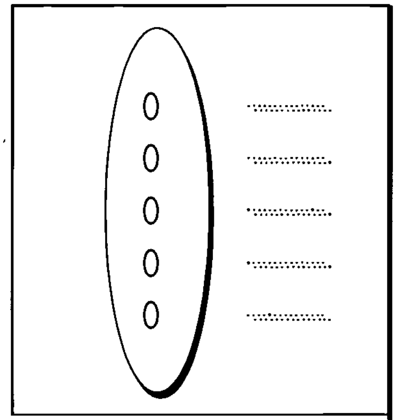

Figure 1: Super-button for compact-subdocument

- Compact subdocuments may be represented by a single sign (name or icon), just as computer scientists represent a subprocedure by its name. Clicking on the button may display its inner structure and the control choices as above.
- In some of current software tools one may get information on an icon by merely pointing the mouse at it, or by clicking the right mouse button. Similarly, some of the initial information on a compact substructure can be so displayed.

Appendix: What's is a link? Since we have made such intensive use of the term *link*, it may be interesting to clarify just what *is* a link. We take as our starting point the definition given to a variable in computer science [e.g., Abelson and Sussman with Sussman 1996]: A variable is a binding between a word or a phrase (called the variable's *name*) and an object (called the variable's *value*). Similarly we may say that a link is a binding between *three* entities: a word or a phrase (the link's *name*), a URL (the link's *address*) and a hypermedia page (the link's *value*). Or we may look at a link as a *double-layered variable*, since the URL is the value of the link's name, and the page is the value of the URL. In other words, the link is like a double-decker hamburger, made of two variables sharing the middle layer: The upper-deck is the variable whose name is the link's name and whose value is the link's URL, and the lower-deck is the variable whose name is the URL and whose value is the link's page. Here is an example to illustrate these terms: On Netscape's home page there is a link called ASSISTANCE, whose URL is *http://home.netscape.com/bbhelp/assist/index.html* and whose value is the page containing assistance, customer service, etc.

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A Multimedia Approach to Music Education in South Africa

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Abstract: The population of South Africa represents a microcosm of the world. The music of various cultural groups and countries is heard daily. A typical South African style is being developed by the blending of these various styles. The Unit for Telematic Teaching and Learning and the Department of Music of the University of Pretoria have designed a music program on CD-Rom, *Music in South Africa*, to expose students in Music Education to the various styles. This paper will describe the purpose of this program, show how it was designed and briefly review a few highlights.

1 The Purpose of the Program *Music in South Africa*

The population of South Africa represents a microcosm of the world. The music of various cultural groups and countries is heard daily. A typical South African style is being developed by the blending of these various styles. An aim of the CD-ROM program *Music in South Africa* was to expose students in Music Education to the various styles.

Those charged with the teaching of music often do not have the resources, knowledge and skills to make Music Education relevant to pupils and students. Especially in the previously disadvantaged communities, this program can also be used for in-service (INSET) training to provide teachers with a wider background of musical concepts and styles. It can also be used for basic teacher training (PRESET) and music enrichment.

The University of Pretoria needs to position itself for the 21st century by employing more appropriate teaching models. These include the expansion of distance learning opportunities with technology, in particular computers, TV's and satellites, that will form an integral part of these teaching models. These modern technologies can be used to provide teaching material to address backlogs in education. This program will provide students with the opportunity to work at their own pace and whenever it suits them. Little has been done in the area of music programs that focus on learning. This program aims to meet this need.

2 The Design Approach

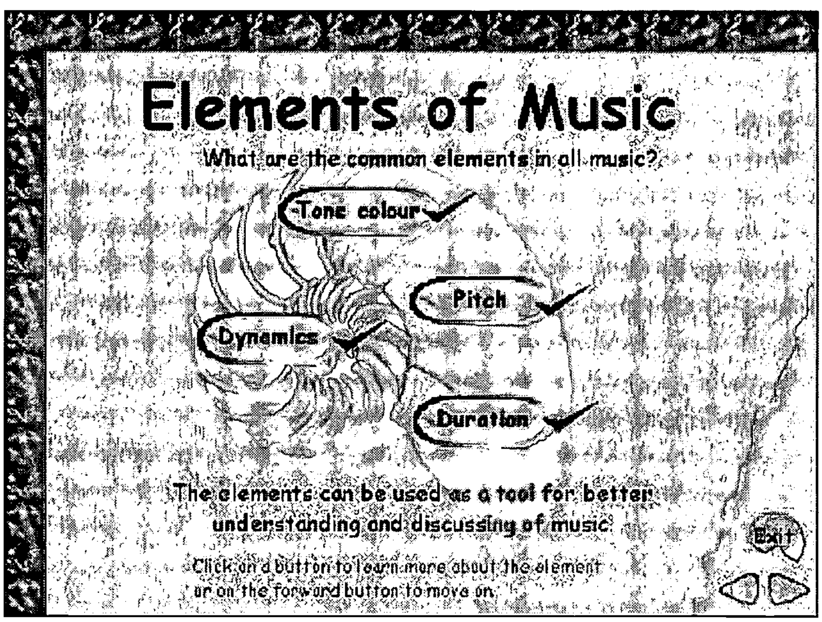
The Quest Net Multimedia Authoring System was used as authoring tool. Using an on-screen design approach, an artist designed the backgrounds and colourful borders, the subject expert provided the content, while the instructional designer was responsible for the layout and structuring of the program. It was an interactive process in which the realization of the possibilities of the authoring system provided new ideas to both subject expert and designer. The instructional design did not start with a full storyboard but evolved from a few basic ideas.

The product was taken to an outside authoring company and they estimated that they would use more than double the time to design the product. Although it was time-efficient to use an on-screen design approach, it had its own problems. The language editing was done at a late stage and changes to a whole screen had to be done. The subject expert is a full-time lecturer and was not assigned only to this project. She had to find extra time to compile the subject content which caused difficulty with the scheduling of the instructional design.

The University of Pretoria is committed to provide a flexible mode of learning to the student in which the physical contact time between lecturer and student is lessened. Multimedia on CD-ROM will be only one of various technologies that provide teaching and learning interventions. The Unit for Telematic Teaching and Learning realises that lecturers often do not know what the possibilities and limitations of multimedia are and that they find it very difficult to create a storyboard. To attain a better production rate it is envisaged that prototyping will frequently be done with an on-screen design approach but that the rest of the program will be out-sourced.

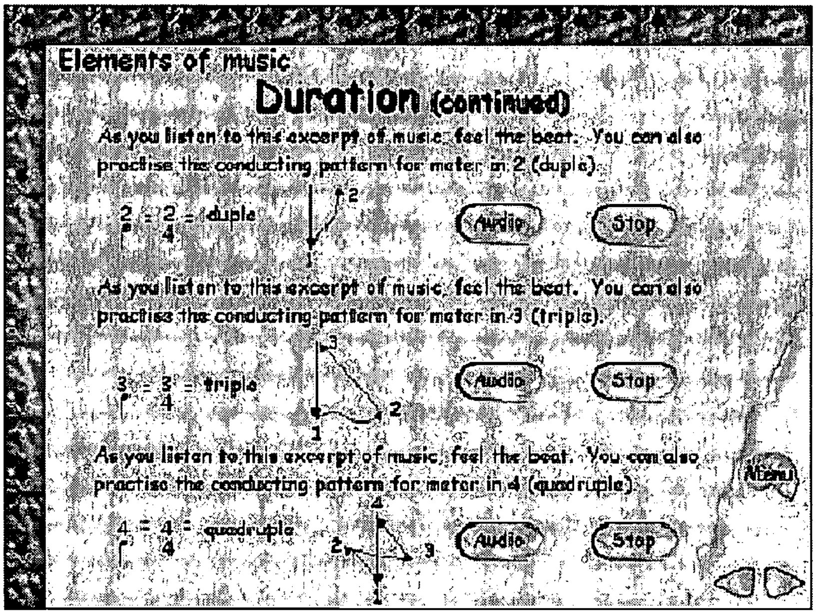
3 Highlights of the Program

The program is divided into four main sections: Elements of Music, Art Music, Popular Music and Folk Music. A *shell*-motif was used in the design because listening to various musical styles forms the basis of the program. The *shell*-motif was used on the first screen and all subsequent menu screens. The soft pink-brownish colour of the shell and the basic background made it compatible with many colours, borders and other design elements. After each main section the student can do a quiz for self-assessment purposes.



3.1 Elements of Music

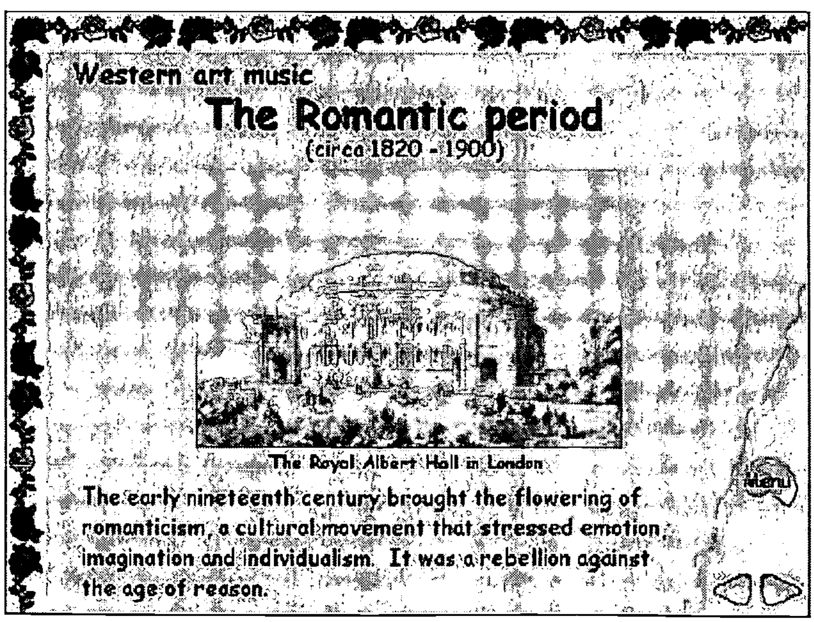
In the first part of the program the student can learn about the common elements of music. The program uses short music excerpts to introduce the student to pitch, dynamics, duration and tone colour. It also deals with form, texture and style. The student needs to work through this section to understand the terminology and concepts used in the rest of the program. The following is an example of a menu screen in which the student can choose to learn about the common elements of music. The ticks will only appear when the student has worked through that particular section. The student can listen to short excerpts of music to reinforce the various concepts that are discussed. The designers tried to chunk the material. The sections on meter in 3 and meter in 4 will only appear on the following screen after a *More*-button is clicked. The top left corner always indicates the main section that is dealt with to provide cognitive support to the student.



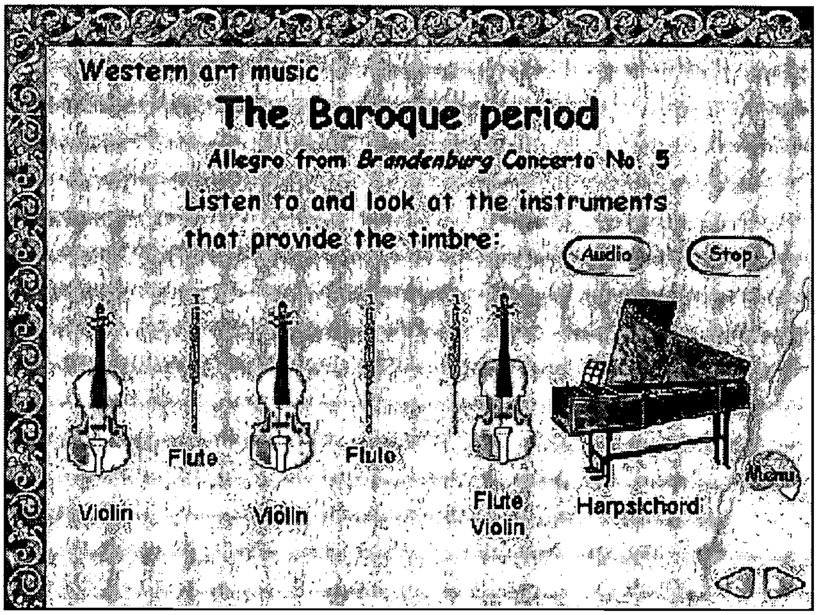
3.2 Art Music

3.2.1 Western Art Music

The Baroque, Classical period, Romantic period and Twentieth Century are considered in this section. These musics are heard daily in South Africa and are therefore important in Music Education curricula. The designers aimed to make the visual layout of the screen complement the style of the music that can be heard. Different borders and visuals such as paintings and buildings of a specific period or style are used to reinforce the characteristics of the music style.



In each style or period an excerpt of music along with an animation of certain pertinent features is presented to allow the students to see what they are supposed to hear. On the following screen the instruments appear when they are heard in the sound example.



3.2.2 *South African Art Music*

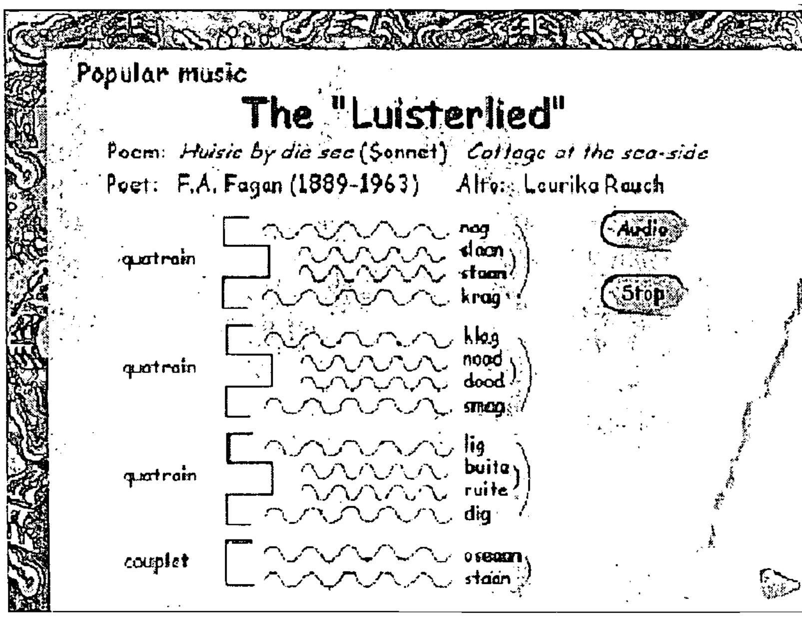
This music is often a blend of styles which includes typical African characteristics such as irregular rhythms. An orchestral work about Shaka, who became king of the Zulus in 1815, is one of the music excerpts used to illustrate South African music.

3.2.3 *Indian Art Music*

This part of the program emphasises the fact that the character of Indian music is spiritual and that it does not blend easily with other music styles.

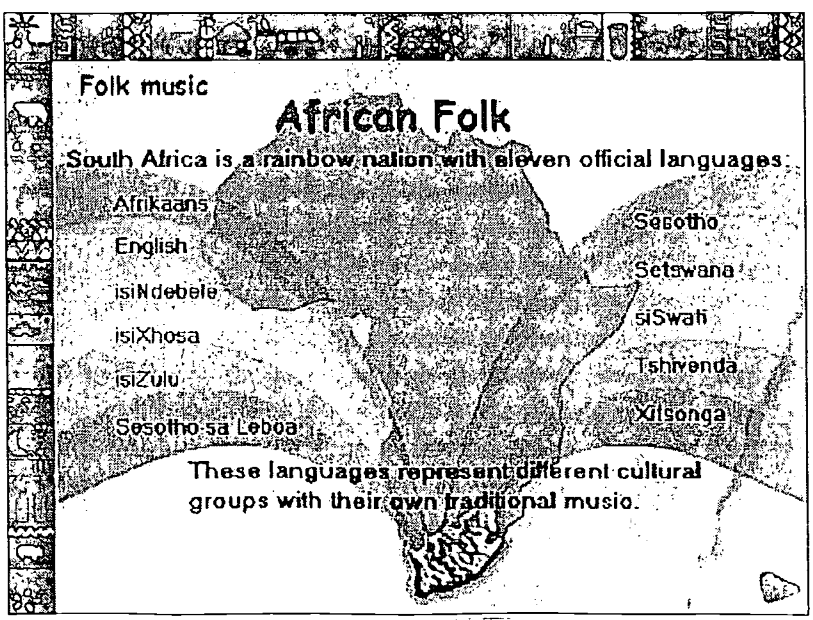
3.3 Popular Music

Popular music is the general term for modern commercialised music. In South Africa there is a rich variety of popular music and in this section of the program the South African style of popular music is discussed as well as Gospel music, the Afrikaans 'Luisterlied' and Township music. On the following screen the poem is animated while being sung.



3.4 Folk Music

Folk music is derived primarily from oral tradition and is passed from one generation to the next. African Folk, "Boeremusiek" and Cape Malay music are heard in this section of the program.



4 Summary

The on-screen design approach used in the development of the CD-ROM *Music in South Africa* stimulated the creativity of both the instructional designer and subject specialist and made it a rewarding project. Putting music technology together in a CD-ROM was not only a new experience for the University of Pretoria, but the beginning of a new research project. How this CD-ROM can be expanded, upgraded, evaluated and used in educational and enrichment programs, are aspects currently being explored further.

5 References

All the resources used for the design of the CD-ROM are listed in the program.

The Design and Application of Tracking Systems for the Web Learning Environments

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Abstract: A Web-based learning environment for elementary school students was created in 1996 with the sponsorship of the National Science Council of Taiwan. For the purposes of evaluation on courseware design and system usability analysis, a tracking system was integrated with the learning environment. The tracking system could monitor learning activities on the learning environment and record them in a database. In addition, the tracking system also could provide teachers the recorded information in the prospect of instructional management. This paper describes the design and applications of the tracking system.

1. Introduction

A Web-based learning environment was created for the study in 1996 under the sponsorship of the National Science Council of Taiwan. The learning environment consists of a courseware with on-line test service and a communication mechanism for users. The courseware is the most key component in the learning environment and it is associated with earth science curriculum in the sixth grade. For the purposes of evaluation on courseware design and learning system usability analysis, a tracking system is integrated with the learning environment.

The courseware was adopted as a required learning material by a sixth grade class of the Affiliated Elementary School of the National Tainan Teachers College in the spring semester of 1997. All the learning activities of the class on the courseware were recorded by the tracking system.

The study is focusing on the design of the tracking system and its application in evaluation on courseware design and system usability analysis based on the experimental data. However, due to the limit of length, this paper describes mainly the design and components of the tracking system.

2. The Importance of Tracking Systems for the Web Learning Environments

The Web and its renovating technologies provide an excellent distance learning environment for K-12 students. However, the fact that Web-based distance learning environment is lack of the capability in monitoring learning processes of students is creating a negative image for its widespread diffusion in the field of instruction. Without the function of monitoring the learning processes, courseware on the Web is unable to keep track of students' learning activities and teachers never have the chance to follow the learning paths of their students. Teachers and students are totally isolated in terms of learning processes under this circumstance. Furthermore, the quality and suitability of courseware are unknown when teachers are unable to monitor the learning activities of their students.

In addition, originally the Web provides nothing for system usability analysis [Bachiochi et al. 97]. Without users accesses information on the courseware, it is impossible for Web instructional designers to evaluate the performance and quality of the learning systems [Newmarch 97].

The tracking system is the answer for both problems above.

3. The Solutions on Tracking Systems

In order to meet the needs of evaluation on courseware and system usability analysis in Web learning environments, people have been searching for tracking systems since the Web was deployed in the field of education. There are two types of solutions that have been adopted for evaluation of courseware and system usability analysis.

3.1. The HTTP Server Log File with Analysis Tools

Every HTTP servers have their own events log files. The system log files are generated automatically. With this solution, there are no further works needed to be done for instructional system designers in collecting users accessing data except preparing log file analysis tools with existing application software or simple coding with scripting languages such as Perl or VBScript [Jones & Jones 97]. However, the data in log files are not accurate and the information inside are poor [Boalch 96]. This solution leads to a lot of problems in making interpretation of learning activities on the Web.

3.2. The Tailor-made Tracking Systems

In order to overcome the problems of log file solution and acquire more meaningful information in terms of evaluation of courseware and system usability analysis, it is necessary to design a tracking system specifically for the system. The tracking system should be independent from HTTP server but has to be integrated with the courseware. The only problem for this solution is the time consuming in design and implementation of the tracking systems.

A tailor-made tracking system, the Web Courses Tracking System (WCTS), was created specifically for the purpose of the study.

4. The WWW Aided Learning Environment and the Courseware for the Study

The WWW aided learning environment that the study created is composed of an online courseware, online testing sessions, and a virtual classroom. All elements of the system are integrated into one user interface ---- MS Explorer, one of the significant WWW browsers [Lin 97].

The online courseware addresses earth science in the sixth grade. The leading Web technologies, such as Java, Microsoft ActiveX, and authoring systems related plug-ins, are employed to create dynamic multimedia HTML pages. The online testing sessions take advantage of hypermedia features and provide instant feedback to the students.

The primary role of virtual classroom in the WWW aided learning environment is to provide communication services among students and teachers. The communication modes include one-to-one, one-to-many, and many-to-many.

The learning environment was developed in the platform of Microsoft Windows NT. The development tools consist of MS Access, MS Exchange Server, MS ActiveX Control Pad, MS Visual J++, MS Visual Basic, and Macromedia Director with Shockwave, etc.

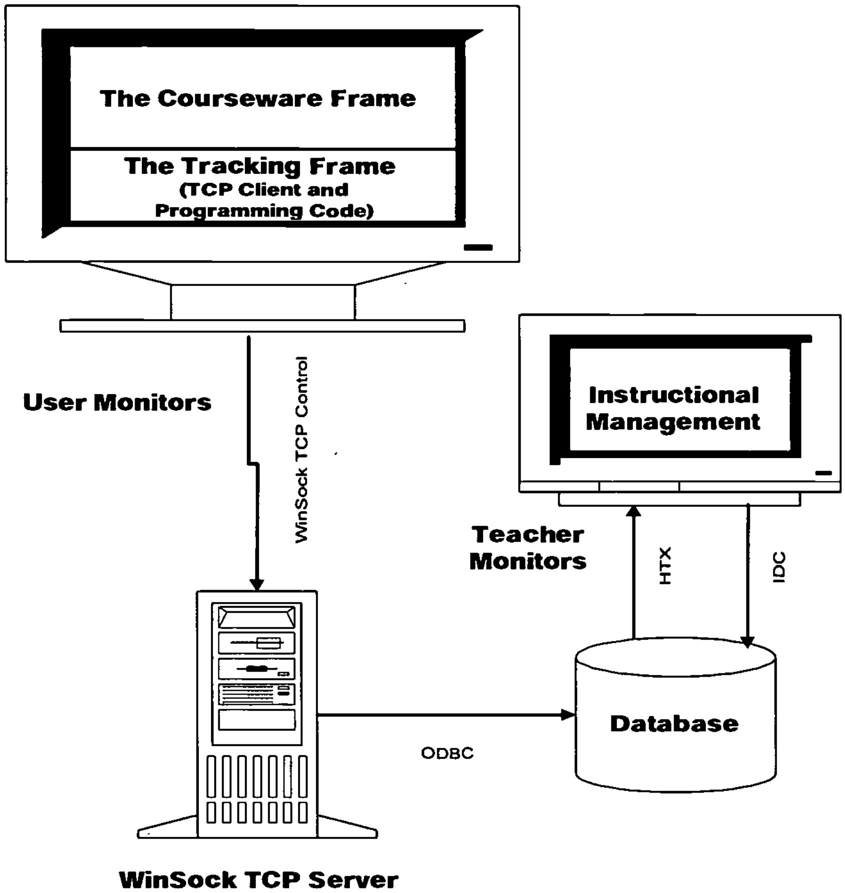
5. The Components and Functionality of WCTS

The WCTS is shown as [Fig. 1]. There are three key components in the WCTS.

5.1 The Tracking Frame

Every HTML files in the system consist of two frames. One is the courseware frame, with 100% scale that carries the courseware materials. The other frame, the tracking frame, with 0% scale that holds the programming code and WinSock TCP Client which are responsible for monitoring the learning activities and transferring the data to WinSock TCP Server respectively.

Figure 1 The WCTS



5.2 The WinSock TCP Control

The control consists of two related services, server and client. The server is sitting on a networked machine and waiting for messages that are sent out from the client. Clients are located at every tracking frame in HTML files.

After receiving messages from clients, the server forwards the messages with ODBC toward the database.

5.3 The Database

The database has two roles in WCTS. It is responsible for storing messages that come from the tracking frame originally. The other role of the database is to retrieve and analyze the data inside the database with SQL language.

6. Evaluation of Courseware Design and System Usability Analysis

It is required for every user to identify himself/herself upon accessing the courseware. As soon as user login the system, WCTS starts to monitor and record his/her learning activities. The recorded information is categorized in terms of individual courseware page and user. The framework of the recorded information is shown as [Fig. 2]. The evaluation of courseware design and system usability analysis are the main themes of the study and they are conducted with the experimental data that are collected with WCTS [Shimada et al. 97] [Yan 96].

Figure 2: The Framework of the Recorded Information.

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The Effect of Being Hypermedia Designers on Elementary School Students' Motivation and Learning of Design Knowledge

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Abstract: Current educational theory and practice clearly show that project-based instruction has the potential to enhance learning. Preliminary findings on one type of project-based learning in which students take on the role of hypermedia designers support this claim. This study examined the effect of being hypermedia designers on fourth-graders' motivation and learning of design knowledge. The findings showed that engaging students in hypermedia authoring could enhance their motivation, and allowing students to be hypermedia designers could support the development of design knowledge and higher order thinking skills. The skills mostly affected in this study included planning, presentation, reflection, collaboration, task distribution, and time management.

1. Research Framework

Project-based learning, requiring students' active participation and engaging them in authentic problem investigations, is considered to have great potential to enhance students' motivation and learning [Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar 1991]. Technology can play an important role in facilitating project-based learning by enhancing students' interest and supporting information gathering and presentation [Blumenfeld, et. al. 1991]. Engaging students in hypermedia/multimedia design is one type of project-based learning which has shown some encouraging results in promoting higher order thinking skills.

Engaging learners as hypermedia designers is an instructional strategy that invites learners to become intellectual partners with the technology and provides them an opportunity of using the technology as a cognitive tool to extend their minds and to construct their own knowledge [Jonassen 1994], [Solomon, Perkins, & Globerson 1991]. Perkins [Perkins 1986] states that the process of design promotes learners' active pursuit and use of knowledge. As designers, learners are encouraged to be creative, to integrate new knowledge with their prior knowledge, and to pursue their own intended goals actively. Because designing hypermedia programs "taps a diverse set of skills" [Carver et al., p. 388 1992] and involves both the process and product, educators believe it can provide a concrete and meaningful context for developing higher order thinking skills.

Research on engaging learners as hypermedia designers has only appeared recently. Lehrer, Erickson, and Connell [Lehrer, Erickson, and Connell 1994] conducted a study in which ninth-graders created hypermedia presentations on American history for other students. They found that students' time on-task increased significantly over the course of successive design projects. In addition, the study showed that the design process helped students to internalize various design skills. Students reported increases in mental effort and involvement, interest, planning, collaboration and individualization. Supporting their findings, Beichner [Beichner 1994] found in his study that junior high school students were highly motivated and often spent extra time when working on producing a multimedia program. Spoehr's study [Spoehr 1994] showed that designing hypermedia programs could help students develop more complex knowledge representations and assist the development of their thinking skills. A study by Liu and Rutledge [Liu & Rutledge 1997] found that high school students showed a significant growth in their value of intrinsic goals, and hypermedia design helped them to acquire several critical design skills. Other studies have shown that seventh graders, both advanced and behaviorally/emotionally disordered, were motivated by creating multimedia projects

[Orey, Fan, Scott, Thuma, Robertshaw, Hogle, & Tzeng 1997]; both boys and girls appeared to like doing multimedia projects [McGrath, Cumaranatunge, Ji, Chen, Broce, & Wright 1997]; and building a community of designers in the classroom could foster learning for students and teachers [Erickson & Wilhelm 1996].

The studies on learner-as-hypermedia/multimedia-designers suggest the following: 1) such a learning environment can have a positive impact on students' motivation toward learning; 2) such an environment encourages creativity and enhances the development of cognitive skills; and 3) high and middle school students learned design skills in addition to content and computer knowledge. While the preliminary findings in this area have shown some encouraging results, much is to be learned about designing and implementing such a learning environment effectively for different learners and curriculum needs.

2. Purpose Of The Study

Given the preliminary findings of the positive effects of the "learner as a hypermedia designer environment" on high and middle school students, we are interested in finding out if elementary school students can benefit from a similar learning environment, and, if so, what issues and factors need to be considered in designing such a learning environment. The research question for this study, therefore, was "What is the effect of being hypermedia designers on elementary school students' motivation and learning of design knowledge?"

3. Design Of The Study

3.1 Participants

The participants of this study were two intact fourth-grade classes (N= 38) from an elementary school in a mid-size city in the southwestern United States. Seventy-nine percent of the student population were white, and twenty-one percent were minority. Thirteen percent (N= 5) were identified as talented and gifted students (TAG). Twenty-four percent (N=9) were resource students who need additional academic help in various subject matters. Seventeen were female and twenty-one were male students.

3.2 The Hypermedia Learning Environment

The research study took place over two semesters, from November 1996 to April 1997. Both classes participated in this hypermedia authoring project as part of their daily 50-minute science class four days a week. The entire project consisted of three phases. During the first phase, which lasted approximately six weeks, students in both classes received the same instruction on the use of *HyperStudio*, an open-ended authoring system specially designed for children to create hypermedia programs with links, nodes, colors, text, graphics, animation, sound and video. The purpose of this phase was for students to acquire the technical skills and create a small *HyperStudio* stack with guidance.

In phase II of the project, which lasted approximately four and half weeks, students in one class worked in teams in a learner-as-designer environment, while students in the non-designer class worked independently. Both classes created *HyperStudio* stacks as part of a unit of study. In the non-designer class, the typical sequence *for a day* was for the teacher to spend about 15 minutes introducing the science content and then instruct students to create a card in their *HyperStudio* stacks on this topic. While students in the non-designer class made decisions individually about the content and organization of their stacks, students in the designer class worked in groups and made those decisions collaboratively. Because students in the designer class shared the responsibility for the creation of a group stack, individual students created fewer cards in the designer class than in the non-designer class. However, students in the designer class received instruction in the design process, including instruction on planning, division of responsibility, peer evaluation, and interface design principles. In a typical *week,* students spent about thirty percent of their time on of the were class-related activities, such as content teaching, design discussion, or group presentation, while about seventy percent of the activities were group related and led by students, such as planning, research, task distribution, and the creation of cards, stacks and multiple types of media. Collaboration within the group was required and between the groups was strongly encouraged.

Phase III of the project was similar to phase II, with the exception that, for both groups, the support from the teacher and researchers was faded.

3.3 Data Sources

Both quantitative (motivation scale, design questionnaire, task ranking, *HyperStudio* tests, and analysis of student-created programs) and qualitative data (observations, response log entries, and interviews) were collected. The triangulation of the multiple data sources provides a better picture of the learning environment under study.

Harter's scale of intrinsic versus extrinsic orientation in the classroom was used [Harter 1980]. It is 30-item scale that measures five aspects of motivation: (1) preference for challenge vs. preference for easy assignments; (2) curiosity/interest vs. pleasing the teacher/getting grades; (3) independent mastery vs. dependence on the teacher; (4) independent judgment vs. reliance on the teacher's judgment; and (5) internal criteria for success/failure vs. external criteria. This instrument was developed for use in grades three through six, and the reliability index for the subscales range from .68 to .84 [Harter 1980]. It was given to both classes at the beginning and at the end of the hypermedia project.

The design questionnaire was based on one developed by Lehrer and his colleagues to assess learners' development of various higher order thinking skills needed in producing hypermedia projects [Lehrer, et al., 1994]. This project questionnaire has been used in the research of learner-as-hypermedia-designer with a reliability index of .97 [Carver et al. 1992], [Lehrer, Erickson, & Connell 1993], [Lehrer, Erickson, & Connell 1993], [Liu, in press], [Liu & Rutledge 1997]. This self-report questionnaire was adapted to include only statements directly linked to the project. The KR 20 for this modified version was .82. Students in both classes completed the instrument at the end of the project.

In the task ranking questionnaire, students were given a list of eight tasks relevant to their project development, and were asked to rank the tasks according to their relative importance. This instrument was a simplified version, tailored to the fourth graders, of the task ranking evaluation used in a number of research studies on the same topic [Lehrer et al. 1994], [Liu & Rutledge 1997], [Liu in press]. Students were given this instrument at the end of the project.

Performance was assessed using the stacks created during phase III. These stacks were judged by two external evaluators in terms of the product quality using a fourteen item survey, with each item scored on a five-point scale. The total score for the survey was the composite score from the two raters, ranging from 28 (14 items X 1 minimum score for each item X 2 raters) to 140 (14 items X 5 maximum score for each item X 2 raters). The development of this evaluation was based upon the literature on assessing interactive multimedia/hypermedia programs [Fleming & Levie 1993], [Laurel 1993], [Mullet & Sano 1995]. It addressed the application of four design principles: consistency, contrast, legibility and simplicity. The interrater reliability of all items for all the stacks was 88%.

Interviews were conducted with the teacher (at the mid-point of the project), the parents (during two open houses), and the students (at the end of the project). Students selected for interviews were from both classes and from various ability groups. Interview questions focused on perception of motivation and comparison with other types of projects.

The teacher kept a journal detailing her observations of the classroom, and students were assigned three response log entries at different times. Observations and response log entries focused on student engagement, their perception of learning, and reflections on the design process.

3.4 Analysis

To understand if hypermedia design had an impact on the elementary school students' motivation, five two-factor mixed ANOVAs were run with the grouping (designer vs. non-designer) as the between-subjects independent variable and the data collection points (pre vs. post) as the repeated measure independent variable. The dependent variable was the pre and post scores of each of the five measures in Harter's motivation scale (challenge, curiosity, mastery, judgment, and criteria). Unpaired t-tests were conducted between the designer and non-designer groups on each of the five categories of the project design questionnaire (audience, presenting, planning, interest, mental effort, and collaboration). Students' responses to the design task ranking were analyzed descriptively. An unpaired t-test between the designer and non-designer groups was conducted on students' performance in creating their stacks.

The interview data and the response logs were analyzed using a two-level scheme following the guidelines by Miles and Huberman [Miles & Huberman 1994]. At the first level, codes were generated directly from the interviews and response logs through multiple passes of the data examination. At the second level, codes generated directly from the data were regrouped into more general categories. Patterns from the data were extracted and the relationships between the coded segments were compared and contrasted. With the research question as a guide, the data were then sorted into categories and sub-categories according to their common themes and shared relationships. The observation data were used to corroborate the findings from the interviews and response logs.

4. Results

4.1 Results from the Quantitative Data

For the motivation scale, the results of the two-factor mixed ANOVAs indicated that there was a significant two-way interaction between the grouping (designer vs. non-designer) and the data collection points (pre vs. post) for scores on judgment: $F(1,35) = 5.3$, $p < .05$ [see Tab. 1]. The designer group increased its score on judgment from pre to post whereas the non-designer group decreased its score slightly. That is, the difference between the pretest and posttest for the designer group was significantly greater than that for the non-designer group. The two groups, however, were not significantly different in scores of challenge, curiosity, mastery and criteria: $F(1,35)_{challenge} = .02$, p=.88; $F(1,35)_{curiosity} = 1.02$, p=.32; $F(1,35)_{mastery} = 1.11$, p=.30; $F(1,35)_{criteria} = .02$, p=.88 [see Tab. 1].

	Challenge		Curiosity		Mastery		Judgment		Criteria	
	Pre	Post	Pre	PostPre	Post	Pre	Post	Pre	Post	
Designer	2.7	2.6	2.83.0	2.9	2.8	2.6	2.9	2.4	2.3	
Group	(.7)	(.7)	(.6)	(.6)	(.7)	(.6)	(.9)	(.7)	(.9)	(.7)
(N=19)										
Non-designer		2.9	2.93.0	2.9	2.7	2.8	2.5	2.3*	2.6	2.5
Group	(.8)	(.8)	(.8)	(.8)	(.7)	(.8)	(.7)	(.7)	(.7)	(.9)
(N=18)										

* = significant two-way interaction at $p < .05$

Table 1: Mean and Standard Deviation (in Parenthesis) for the Motivation

For the design questionnaire, the unpaired-T tests showed that there were significant differences between the groups for the following categories: (1) planning: $t(1,35) = 3.0$, $p < .01$; (2) interest: $t(1,35) = -2.8$, $p < .01$; and (3) collaboration: $t(1,35) = 2.2$, $p < .05$ [See Tab. 2]. The average scores for planning and collaboration were significantly higher for the designer group than for the non-designer group. However, the non-designer group had significantly higher scores in the category of interest than those for the designer group. Such results showed that the students in the designer group had a better understanding of the importance of planning and collaboration, while students in the non-designer group showed more interest in the project than the designer group. No significant differences were found between the groups for the categories of audience, presentation, and mental effort [see Tab. 2].

	Audience	Presenting	Planning	Interest	Mental Effort	Collaboration
Designer Group (N=19)	3.0 (1.1)	3.4 (.6)	4.4* (.8)	3.9 (.6)	2.8 (1.0)	3.4* (1.3)
NonDesigner Group (N=18)	3.1 (.9)	3.4 (.8)	3.6 (.8)	4.5** (.3)	3.1 (1.1)	2.6 (1.0)

* significantly different from the non-designer group, $P < .05$.
** significantly different from the designer group, $P < .05$.

Table 2: Mean and Standard Deviation (in Parenthesis) for the Design Skills

In the task ranking measure, students from both classes were given a list of eight design tasks and were asked to rank their relative importance. Both the designer and non-designer groups ranked planning tasks as most important [see Tab. 3]. However, the two groups were different in ranking some of the other tasks. The designer group ranked the task of having "someone to try out the stack" as having greater importance than the non-designer group did. It ranked the tasks of "making the graphics very colorful," and "making animation" less important than the non-designer group did. Some of these differences between the two groups were statistically significant [see Tab. 3].

Planning and having others evaluate a product are more important steps for hypermedia design than making graphics colorful or making animation [Lehrer et al. 1994], [Liu & Rutledge 1997]. The results of the task ranking showed that the designer group had an overall better understanding of the design tasks and their relative importance than the non-designer group.

Design Tasks	Designer Class Average**	NonDesigner Class Average**
1. Plan and write down on your index card what your card will look like.	1.9	1.7
2. Discuss with your group what information to include.	2.0	2.6
3. Make sure the buttons and colors are consistent from one card to another.	4.0	4.8
4. Someone to try out the stack.	**4.8**	**6.6***
5. Make the graphics very colorful.	**5.7**	**4.7**
6. Scan in pictures.	5.3	5.1
7. Make sounds.	6.1	5.9
8. Make animation.	**6.1**	**4.5***

* significantly different from the designer group, $p < .01$ according to the unpaired-tests.
** The lower the mean, the higher the importance. The boldface letters indicate the differences in ranking between the two groups.

Table 3: Importance of the Design Tasks Ranked by the Students

Performance on the stacks created during phase III was assessed by two external evaluators with regard to the quality, the breadth, the depth and the use of the four design principles (consistency, contrast, legibility and simplicity). The unpaired t-test showed that there were significant differences between the designer and non-designer groups: $t(1,19) = 2.6$, $p < .01$ with the designer group having a mean of 95.2 and the non-designer group having a mean of 74.94. The higher the mean, the better the quality of the stacks. The designer group contributed 5 stacks (one from each of the 5 groups) and the non-designer group contributed 16 stacks (one from each student). The highest score for the designer group was 120 and the lowest score was 63, whereas the highest score for the non-designer group was 93 and the lowest score was 50. Eight of the 14 statements in the stack evaluation survey relate directly to the application of the four design principles, including "The text on the screen is very readable," and "The navigation buttons are laid out consistently on each card," The designer group did significantly better than the non-designer group when their stacks were evaluated using these eight statements: $Mean_{designer} = 61$, $Mean_{nondesigner} = 45.38$, $t(1,19) = 4.25$, $p < .01$. These findings suggested that on the whole, the quality of the stacks produced by the designer group was superior to those produced by the non-designer group.

4.2 Results from the Qualitative Data

The interviews with the students and their entries in their response logs showed that both the designer and non-designer groups enjoyed the project and that they felt this high interest level impacted their level of learning. Parents seemed to agree that the project had motivated their children and made learning more fun. Their comments included "It really grabbed the kids' attention" and "K was so excited, motivated, and proud to have created and succeeded in this project." The teacher shared this view on students' interest, explaining that "They look forward to coming to the computer lab to continue their projects."

The interview data and response logs indicated that students in both classes learned design skills by participating in this project. Students in both groups mentioned that they learned the technical skills of how to scan pictures, make colorful backgrounds, and use clipart pictures to enhance their stacks. Additionally, several students in the designer group mentioned the value of collaboration: "I'm getting a learning experience working in groups and deciding what's best for the group," Students from both groups appeared to recognize the importance of planning, though responses from the designer group were more concrete than those by the non-designer group. For example, students in the designer group commented on the need for planning in order to ensure consistency and avoid redundancy. One parent of a student in the designer group summarized the feelings of many parents well: "What a wonderful application and assimilation of learned content as well as skills. Clearly, the computer skills are of great value, but it is really exciting to see the children apply development skills and make choices for format and presentation."

The teacher commented on how a few students who were identified as having difficulty in learning reacted to the different treatments, stating that in the beginning those in the non-designer group seemed to "accept more responsibility for their work as it is [an] individual [project]," while the low ability students in the designer class tended to depend on the stronger students in the group. However, during the course of the project, the low ability students in the designer group eventually took responsibility for their group's work with the help of their team members. In the end, "the needy students did more [for their stacks] in the designer group than those in the non-designer group because of the continual help from other members." while those low ability students in the non-designer group who did not ask for help and did not work hard accomplished little. In commenting about the gifted children, the teacher said that "They generally would do well whenever given the opportunity. This [the project] is a vehicle for them doing that." The gifted students in the designer group took initiative to help others in the groups and ensure that work was completed on time.

5. Discussion

Using *HyperStudio* as the students in the non-designer group did is a typical way of using hypermedia authoring in a classroom. Engaging students as hypermedia designers, on the other hand, extends hypermedia authoring by placing students in a designer position. Instead of merely learning the technical skills and creating a project, the designers need to consider other issues such as the needs of the audience, the distribution of work in a group, the management of time and resources, and the deadline. They need to implement steps such as planning, designing, evaluation, and discussion. The authenticity and complexity of the design tasks provide students a learning environment where they can develop higher order thinking skills and skills of high value to the work place. This study investigated the effect of being hypermedia designers on elementary school students' motivation and learning of design knowledge, and found some interesting results.

The findings on motivation, as reflected in the Harter's motivation scale [Harter 1980], showed that there were no significant differences between the designer and non-designer groups on the categories of challenge, curiosity, mastery and criteria. That is, both groups were interested in the hypermedia project, a finding which was supported by the qualitative data in that comments from students in both groups, their parents, and the teacher showed that the students enjoyed doing the project and viewed as a good way to learn science as well as computer skills. This finding is consistent with the literature in showing that engaging students hypermedia authoring is motivational and promotes students' interest in learning [Beichner 1994], [McGrath et al. 1997], [Orey et al. 1997].

The designer group, however, outperformed the non-designer group on the category of judgment from pre to post, indicating that they felt more comfortable making independent judgments, rather than relying on the teacher's judgment, than their peers in the non-designer group. This suggests that the learner-as-designer environment may encourage the development of intrinsic motivation.

Both the Harter's motivation scale and the qualitative data showed that all students liked and enjoyed the project. Yet, the results on the project questionnaire showed that students in the non-designer group showed more interest than students in the designer group in the project. This gap between the two groups can possibly be explained by the frustrations experienced by the designer group, who had a greater variety of activities to handle, and who were responsible for planning and providing peer support. The peer pressure created by heterogeneous grouping, while beneficial, may also have added to the frustration. Finally, the designer group also had to transfer cards from one disk to another to create a group stack, a fact which became frustrating as file sizes grew and work was lost due to computer error.

Learning the science content was one of the objectives of the project. The two science tests (on plants and oceans) showed that students in both groups had significantly increased their knowledge on the subject matter ($p < .01$) from the pretest to the posttest[1]. In addition to the science knowledge which the students would have gained by working on other types of projects, this project allowed the students to learn some important technical skills involved in hypermedia authoring.

For the designer group, students also learned skills such as planning, project management, reflection (getting feedback from the peers and the audience), and working in groups to achieve a common goal. The statistical analyses indicated that students who were hypermedia designers had a significantly better understanding of planning and collaboration than the non-designer group, and valued these tasks above those of a more mechanical nature, a finding which supports other research [Lehrer et al. 1994], [Liu in press], [Liu & Rutledge 1997]. As Carver and her colleagues pointed out [Carver et al. 1992], such skills are invaluable for students to learn, especially when they are young. It is obvious from the data that the students as well as their parents viewed the opportunity of learning both science and hypermedia design and authoring as not only important but also beneficial to their future.

6. Conclusion

In an effort to examine if being hypermedia designers can have an effect on elementary school students' motivation and learning of design knowledge, this study found that engaging students in hypermedia authoring can enhance students' motivation, and allowing students to be hypermedia designers can support the development of design knowledge and higher order thinking skills. The hypermedia design project allowed the students to grow at their own pace cognitively, affectively and socially. The findings of this study support other research on the same topic in showing the benefits of a learner-as-designer environment [Beichner 1994], [Erickson & Wilhelm 1996], [Lehrer et al. 1994], [Harel 1991], [Kafai 1996], [Liu in press], [Liu & Rutledge 1997], [McGrath et al. 1997], [Orey, Fan, Scott, Thuma, Robertshaw, Hogle, & Tzeng 1997], [Spoehr 1993]. At the same time, it calls for more research in replicating and extending the findings. Literature has clearly shown the benefits of engaging students as hypermedia/multimedia designers.

[1]The science tests are the ones the teacher had used in the science class last year and would give to students regardless of types of projects they were working on.

Designing such a learning environment is nevertheless a very challenging task. Continuous research on the topic can advance our understanding and help us to search for new ways to design such a learning environment effectively.

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Design and Development of an Intelligent Simulation Training System for Process Control Operators

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Abstract: An interactive knowledge-based simulation has been developed for training process plant personnel to operate distributed control systems. It addresses generic skills by focusing on four basic control loops used by operators across various industries. At the heart of the simulation is a model representing process control expertise in terms of production rules. The tuition situates trainees in a simplified process control environment designed to foster a dynamic problem solving approach without cognitive overload. Instructional design challenges involved in training for dynamic tasks are discussed.

Introduction

This paper reports the development of a knowledge-based simulation system for training process control operators. The project utilises cognitive tutoring principles that are implemented by way of a research-based model of expert performance in the content domain. A number of complementary learning modules are used to support trainees' construction of a mental model of the fundamental control loops underlying effective process control operation. The staged simulation environment is designed to expose learners to the special challenges of dealing with a dynamic problem solving situation while at the same time carefully limiting the cognitive demands imposed. To appreciate the purpose of the process control training system reported in this paper, it is necessary to understand the type of setting for which it is designed. We will introduce the concept of process control by considering the example of an electric power plant. This example allows us to illustrate a typical setting and to characterise the performance demands faced by process control operators.

Process Control: an Example

Ensuring a continuous and well-regulated supply of electrical power to consumers 24 hours each day requires that the process of power generation is maintained within strict limits. In a steam-driven electric power plant, the generators that produce electricity are turned by pressurised steam flowing from jets onto turbine blades attached to the generators. To keep this type of power plant operating safely and properly, there needs to be careful control of:

- the *temperature* of the steam supplied to the turbines,
- the *flow* of steam leaving the jets that turns the turbines,
- the *pressure* of the steam as it leaves the jets,
- the *level* of water in the tanks supplying the steam boilers.

In modern power plants, these four *process variables* of temperature, flow, pressure and level are monitored continuously by electronic sensors installed at relevant parts of the plant. This sensing equipment is complemented by a range of electronically operated control devices which automatically perform functions such as changing the temperature, regulating the flow, varying the pressure and maintaining the water level. For each critical function, there are also alarms that will be triggered automatically when any one of the process variables goes outside its permitted range of values. The various components involved in keeping the plant operating properly (sensors, control devices, etc.) work together as an integrated whole known as a *control system*. Information gained from the monitoring of process variables by means of electronic sensors distributed around the power plant is fed back to the central control room. The operator in the control room views this status information which is displayed diagrammatically on computer screens. Alarm information is displayed in a similar way. Further, the control room operator can remotely adjust settings on the various control devices that alter the process variables out in the plant. The operator may take manual control to exert faster control or to override an alarm. This procedure of adjusting settings in response to monitoring and alarm information is carried out via dynamic interaction with the displayed graphic information. The type of control system described here is known as a *Distributed Control System* (DCS) because an operator working in the single location of the central control room is able to exercise control over many individual aspects of the process that are in reality widely distributed throughout the plant. Although the above example used a power generation process to illustrate the concept of a distributed control system, such systems are widespread across a diverse range of industries.

Overview of Process Control Training System (PCO_CBT)

The PCO_CBT training system was developed as a interactive simulation for delivery via personal computer in either stand-alone format or as a hands-on supplement to an instructor-led course. It was designed to develop generic skills in process control, rather than focusing on developing the specific skills needed for a particular industry. The training addresses four basic control loops that operators must typically master (temperature, flow, pressure and level). These are treated by means of interactive simulations that give trainees experience of working in a simplified process control environment in which the cognitive load is carefully limited to a manageable level while retaining the essential dynamic problem-solving approach required for such operations. The main modules comprising the training are Introduction, Preliminary Training, Job Oriented Simulation Training, and Reference. The instructional environment resembles the sort of control room context which a trainee might encounter if being given more conventional one-to-one training by an experienced process control operator. The approach used in the Job Oriented Simulation Training emulates the usual training situation in which inexperienced operators are trained by attempting to perform actual control tasks under the supervision of an experienced mentor. During training, the trainee's knowledge and capacities are engaged and developed from the outset when they choose a job to do or an error condition to correct. The different jobs or error conditions trainees can choose range across various types of process variables and levels of complexity. [Figure 1] shows a typical display presented to the trainee during the Job Oriented Simulation Training. The learner's task is to interpret the abstract representation of the control loops depicted (left hand side of the display), read the information provided in the faceplates (bottom right) and monitor the trend data as adjustments are made (top right). Expert advice and feedback is provided by way of an on-screen mentor (paralleling the situation that might exist with a supervisor in real life). Involvement of the mentor has been carefully designed to be context-sensitive so as to maximise correction of errors at the point of need while minimising possible disruptive effects. The mentor functions by having the knowledge of an expert process control operator encapsulated in "if-then" rules.

Process Control as a Dynamic Task

Process control operators, such as those working within DCS contexts, perform their duties in a highly dynamic task environment [Decourtis 1993], [Wallach 1995]. As with other dynamic tasks such as driving a motor car [Aasman 1995], [Donges 1978] or controlling air-traffic [Lee, Anderson & Matessa 1995], process control requires operators to respond in real-time to a continually changing set of task conditions. Many of these changes in the nature of the task are due to alterations in process variables that occur independently of the operator or that are beyond the operator's immediate control.

Rather than simply being fixed problems that can be dealt with by making a finite set of choices, dynamic tasks can be considered to be control problems [Brehmer & Allard 1987]. As such, these tasks are qualitatively different from the static problem solving situations that have been extensively studied by cognitive psychologists in recent years. For example, in domains such as physics [Chi, Glaser & Rees 1982] and computer programming [Davies 1994], the nature of the overall problem is defined at the outset and does not change. A satisfactory outcome can be obtained if an appropriate set of steps is followed through to the solution. However, this is clearly not the case with process control.

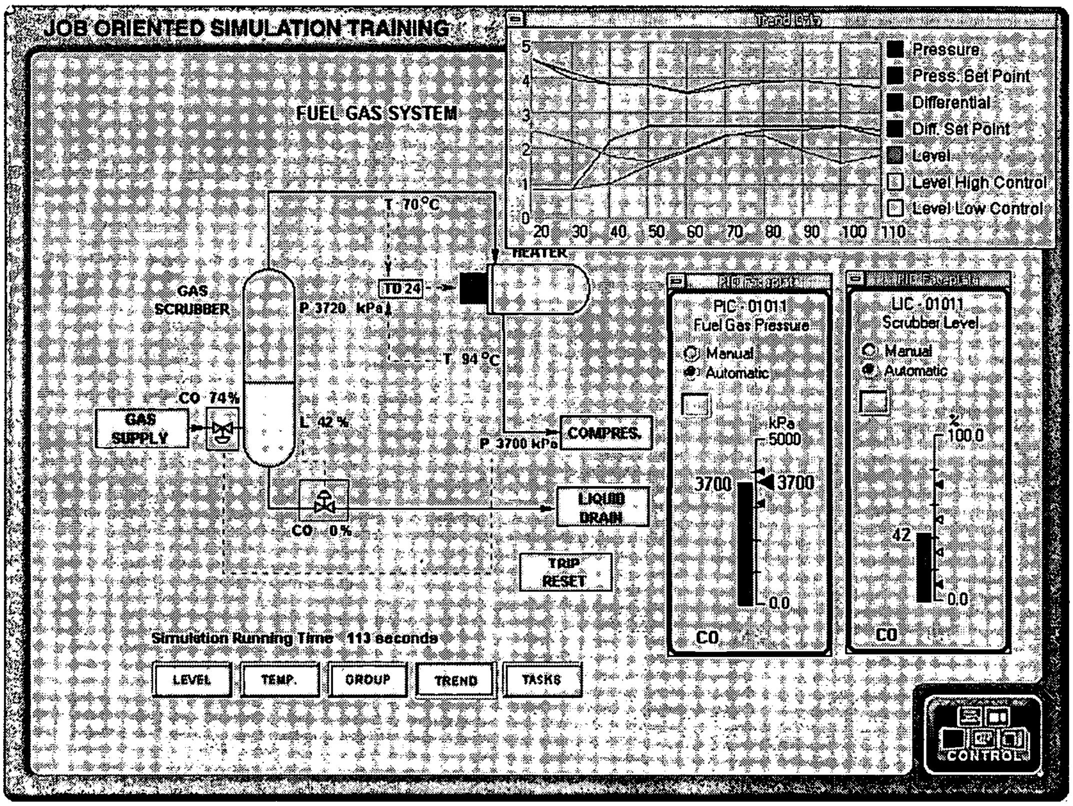

Figure 1: Simulation training display showing loops, faceplates and trend data

The immediacy of the task demands in process control are such that there can be little or no time for deliberation on the part of the operator. As with driving a motor vehicle, skilled performance needs to be a largely automatic process that involves significant unconscious control of behaviour. The time imperative for continuous interactive adjustment to the system does not allow for lengthy decision-making processes or extensive introspection. Nevertheless, process control cannot be carried out effectively in a purely intuitive manner. The choices of actions made by a skilled operator in the control room from moment to moment must ultimately be related to their likely physical consequences within the plant itself. This suggests that skilled process control involves the operator constructing some type of mental representation of the situation depicted on the DCS displays and basing decision-making on that representation.

Further complicating factors involved in the learning of dynamic tasks such as process control arise from the inherent unpredictability of the situation the learner is dealing with. This means that it is typically impossible to do a look-ahead search, or to carry out extensive backtracking due to uncontrolled changes in the task environment. In addition, there are temporal characteristics of a dynamic skill that need to be considered, such as the time taken for changes to occur in the process environment and the time taken to complete tasks within the operating environment [see Brehmer 1990]. To perform process control effectively, the operator must take proper account of these temporal aspects. Trainee operators therefore need to be given the opportunity of learning to handle these aspects during their instruction. These additional demands all increase the complexity of the task for which operators must be trained.

Expertise in DCS Operations

As with performance in other complex problem solving domains [see Lowe 1993], some aspects of the skills involved in process control are largely implicit and therefore unlikely to be revealed during an expert's explicit explanation. However, carefully designed investigations have allowed researchers to infer many of the underlying cognitive structures and mental activities that underpin expert performance. The expertise exhibited by skilled operators in many fields is associated with their possession of extensive stores of domain-specific knowledge.

Expertise in DCS operation has been studied by [Nielsen & Kirsner 1994] and characterised in terms of its proactive nature (a response to the complex dynamic environment involved). From these investigations, a computer model has been developed which represents such expertise in terms of production rules ("if-then" condition-action combinations) and follows on from the extensive work of [Anderson 1993a] on this form of knowledge characterisation. This external modelling of DCS expertise has led to a proposal that skilled DCS operators may possess knowledge structures that allow them to model process control functions in a fashion somewhat analogous to the operation of the computer model. According to this proposal, these knowledge structures would include the mental equivalent of production rules and be the basis on which expert DCS operators constructed their highly flexible mental models of the system's behaviour.

The main function of the DCS training system discussed in this paper is seen as being to help trainee process control operators develop the capacity to build suitable mental models of the situations they were required to handle. A similar approach has recently been used with some success to improve trainee meteorologists' capacities to make weather map predictions [Lowe 1995]. A fundamental requirement for designing instruction based upon such approaches is for the design team to have a clear, explicit conception of the knowledge structures that underlie the model-building capacities of expert performers in the domain. However, this conceptualisation on its own deals only with the nature of the desired outcome of instruction. It does not give any guidance about what instructional processes are likely to be effective in promoting that outcome. We also need to consider the way in which characteristics of the learning situation itself may interact with the development of expertise.

Challenges for Training: Developing Expertise in Process Control

One approach to training DCS operators might be to use a straightforward simulation that closely resembles the actual situations which such operators would typically be expected to encounter. However, it can be seen from the discussion in earlier parts of this paper that this approach may be ineffective due to the undesirably high cognitive processing demands it would make on the learner [see Sweller, 1993]. Faced with a conventional simulation of this type, the learner's response is likely to be primarily one of survival. That is, the actions taken would be a result of the learner's attempts to cope with the immediate exigencies of the situation, rather than efforts directed towards the building of an expert-like knowledge representation.

Coping strategies such as the focusing of processing resources on some aspects of a task while paying less attention to other aspects are often adopted in situations of high task demand. This type of cognitive load-shedding would be a possibility if multimedia-based training in process control was to rely upon high demand real-time problem solving tasks. [Sweller 1988] has suggested that the cognitively-demanding nature of problem solving activity itself may mean that it is not the most efficient way to acquire expert knowledge representations.

The specific results from studies of process control operators in a German power plant [Wallach 1995], [Wallach & Tach 1994] appear to be consistent with the general concerns about cognitive load expressed by Sweller. Wallach has speculated that subjects who were given the dual tasks of learning and controlling the process achieved relatively poor results because of the effects of cognitive overload. If this was the case, it may be that DCS instruction would be more effective if, rather than being asked to cope with the demands of a full-blown control situation, learners were presented with a considerably scaled-down level of control demands. However, it would be important that the way in which the control demands were scaled down still required the operator to switch between the dual roles of (a) passively *supervising* an automated process and (b) actively *manipulating* process control variables in a direct fashion [see Reinartz & Reinartz 1989].

Approach to Instructional Design

At the heart of the instructional design of the DCS training materials described in this paper is a knowledge-based system that models the performance of an expert process control operator. While in certain respects some its features resemble those of traditional simulation training, it goes beyond the preoccupation with surface fidelity that characterises most such approaches. This is partly because it deals with an abstracted working environment in which the reality of the equipment out in the plant is replaced by highly simplified two-dimensional symbolic representations. However, it is also because of the incorporation of an explicit model of process control performance. In contrast to many other model-based approaches, this system does not attempt to model the cognitive processes of the trainee but rather is derived from cognitive modelling of expert performers. As a consequence, its function is to act as a powerful resource for monitoring trainee actions while providing context-sensitive feedback to guide the learning process in an efficient manner.

With respect to the practical design of intelligent tutoring systems, Anderson [Anderson 1993a], [Anderson 1993b] has enunciated general principles intended to support the implementation of cognitive engineering approaches in computer-based instruction. These principles can have implications for design decisions taken at the micro level (computer programming of the rule base) or the macro level (development of practical instructional strategies). The following list summarises these principles:

1. Represent student competence as a production set.
   (The skill is decomposed into an accurate model).
2. Communicate the goal structure underlying the problem solving.
   (To be done through the interface as much as possible).
3. Provide instruction in the problem solving context.
   (Instruction is provided as each new set of production rules is introduced).
4. Promote an abstract understanding of the problem solving knowledge.
   (The conditions of the rules are sufficiently general to do this).
5. Minimise working memory load.
   (Do not present instruction while problem solving).
6. Provide immediate feedback on errors.
   (Cut down on time in error state).
7. Adjust the grain size of instruction with learning.
   (The grain size to reflect larger chunks built during problem solving).
8. Facilitate successive approximations to the target skill.
   (The tutor fills in some steps during early stages).

Wherever possible, the design of the present project was carried out in accordance with these principles. In some cases (such as point 1), the principles are concerned with the characterisation of the knowledge structures that underlie the desired performance outcomes. In others (such as point 5), the principles address the demands of the instructional situation by considering ways in which the learning which ultimately leads to the performance outcomes can be facilitated. For the design situation described here, strict adherence to Anderson's principles was not always possible and sometimes not even desirable because of the special nature of expertise in process control (including its dynamic character and the need to support construction of a coherent mental model). For example although representation of student competence as a production set certainly became the core of the design, it proved to be impractical to build in meaningful computer-based adjustments of the grain size of instruction with learning.

Conclusion

Instructional design typically involves some degree of optimisation in which competing demands arising from the nature of the content and the characteristics of learners must be reconciled. For the DCS operator training discussed in this paper, this reconcilation process was particularly challenging because of the complexity of the task involved, its dynamic character, and the abstract way in the information involved is represented. The learner is dealing with what could be thought of as a moving target. However, developing the capacity to deal with this target effectively relies on a the construction of knowledge structures that will permit the learner to generate and modify mental models of the depicted remote situation in order to take appropriate action. A major challenge to the developer of instruction in this area is the lack of a comprehensive theoretical framework to guide design activities. An important reason for this deficiency is that conventional approaches to instructional design are not able to handle the complex issues that arise in dynamic environments. In the project reported here, although we have taken a strongly theory-driven approach to the design of the instruction, it has been necessary to be quite eclectic in our approach. It may be that this is unavoidable in a domain such as DCS but the absence of coherent, principled approaches to guide the design of instruction for dynamic environments in general is a matter of some concern. In our future development of DCS operator training, we will be exploring possible approaches and design methodologies that can be used in this demanding area. It is anticipated that the innovative use of cognitive modelling based upon expert performers rather than trainees will contribute to more principled instructional design for dynamic environments in general and effective training in the specific context of distributed process control.

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DEVELOPING AND FACILITATING A SELF-PACED TECHNICAL CALCULUS COURSE ON & OFF CAMPUS

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Abstract: Developing and facilitating a self-paced Technical Calculus course on and off campus is a learning experience. The course was first developed for Focus: Hope and is now being taught at Lawrence Technological University. This paper goes into details describing the course at both sites. It describes the structure of the course, the materials used, and a summary of my experiences. I have also described changes I have made to the course based on the needs of the students and how I envision this course in the future.

The Technical Calculus course described in this paper was developed in the summer of 1996 by me and Professor Barbara Chambers of the Northern Virginia Community College for Focus: Hope in Detroit, Michigan. Focus: Hope is a metropolitan Detroit civil rights and human rights organization. It was founded in 1968 following the 1967 Detroit riots by Eleanor Josaitis and Father William Cunningham. The goal of Focus: Hope from the very beginning has been to help build a strong community among people of diverse backgrounds through practical action to overcome racism, poverty, and injustice.

Focus: Hope began by distributing food to low income mothers with children and senior citizens. Over the years it has expanded tremendously to include the following:

1) Fast Track education program to provide basic math and reading classes along with short term job skills for inner city people who wish to work toward advancement or prepare for a longer course of study in Focus: Hope's Machinist Training Institute (MTI).
2) Machinist Training Institute provides State-licensed, fully accredited training in precision machining and metal working. Trainees gain comprehensive machining skills working from blueprints to a finished product.
3) Center for Advanced Technologies - The highest level of education and training is provided through the Center for Advanced Technologies which accepts graduates of MTI.

In the Manufacturing Technology Education provided by the Center for Advanced Technologies (CAT) the candidates (students) receive manufacturing training along with academic learning in an actual production setting. It is a federally funded project to educate it's candidates in advanced manufacturing engineering at world class levels. The candidates learn how to build, operate, maintain, and repair complex computer-integrated, flexible manufacturing equipment and systems. The typical candidate is 20 years old or older and comes from a disadvantaged background. They have progressed through the Fast Track and MTI programs to be eligible for CAT. They often are supporting families and receiving paychecks from Focus: Hope for the production work they perform on a full-time basis. The combination of working a production job and taking college level courses toward a degree is very rigorous and time consuming.

Upon entering the CAT, the candidates take a diagnostic math test which places them in one of 18 mathematics modules which are based on the Technical Mathematics 1 and Technical Mathematics 2 courses at Lawrence Technological University (LTU). Lawrence Technological University is an independent, co-educational, accredited university founded in 1932 in Southfield, Michigan. The University is composed of the Colleges of Architecture and Design, Arts and Sciences, Engineering, and Management.

Once the CAT candidates at Focus: Hope are placed in a math module they proceed on a self-paced basis until they are ready to take the module test. They must score 85% or higher on the test to proceed to the next module. Once they have passed the final exams for Technical Mathematics 1 and 2 they can proceed to Technical Calculus. Prior to summer of 1996 Technical Calculus had not been developed into self-paced modules. I taught the course at Focus: Hope just like I would on LTU's campus, as a lecture course. There was a need to develop this course as a self-paced course to also be consistent with Technical Mathematics 1 and 2. During the summer of 1996 Barbara Chambers and I developed eight self-paced modules that make up the Technical Calculus course.

STRUCTURE OF THE COURSE

The course is designed as an introduction to Calculus for Manufacturing Engineering Technology. This is a course in which the candidate (student) works at their own pace and should take no more than 15 weeks to complete. The course is made up of the following eight modules:

1) Limits and derivatives
2) More derivative rules
3) Applications of derivatives
4) Curve sketching
5) Derivative of trigonometric, logarithmic, and exponential functions
6) Integration
7) Applications of integration
8) Methods of integration

When the assignments in a unit are completed and understood, a unit test is taken. There is also a comprehensive final exam following completion of the eighth module. A unit test, on which a grade below 75% is scored, may optionally be retaken only once with the higher of the two scores counting toward the candidate's average. The final exam may only be taken once. I spend approximately 2 hours twice a week at Focus: Hope either tutoring the candidates, administering exams, or conducting mini workshops with a few of the candidates. It is very important for the candidates to see that I am available and very willing to work with them. The semester grade is based 50% on unit tests and 50% on the final exam. The grading scale is:

Average	Grade
95-100	A
90-94	A-
87-89	B+
83-86	B
80-82	B-
77-79	C+
73-76	C
70-72	C-
67-69	D+
63-66	D
60-62	D-
below 60	F

MATERIALS FOR THE COURSE

The book we developed summarizes each module. It has an assignment sheet for each unit keyed to the textbook entitled Basic Technical Mathematics With Calculus by Allyn J. Washington 6th edition Addison Wesley Publishing. The units utilize video tapes which are basically lectures on demand, along with worksheets, and Calculus software. The software available at Focus: Hope is Calculus by Broderbund and

Calculus Connections. There are 20 video tapes available for the course, with each module requiring the student to view anywhere from 1 to 5 tapes. The use of a graphing calculator is also strongly encouraged.

SUMMARY OF THE SELF-PACED TECHNICAL CALCULUS AT FOCUS: HOPE

The first time I taught Technical Calculus at Focus: Hope was the Winter 1996 semester. The modules were not developed at that time so the class was a lecture course. I have been facilitating the self-paced Technical Calculus at Focus: Hope since the Summer semester 1996. If a candidate does not complete the course in 15 weeks they are given an I grade and given the opportunity to complete the course in the next 15 weeks. If after that time they do not complete the course, they receive an F grade and they have to register for the course at another time. There are many reasons that this can occur. Since all the candidates work at least 40 hours/week operating machinery at Focus: Hope to produce parts under contract with the Big Three Auto Makers, their jobs often interfere with the course. Production scheduling can vary from week to week to meet the customer's demands for parts. In other cases they may be overburdened with other courses they are taking that are not self-paced. They are strongly encouraged to register for the class again at their earliest convenience since the Mathematics is a basis for their other courses.

SELF-PACED CALCULUS AT LAWRENCE TECHNOLOGICAL UNIVERSITY

Technical Calculus has traditionally been taught at LTU using the lecture mode of delivery in the evening school. The evening school student typically works during the day and is trying to complete a degree at night. They are usually older than the typical freshman in college. They quite often are in their twenties, thirties or even older. I was encouraged to apply what I was doing at Focus: Hope to our LTU campus. As a result, during the winter semester 1997 school year, I facilitated a self-paced Technical Calculus class at Lawrence Technological University. We also offered a lecture course if the students did not want a self-paced course. At the beginning of the semester 16 students registered for the course. Two students withdrew from the class within 3 weeks because they did not like the concept of self-paced.

The materials used were basically the same as at Focus: Hope. They used the book Barbara and I developed, the textbook, and the video tapes were available for reference. There was no Calculus software available during the LTU course however. I gave the students a schedule approximately half way through the course describing where they should be in terms of the modules. They thought that was very helpful and I should have distributed this at the beginning of the course. I also distributed a questionnaire at the beginning and the end of the course. The questions were based on a scale from 1 to 5 with 1 indicating least and 5 indicating most. Some of the questions at the beginning of the course were:

1) How motivated are you to take a self-paced course?
2) How helpful do you think the video tapes will be?
3) How helpful do you think the self-paced book will be?
4) How disciplined do you think you are?
5) Do you think it will be helpful to have an Instructor in a classroom?
6) Do you think it will be helpful to progress at your own rate?

Their answers to these questions ranged between 2 and 5. At the end of the course the same questions were asked in the past tense. This time the answers were strictly 4's and 5's. I also asked the students if they now preferred a traditional or self-paced course. All but one answered self-paced. They liked the idea of the flexibility that is built into the course.

SUMMARY OF SELF-PACED CALCULUS AT LTU

After I facilitated the course for one semester at Lawrence Technological University I realized I needed to make some changes. The video tapes were a problem because the students could not check them out. I had more copies of the video tapes made so the students in the next course offering could check them out for a couple of days. The students this semester like this idea. I also did not think there was enough interaction among the students and myself. As a result, I have put more of an effort into interacting with the students this semester. They have my home phone number and I have their work and home numbers. I talk individually to each student at least once a week. The class is a 3 credit hour course, and I am available each week for 1 ½ hours in a classroom to answer questions and administer tests. There is also another instructor available another evening to tutor them. I feel the interaction with the students is essential but it is more time consuming on my part. The book that Barbara and I developed is also now available on a CD in preparation of offering this course on a distance learning basis. The students have been given the option of purchasing the book or using a copy of the CD to try for the semester. They need a browser to view the CD such as Netscape or Microsoft Explorer because the CD was developed in HTML in anticipation of being placed on the internet. I am also requiring the students to turn in the worksheets I provide them before they take a unit test so I can see what types of mistakes they are making if any. To incorporate this into the course I have changed the grading for the course. The 8 module exams count 55%, final exam 35%, and the worksheets count 10% of their grade. The students seem to feel very comfortable with this structure.

THE FUTURE OF THE SELF-PACED CALCULUS COURSE

The first point I feel very strong about is that a self-paced course is not for everyone. Some student definitely learn more effectively as a lecture. We all learn differently. I think we will continue to need to offer Technical Calculus as a lecture course for the time being in addition to the self-paced course. The CD will eventually be offered over the internet as an LTU course. The students should also be given the option of purchasing this in printed form as it is now. They should be given all the necessary information at the beginning of the course such as a syllabus, worksheets for the course, and a schedule of possible exam dates to keep them on target. The students should have access to my home number, work number and email address. This I believe has been successful this semester. They can either mail, fax, or email the completed worksheets to me to correct. The video tapes should be available on video tapes and CD. This will give the students complete flexibility at their site. The unit tests can be given via a proctor at a given site or sites designated. The exams can then be faxed to me to grade. A chat room can be set up so the students can interact with each other. I would still like to do a survey at the beginning and end of the course so I can constantly improve the course.

Next semester (Winter 1998) I will be advising a senior in a directed study course to make the CD more interactive by adding audio, animations, and video. Good educational software is active, not passive. Students ought to be doing something, not watching something. [Schank, 1993] At the end of the directed study course the CD will be a true multimedia product. According to the literature, the more senses you involve the more learning takes place. It is also very important to interact with each student. I would like to either travel to their sites at least once or schedule at least one video conferencing section. If they do not own equipment like Vtel, then possibly it could be rented. As we reach out via distance education to attract more non-traditional and place-bound students, we need to think of them as our students. [Sedlak & Cartwright, January/February 1997] Distance education is not a new phenomenon; it has been a mode of teaching and learning for countless individuals for at least the past one hundred years. [Moore & Kearsley, 1996] Imagine a nontraditional learner where learning can take place anytime, anywhere, and where the learner makes the choices. [Perrin, February 1995]

CONCLUSION

Distance education offers students more choices and increases access to higher education. Dooley believes that with the technology now available, education is entering the most creative period it has ever seen. There is definitely a need to provide distance educators with systematic guidelines for selecting instructional strategies. [Dooley, 1995] The purpose of distance education is to meet the diverse learning and scheduling needs of students. Interactivity is an important aspect of learning regardless of whether the class is being taught in the traditional lecture mode or as a self-paced course.

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Formative Evaluation of a Virtual Campus Prototype

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Abstract: In an attempt to converge the visions of a Virtual Campus, several research teams at LICEF [1] developed a prototype. To formatively evaluate this prototype, consisting of 18 computer tools facilitating communication, information gathering, learning management and navigation, 15 students and 3 tutors were employed during 7 weeks. The goal was to identify the strengths and the weaknesses of this learning environment from a technological, a pedagogical and a methodological viewpoint.
This article reports the global results of this formative evaluation allowing for some guidelines to be expressed.

1. Introduction

Since 1992 the LICEF research centre is involved in designing, developing and experimenting a Virtual Campus (VC) which co-ordinates the activities and tools required in a tele-learning process. During the spring of 1997, a prototype was developed by an interdisciplinary research team [Paquette et al. 1993; Paquette et al 1996a, 1996b; Paquin and Bleicher 1996; Dufresne et al. 1997; Dufresne 1997; De la Teja 1997]. The prototype integrated the research from several domains: system architecture, telecommunication, instructional design, interface design, tutor intervention methods, collaborative learning, meta-cognition, learning management, terminology and linguistic discourse analysis. On the technical side, the prototype included:

- three types of telecommunication systems (ISDN, ADSL, cable-modem) to accommodate both real time communication (video/textual) and asynchronous communication (FTP, e-mail, computer conferencing).
- multiple electronic tools to facilitate production, peer communication, self-management, and information gathering

The formative evaluation of the Virtual Campus had a two-folded goal:

- the integration of research from all the members of the team;
- to identify the learners reasons for using and their attitudes towards the tools included in this model of the Virtual Campus.

2. Theoretical underpinnings

The underlying principles shaping, both the instructional and the technical development of the prototype, have its roots in a constructivist philosophy. The following points stand out as basic guidelines for the design:

- *Active learning* through exploration of the environment, the content and getting to know peers, that is, the learner takes on the main responsibility for the learning;

[1] L'inforamtique Cognitive et Environnement de Formation

- *Collaborative learning* encouraging negotiating and validating newly found knowledge with peers, tutors and experts, and consequently yielding a gradual construction of a personal representation of the content [Henri and Lundgren-Cayrol 1997; Lundgren-Cayrol 1996];
- *Tutor as a facilitator* of learning rather than a instructor [Hotte 1995];
- *Providing multiple perspectives of the content* to facilitate the acquisition, elaboration and evaluation of both the content and the learning process.

3. Methods

A learning situation was designed allowing to apply the "Learner Verification and Revision" method [De la Teja 1997; Weston 1988]. This method aims at the improvement of learning materials and tools, during the development phase, by identifying the flaws through an iterative trial and revision process with the learner as the main evaluator. The learners were asked to do "real tasks" admitting a variety of data gathering techniques.

3.1 Participants

Fifteen students in Management and/or Administration, with differing knowledge in computer use, various experiences in distance learning, and from two age categories, were employed to take on the role as the learner. The initial selection also catered to two research demands, that students had some interest in the course content, a basic knowledge of the IBM desktop environment and possessed essential word-processing skills. Three tutors were involved in the experiment, a subject-matter specialist, a moderator and a method's specialist. These tutors worked together as a team using a private asynchronous conference as their workspace. Further, the complexity of the learning environment demanded technological assistance in terms of telecommunication, hardware and software problems.

3.2 Materials

The prototype of the Virtual Campus included different ways in which the learners could proceed in the environment to acquire the course content. Three levels of navigation were designed:
- the Virtual Campus in form of a space station named Explora (Figure 1); Each node brings the learner to a set of tools;
- the course scenario designed as a Centre of Congress (Figure 2);
- the Knowledge Model and the Learning Scenario offering different perspectives of the learning content (Figure 3 and Figure 4).

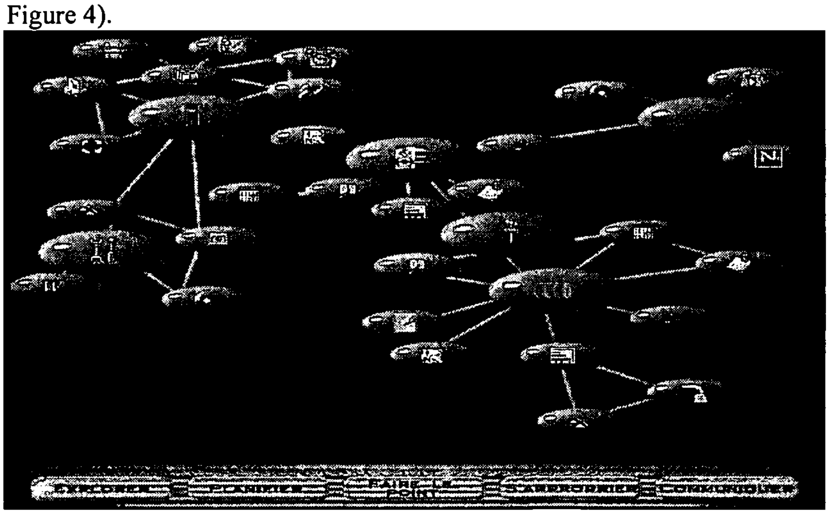

Figure 1. The interface to the Virtual Campus, Explora

The tools supporting the environment operated in a Windows-97 environment and provided means of
- Navigating in the learning environment
- Communicating with peers

- Producing academic work
- Gathering, organising and structuring content information
- Managing the learning [Ruelland and Bergeron 1995]

The learning scenario was designed around an undergraduate economics course, ECO 3004: Training and Economical Competitiveness [Tremblay 1997] divided into five modules: stating the problem, doing a literature search, sharing information, holding a multi-point video debate, participating in an asynchronous debate, and completing a take-home exam. These activities were available at the Centre of Congres.

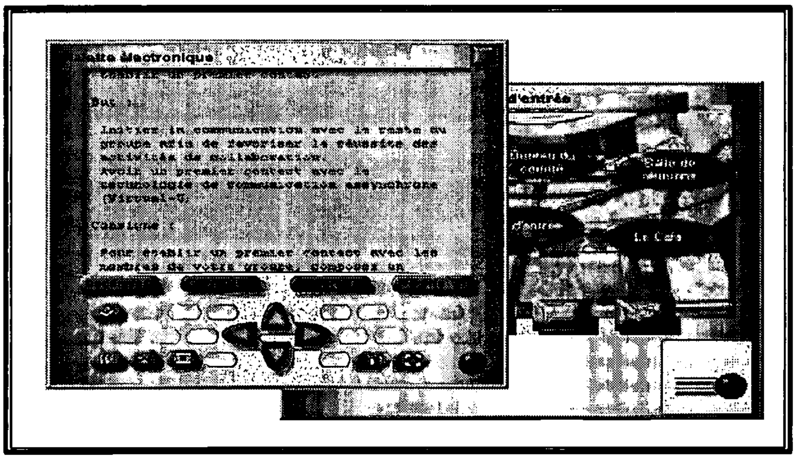

Figure 2. The Centre of Congress view of the course.

The course modules took the graphical form of a map, linking modules in terms of precedence in time. These modules could be viewed from different perspectives, as an outline of the course with or without all the details of an event.

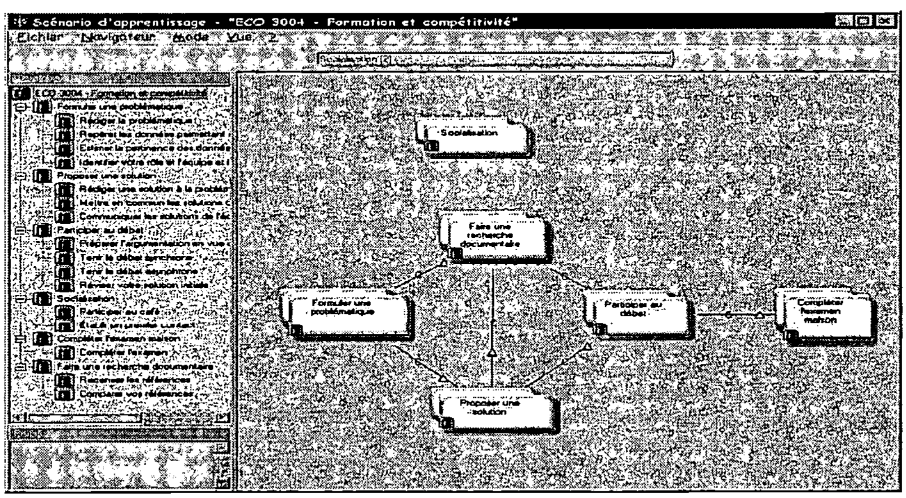

Figure 3. The graphical interface of the course scenario

The Knowledge Model took the form of a conceptual map allowing the learner to explore the content from an expert's point of view. Another view of the content took the form of an outline from which the learner could explore the documentation (book chapters, articles and videos).

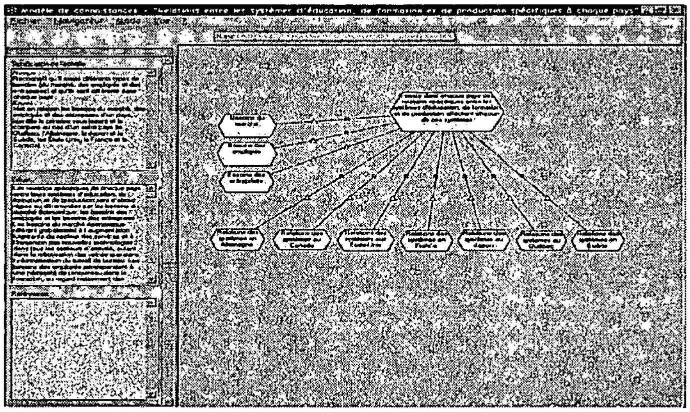

Figure 4. The graphical interface of the Knowledge Model.

A detailed description of the Virtual Campus can be found in 'Developing the Virtual Campus' [Paquette et al. 96a ; 96b].

3.3 Instruments

Data were gathered through questionnaires, telephone interviews, video observations, think aloud protocols, automatic computer traces, academic productions, computer-conferencing messages, and informal discussions with the students.

3.4 Procedures

The course scenario revolved around a video debate that was prepared first on an individual basis, then in teams. Once the teams were ready, they held a debate using multi-point videoconferencing. The main points of the discussion were elaborated upon in an asynchronous computer conferencing debate. In all, the learning activities lasted 7 weeks. Subjects were geographically distributed in the Montreal area as well as two other cities.

Since the LRV method proposes that the evaluation is carried out in a situation as realistic as possible, the data gathering took place according to these three phases :

- *Exploring the environment* (privately and in teams). Data was gathered through videotaped training sessions, and an attitude questionnaire. To keep track of technical problems occurring in this initial phase, a log was held.
- *Elaborating the content* (alone/team/group). A log was held to keep track of the academic performance and participation in the collaborative activities by the transcript of the conferences. A second attitude questionnaire was administrated.
- *Evaluating the experience* (group). Messages in the asynchronous conference and a videotaped face-to face debriefing session, that was held on the last day.

4. Results and recommendations

The formative evaluation of the prototype allowed the integration of efforts from different teams at LICEF as well as the development of an efficient and effective communication among teams. This translated into the harmonisation of terminology and in the sharing of a common vision of the Virtual Campus.

In terms of technical issues, overall findings reveal that participating students relied on synchronous communication when in need of technical help or for motivational purposes, but preferred asynchronous communication to learn content. Moreover, it became evident that in order to appropriately serve students and tutors at a distance, the technological expertise must be both varied (telecommunications, software, hardware) and distributed.

In terms of pedagogical issues, the time to explore the environment was underestimated and students felt slightly overwhelmed by the plethora of tools in the beginning of the experience, but reported 'at home' at the end. However, 86% of the students reported satisfied or very satisfied with the experience.

The development of an integrated prototype brought forth the problems that future research must face:

- Initial learning activities must be designed to use the technology in a purposeful manner; e.g., the note taking tool, Atelier FX [Desjardins et al. 1996], was very appreciated by the students, and which was the purpose of the first activity;
- From the tools designed to assist in learning management, only a few seemed to be useful in this situation.
- Multiple access to the content as well as to the learning activities are appropriate to cater to different learning styles;
- Tele-learning seems to benefit from different types of tutors, the three tutors were very appreciated by the students;
- A fine balance between the use of videoconferencing and asynchronous conferencing is necessary, since students preferred the asynchronous mode for learning content, but the synchronous mode for motivational purposes and technical help;
- Interface design for these types of learning environment appears to profit from metaphors.

A bigger sample and a longer learning period might shed more light on the purposefulness of the different tools proposed in the Virtual Campus prototype.

Detailed reports are being prepared by each one of the research members involved in the Virtual Campus project. The prototype is presently being revised and developed as a Web version.

Acknowledgement

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Using Design Patterns in Educational Multimedia applications

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Abstract:

Designing and implementing Educational Multimedia Systems (EMS) is hard; even when design methods may help in this task, most critical design decisions remain undocumented making reuse a difficult task

In this paper we show how to use design patterns while building Educational Multimedia Applications. We first present the idea of design patterns and then discuss some simple though effective design patterns addressing different concerns in this kind of applications. Each one of them is exemplified with successful educational applications.

1. Introduction

In the past four years there has been a growing interest in hypermedia design techniques. The different problems an educational hypermedia author has to deal with are complex, since the combination of navigation through an intricate information space with the unstructured nature of multimedia data poses new challenges. There are some well-established notions of good hypermedia development, outlining three groups of design issues:

- The first group comprises the problem of organizing the information:
  - *How do we organize the information space to let the user navigate following meaningful links established between information units, and let the users understand?*
- The second group of design issues explores the organization of the interface:
  - *Which objects the user will perceive and how these objects relate to the navigation objects?*
  - *How will the interface behave as the user exercises it?*
- The third group of design issues has to do with implementation:
  - *How these information units mapped into pages?*
  - *How are navigation operations and interface objects implemented?*

Design Methodologies help the software designer to express an idea with an appropriate language, and the way it has to be implemented. Unfortunately, there is an important issue that no existing methodology addresses and that is: how to make good, effective designs.

This is the barrier that separates successful experienced hypermedia authors from the rest. Having reached a certain maturity in the process of designing hypermedia applications it was, until now, hard to talk about effective design solutions and convey experience to other people, mostly due to the lack of an abstraction mechanism.

Such a mechanism allows to express design strategies to face common design problems and to record design experience; it is a language to talk about how things must be designed rather than how they are written under any given methodology. If we are not capable of transmitting the experience gained through the years, how will we develop and enhance the next generation of Educational Multimedia Systems?

Though originated in architecture [Alexander77] design patterns are being increasingly used in software design [Gamma95]. Design patterns are a good means for recording design experience as they systematically name, explain and evaluate important and recurrent designs in software systems. They describe problems that occur repeatedly, and describe the core of the solution to that problem, in such a way that we can use this solution many times in different contexts and applications. Looking at known uses of a particular pattern, we can see how successful designers solve recurrent problems.

In some cases, it is possible to give structure to simple patterns to develop a pattern language: a partially ordered set of related patterns that work together in the context of certain application domain. Design Patterns complement methodologies in that they address problems at a higher level of abstraction. Many design decisions that cannot be recorded through the uses of the primitives of a method can be described using patterns.

We next present a set of simple design patterns that address usual concerns in Educational Applications; though it is not our objective in this paper to show how they interact with each other, it will be clear from each example that they can be used together in a synergistic way.

2. Navigating through information

The patterns presented in this section, face common problems in the organization and access to the information. There is an underlying idea connecting the patterns presented here that stressed the importance of a clean separation between interface and. Some methodologies such as OOHDM [Schwabe96] propose an architectural model that follows this principle. Similar separations can be found in other methodologies such as RMM [Isakowitz95] and HDM [Garzotto93].

We next present some patterns discovered and used in the context of developing educational multimedia applications. We describe them using a single template describing the problem that originates the patterns, the motivation, the solution and an example in the context of Educational Multimedia Systems (EMS). This template allows expressing solutions in a "methodology-independent" way and so they can be used with different Hypermedia design methods, such as OOHDM, RMM or W3DT [Bichler97]. For each pattern we add a short comment explaining why it is relevant to EMS.

2.1 Navigational Context

Problem: How to organize the EMS navigational structure, providing guidelines, information and relationships that depend on the current state of navigation, in such a way that information can be better presented and comprehended?

Motivation: EIS usually involve dealing with collections (e.g. Concepts, Paintings, Cities, Persons, etc) These Collections may be explored in different ways, according to the task the user is performing. For example, we may want to explore Books of an author, Books on a certain period of time or literary movement, etc., and it is desirable to give the user different kinds of feed-back in different contexts, while allowing him to move easily from node to node.

Suppose for example that in an EMS about inventors and inventions, we reach Thomas A. Edison and then we arrive to the Light Bulb invention. However, we can also reach the Light Bulb while exploring inventions during a specific period of time, following a history of the most famous inventions, or while visiting another invention such as the "Fluorescent Light" and we follow the link to related inventions. It is clear that we will explore the same object under three different perspectives: as a Thomas A. Edison's invention, as an invention of the past century, and as an invention related to others such as the Fluorescent Lamp.

Solution: Decouple the navigational Objects from the context in which they are to be explored, and define objects' peculiarities as Decorators [Gamma95], that enrich the navigational interface when the object is visited in that context. Navigational contexts are composed of a set of Nodes (like Books or Inventions) and Context Links (links that connect objects in a context).

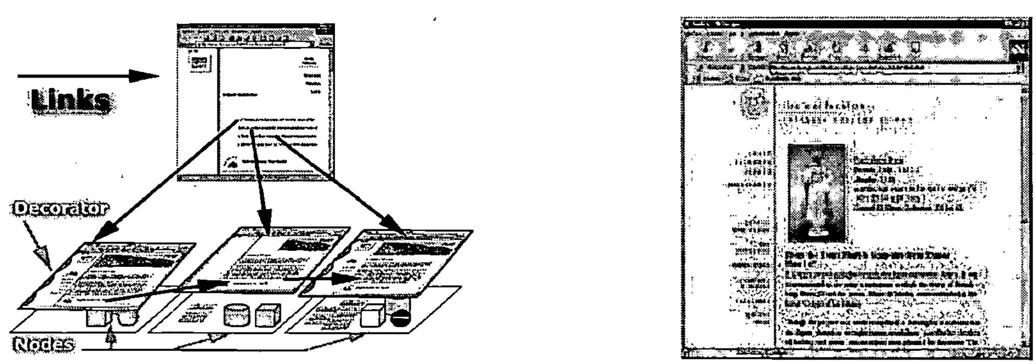

Figure **Error! Unknown switch argument.** :Diagram of "Navigational Context" pattern and a working example

Relevance to EMS: It is usual in EMS that the same concept may be reached from different "learning paths"; in each one of them we want to help the learner to explore other related concepts conforming with the actual context. The navigational context navigation pattern helps to group nodes in meaningful sets that can be easily explored. It also address the problem that arises when the same node belongs to more than a set by indicating that in each case the node must be decorated according to the context.

2.2 Information Factoring

Problem: How can we present information needed by the reader to understand a given topic/Information unit?

Motivation: This problem is of a particular interest in EMS. Many times, for example when introducing a new topic, it is necessary to refer to related concepts. The author has the possibility of adding links to the nodes of the referred concepts. But, if the reader is forced to navigate back and forth the original topic to read about complementary ones, the navigation overhead is high and the users' focus desagregated through a number of nodes, instead of concentrating in one topic at time. Thus the effectiveness of having links with related information is reduced by the distraction penalty it imposes over the reader.

Solution: This problem has been devised in hypertext systems from the early days. The usual technique is to activate those nodes of related information inside the current node. The user sees this "in-place activation" as a pop-up window that generally can be easily dismissed with an escape keystroke. In this way, the reader does not have to navigate to other nodes avoiding the inherent context switch and cognitive overhead.

Known Uses: In the "The Way Things Works", complementary concepts are shown in this way in figure 3, where the concept of "energy" is mentioned in both topics, and a reference to a node containing its definition is given. Notice that the definition of energy is not a part of the topics but rather an independent node that is activated as a pop-up window. Also, the MS-Windows Help System [Win95], provides different ways of specifying anchors, depending whether the result of activating the anchor is navigation or in-place activation of the target node (these are called: jump-anchors and popup-anchors).

Related Pattern: Information on demand [Rossi 97], since additional information enriches the contents by activating other nodes in pop-up windows. The difference with Information On Demand relies in that information is not part of the current node, that is, it is not part of the node's attributes and might be accessed from other ways, not only from the current node. The user activates simultaneously other nodes of information.

Relevance to EMS: This pattern address a common concern in EMS; how to provide background information to the reader without distracting his attention.

Figure **Error! Unknown switch argument.** :An Example of "Information Factoring" from the "The Way Things Work" CD.

3. Organization of the interface

3.1 Information-Interaction Decoupling

Problem: How do you differentiate contents and various types of controls in the interface?

Motivation: A page of a complex application display different contents, and is related to many other pages, thus providing many anchors. Moreover, if the page supplies means of control activation other than navigation (such as triggering some query), the user may experience cognitive overhead. It is well known that when too many anchors are provided in a text, the reader is distracted and cannot take profit of all of them.

Solution: Separate the input communication channels from the output channels, by grouping both sets separately. Allow the "input interaction group" to remain fixed while "the output group" reacts dynamically to the control activation. Within the output group, it is also convenient to differentiate the "substantive information" (i.e. content) from the "status information". This solution not only improves the perception of a node's interface, but also the efficiency of the implementation.

Example: in figure 3, all links to related information on the current topic are displayed on the left. The graphics/video relevant to the current topic is displayed in the middle. Notice there are no links in the text itself.

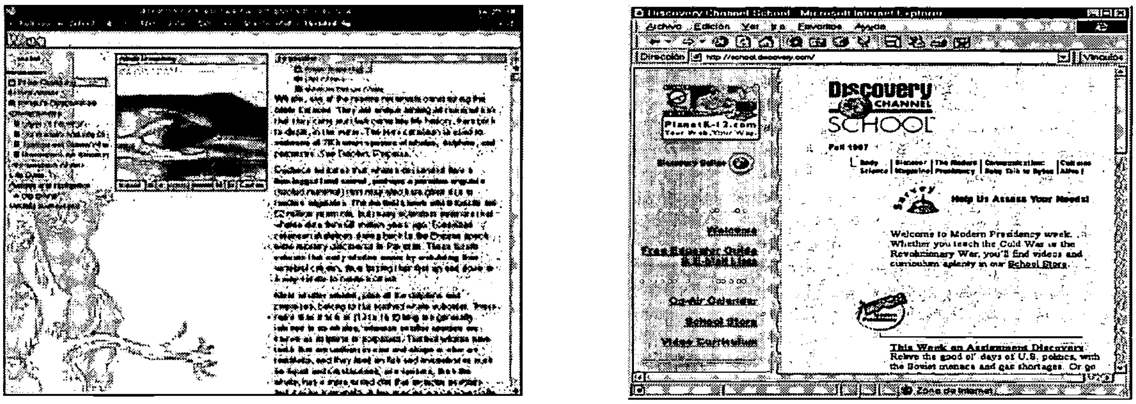

Figure **Error! Unknown switch argument.**:Two examples of "Information-Interaction Decoupling" from the MS-Encarta97 CD-ROM and the Discovery Channel's educational web page (http://school.discovery.com/)

3.2 Behavioral Grouping

Problem: How to recognize the different types of controls in the interface so that the user can easily understand them?

Motivation: A problem we usually face when building the interface of a EIS is how to organize control Objects (such as anchors, buttons, etc.) to produce a meaningful interface. In a typical EIS there are different kinds of active interface objects: those that provide "general" navigation, such as "back" button, or anchors for returning to indexes, objects that provide navigation inside a context; objects that control the interface, etc. Even when applying Information-Interaction decoupling, there may be a lot of different kinds of control objects.

Solution: Group control interface objects according to their functionality in global, contextual, structural and application objects, and make each group to enhance comprehension.

Example: in figure 4, the first picture is taken from MindQ's CD-Rom "An introduction to Java Applets" groups the navigation controls at the left and the current topic playing controls at the bottom.

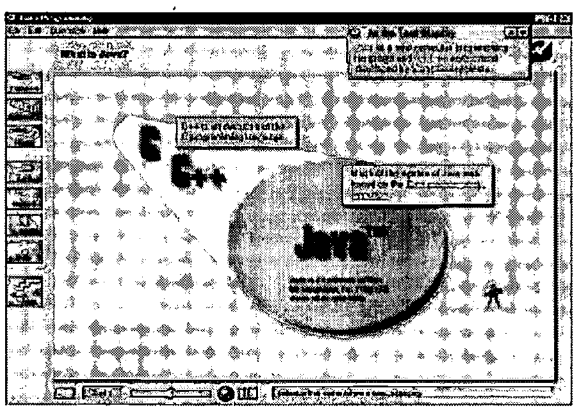

Figure **Error! Unknown switch argument.**: An example of "Behavioural Grouping" from the MindQ's CD-ROM "An introduction to Java Applets".

3.3 Behaviour Anticipation

Problem: How do you tell the user the effect or consequence of activating an interface object?

Motivation: Many times, when building an interface, it is necessary to combine different interface elements such as buttons, hotwords, media controls or even custom-designed controls. It is usual to find readers wondering what has happened after activating a control, and the exact consequence of the action performed.

Solution: Provide feedback about the effect of activating each interface element. Choose the kind of feedback to be non-ambiguous and complete: different cursor shapes, highlighting, small text-based explanations called "tool tips". Also, these elements can be combined with sound and animations. If we are using the behavioural Grouping interface pattern we can select different kinds of feed-back according the kind of behaviour provided; when the interface controls refer to a particular media such as animation, we could use a small status field for that family.

Example: In figure 5, there is an example from the Microsoft Atlas Encarta97. Each time the user positions the cursor over an interface element, a tool tip pops up with an explanation about the effect of activating the control.

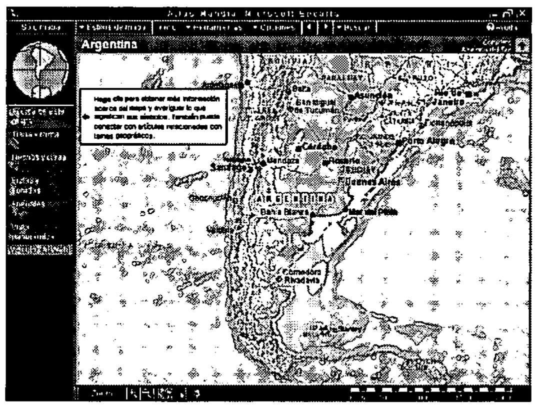

Figure **Error! Unknown switch argument.**: Example of "Behaviour Anticipation".

3.4 Process Feed-Back

Problem: How do we keep the user informed about the status of the interaction in such a way the he knows what to expect?

Motivation: When the user interacts with a hypermedia application, it may happen that many options result in non-atomic operations, such as getting information from the database, loading an image, or contacting another machine (in the case of the web browsers). In these cases, the user may feel the system didn't receive the order or simple is not working fine. As the user looses his patience without any positive feedback from the system but a silent screen, he may start retrying the last action or even any other action no matter whether it is connected or not with the sole target of getting some response. At this point, the user may have already lost the orientation and the task to be performed has been left in a second place.

Solution: Provide a constant perceivable feedback about the status of the operation that is being carried out, indicating progress in the case of non-atomic operations. Analyze which operations are atomic and do not need to be tracked. For non-atomic operations, give information about the current status: beginning, progression and ending of the operation. The kind of feedback depends on what kind of operation is involved: network connection, file loading or database search.

Related Patterns: Both process-feedback and behaviour anticipation address a similar problem: giving prompt feedback to the user about the actions he is performing.

Known Uses: In Web Browsers like Netscape Navigator and MS-Explorer, process feedback is given through a status bar showing the state of the http connection. On many CDs, the feedback given to the user is to set the cursor to the OS busy-hourglass. However, there are others that explicitly implements such feed to the user, as the example shown below.

Example: In figure 6, we can see an example of "Process Feedback", from the "Programming Java Applets" CD. The slider bar tells the user about the amount of information that remains for a given topic, and the rolling knob tells that animation is taking place.

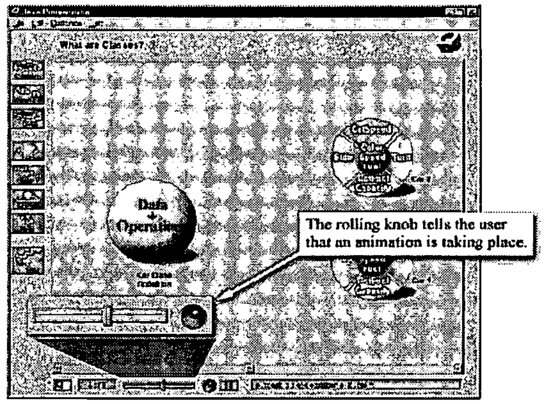

Figure **Error! Unknown switch argument.** :A "Process Feedback" example from Mind Q's CD-ROM "

4. Conclusion

The process of designing and building educational hypermedia applications is far from being a simple task. There are several methodologies that already provide the necessary constructs and support for the different design tasks, though none the means to record the author experience and knowledge in the field.

We claim that through the use of patterns, authors are now able to identify common design problems and express solutions in a methodology-independent manner. Furthermore, now authors can talk about their designs with a common language and learn which were the ideas behind successful educational hypermedia systems.

In this paper we have presented some patterns we have found in different educational hypermedia systems on CD-ROMs and WWW. These patterns address important concerns in EMS and they can be used together to build complex but effective systems. Our aim is to define a pattern system containing a rich set of patterns dealing with most relevant issues in EMS.

It is our hope that, once a rich set of patterns is available, authors will be able to learn and work on multimedia systems at a higher levels of abstraction and with better results, since their work will be based on proven successful techniques.

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Communications Technology and Video Production: An Evolutionary Study of Their Effects On a Distance Learning Program

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Abstract: The purpose of this paper is to examine how the use of video has inspired and altered the implementation of teaching and learning in the delivery of a master's program offered in a distance learning format. In the process of this examination, technical issues concerning video production techniques, distribution, and utilization are also analyzed.

Introduction:

The Educational Technology Leadership program is a master's degree curriculum, which has been delivered entirely at a distance since 1989. Although the program was designed with distance education in mind, it has evolved substantially in form, substance, and philosophy since its inception. Challenged to utilize current distance learning delivery methods for academic and market reasons, options were continually evaluated in terms of accessibility, affordability, and curricular effectiveness. It appeared to be true, however, that as the technological applications evolved to accommodate market conditions, programmatic shifts also occurred. The current project explored the possibility that technical decisions, seemingly unrelated to curricular decision making, were, in fact, directly related to curricular changes.

Background of the Problem:

The Educational Technology Leadership program is aimed at adult students seeking career advancement or reorientation in the area of educational technologies for a wide array of professional settings. An examination of the student profiles reveals that they each bring a relatively unique set of backgrounds and expectations to the educational environment. The richness of this diversity is desirable, but it can also generate conflicting visions for the educational experience itself. It can also generate conflicting valuing for the instructional approach. Some students desire a straight forward 'give it to me and I'll learn it approach' while others want validation through extensive feedback, while still others enjoy the discovery oriented problem solving approach. One of the challenges confronting the program, therefore, is to provide an educational experience which meets a variety of learning styles and preferences, but does so in a way that is fundamentally oriented to a basic philosophy and theory of learning.

The ETL program basically pursues a constructivist approach to learning, utilizing a wide array of techniques to deliver the basic information and intellectual tools that can be used in building new understandings and meaning. Despite some general evidence to the contrary, the experience of the ETL staff is that the techniques of instruction do make a difference in how well this occurs. Over the years, improvements in the technical delivery of the program have led to improvements in learning. In other words, the conception and use of a particular technological form (e.g. video) can change the nature of the information that is delivered and the manner in which information is perceived and valued. Content is not all that matters, the style of instruction is also important.

During the history of the ETL program the role of educational video has changed progressively. In the early years, video was supplementary to computer use in the program, but as the technology, student audience, and style of instruction changed so did the role of video. As the role of video changed, the concept of learning became more flexible. In the ETL program's present configuration, computer based video in the form of web based streaming video, digitized audio/video files, real time video conferencing, streaming animations and traditional video tape are each utilized in unique ways that shape as well as deliver the program content.

The ETL program was originally designed using multiple media for delivery. The basic media elements have always included video with audio (for demonstrations, interviews, illustrations), the bbs / Internet / web (for interaction), and print materials (for basic information and original source material). The ETL program staff has consistently viewed these media as different channels of information operating at different levels of effectiveness for variety of learners. The simplicity of the model and its appropriateness has been repeatedly challenged by several factors over time: 1) the student population's skills and needs changed, 2) the available communications technology changed, and 3) an interest in a more streamlined efficient method of course production emerged. It is the position of this paper that changes in the instructional methodology of the ETL program can be directly understood as a function of the changes in students needs, available technology, and desired efficiency. This reality alone would not be significant were it not for the additional contention that by changing the technology to adapt to changing needs and possibilities, the program consistently reinvented itself in a systematic fashion. The following research question was pursued to determine if, in fact, the technology did have a substantive impact on the conceptual development of the program from an instructional perspective.

The Question

Does technology used to deliver education at a distance affect the conceptual development of instruction for academic programs?

Methods

Although many technologies are utilized in the delivery and support of distance learning and the ETL program specifically, none was more pervasive or more strongly associated with this program that the various video technologies that have been implemented. For the purposes of this study, therefore, a study of the role of video was selected to determine what effects were present in the orientation of the students to the program materials

The form and use of video in the ETL program was determined by analyzing video products utilized over the past eight years. This preliminary analysis resulted in four categories:

1) the technology used to deliver video resources,
2) the style of video production for each technological form,
3) the type of content delivered, and
4) curricular outcomes of each video form.

In each of these categories data was collected from the eight years of the program's history. Instructors were interviewed and shown the outcome of the video analysis to validate the categories and conclusions drawn. In such cases, where there was disagreement by more than one subject, the conclusion was either withdrawn or corrected. Only instructors who had taught in the ETL program for more than 3 years were included in these interviews. As a result of the preliminary analysis, four categories emerged for comparison and presentation purposes. These categories and the results are described in the next section "Conceptions of Teaching with Video.

Conceptions of Teaching with Video

For comparison purposes, characteristics of each of four historical phases of the program are summarized in four parts. Part one, "Students, Organization and Technology," summarizes the general state of the program. Part two, "Video Concept," describes the basic ideas guiding the use of video and its intended effects. Part three, "Production Techniques," concerns the approaches taken to create video products consistent with the "video concept" and the general program parameters. Part four, "Outcomes," reports the effects that specific approaches to video use had on students.

Phase I

Students, Organization and Technology

Starting in 1989, the ETL program was marketed exclusively to suburban Washington, DC. An ITFS transmitting system was used to send a line of sight signal to two large county school systems. The school systems in turn redistributed the signal on the education channel of their respective cable systems. The idea was to provide in-school and in-home access to educational programming for teachers from The George Washington University. This was the first National Capital area delivery of graduate education into student's homes where it could viewed live and/or recorded it for later use. Transmission of the live classes lasted for two hours and included two-way audio connections for up to twenty-five phone callers. For the first year of the program students could opt to take the courses on-campus in the production studios.

Video Concept

The use of video in this initial context was conceived as the primary instructional vehicle. The basic content of classes was instructor led lecture, group exercises, and special content guest presenters. The instructors were responsible for the development of material and organization of classes. Video was viewed a powerful and almost exclusive replacement for the traditional class meeting, although the ETL program staff made a persistent effort to recognize telecast video as only one part of a three part system. In additional to telecast video, the ETL program also used a computer based electronic bulletin board system, and a printed materials sent by mail.

Production Techniques

Whiteboard graphics, props and printed materials, an overhead camera, and a three-camera production crew supported live production video. Computer generated text slides were integrated into the instruction through the use of video switcher and a scan converter. Instructors typically pre-planned the production with the director a week or even a few days ahead, arrived fifteen minutes before airtime, received make-up and a microphone. A director managed camera switching, while instructors taught to both the studio class and those at a distance simultaneously.

Outcomes

Skills developed by instructors included keeping the distance students feeling part of the class through realistic question and answer management. Live broadcasts with telephone call-ins provided opportunity for student interaction, personal attention, and fun. The camera movements, however, distracted students in the studio, and accommodations to the distance students; while distance students sometimes felt excluded when instructors spoke exclusively to the studio students. In addition, less than 10% of the distance students actually spoke during the live interaction (about the same for the studio students), the value of the totally live format was brought into question.

Phase II

Students, Organization and Technology

In 1992 international satellite and cable distribution of the video began in cooperation with Mind Extension University (now Jones Education Network: College Connection). The two-hour video format was retained, but live productions with real-time audio (telephone call-in) interaction were reduced to four per semester. The numbers of students enrolled increased dramatically; the audience was broadened to include educators other than schoolteachers. The on-campus studio audience was eliminated and the program became dedicated to distance education delivery.

Video Concept

The use of video in this second context was conceived as context setting, intellectually and emotionally motivational, and informational. Stylistically, the video followed either a news talk show format or a technology variety approach. Production standards were increased significantly including a professionally designed set and props.

Production Techniques

Production was accomplished through a team development model including television production staff, content experts (course instructor), and the program director. Production techniques were elaborated including the addition of pre-produced video segments including field shoots, text and graphic slides with some animations, software and hardware demonstrations, interviews, live games and simulations. Emphasis was placed on good lighting, lighting effects, frequent scene changes, semi-scripted events, three camera selection of shots including pans, zooms, and moving camera work. The primary goal was to achieve high quality instruction, but contextual motivations such as the training and values of the television staff, the standards of the distribution company, and the program staff's interest in appearing more professional, led to an upward scaling of production values to approach commercial quality production outcomes.

Outcomes

High quality video productions had a strong appeal to those looking for video quality and added prestige to the program overall. Some students, however, complained that the high production value made the instructors feel more distant and less real. In addition, the production rigor, however, caused instructors to experience time / work overload and video productions became more expensive. Coordination of efforts consumed too much time and energy. The two hour production time frame was tyrannical often leading to production segments that were included simply because "five more minutes' were needed. Production staff had greater control over the instructional product than the instructional staff during this time and small problems became big ones working against production deadlines. The project had begun to place too much emphasis on the quality of the production, following television production principles; rather than an emphasis on instruction, following instructional design principles. A more streamlined approach was needed.

Phase III

Students, Organization and Technology

In 1995 several changes were introduced to streamline production and improve the efficiency of information delivery. Live video was eliminated based on low usage, expense, and limited interactivity on the part of the students and the instructors. Consequently, prime time televised delivery was reduced and telecasts were moved to marginal viewing hours. In addition, video production was reduced to one hour segments. Since most students were either purchasing videotapes or recording off-air for delayed viewing, this did not have a serious impact on enrollments or student satisfaction. Audio interactivity was transformed into a greater emphasis on email interaction and asynchronous conferencing. Perhaps most dramatic was the shift to the World Wide Web and web pages as the primary focal point for course delivery, thus altering the significance, if not the role, of video.

Video Concept

Video was now conceived as a specialized information source. As more emphasis was placed on the development and utilization of the web as an analog for the classroom, video was re-conceptualized as a data source rather than a communications channel.

Production Techniques

Reducing two hours video "shows" to a one hour format forced a new strategy for production. One principle was to compress presentations to a more efficient communications format. An interview that would have formally taken twenty to thirty minutes would now be produced in a 10-15 minute segment. Chattiness and congeniality would be replaced by efficiency and focus. Demonstrations would be pre-produced, and often edited, segments were designed to show the highlights of software and hardware performance without the usual wait time of live productions. This strategy helped in circumstances where the instructor was not very interested in or suitable for TV teaching. In addition, classic materials such as interviews with policy makers, futurists, and educational philosophers were reedited from previous courses for reuse. In some cases, videos were produced as supplementary materials to pages and topics on the course web pages.

Outcomes

Placing less emphasis on the video as classroom analog created a subtle shift away from student identification with instructors and a sense of place which video tended to create, even if it was only in two dimensions. On the other hand, focus on the web site created a better integrated instructional experience where students moved seamlessly from one information source to another including interaction. The exception to the seamless transitions was tape-based videos. For example, when developing the web site, instructors tend to think less about the necessity and value of the video relying instead on the primacy of the web site and the greater flexibility for materials production that the web provides. Some students seem to think all the information should be in either the video or the website, but not in a combination of the two.

Phase IV

Students, Organization and Technology

Seeking to achieve the goal of seamless information channels on the web, experiments with digitized audio and video were executed using very brief segments (2-5 minutes). Content was drawn from previous classes plus new material acquired via digital tools. Team development involving multimedia and web developers provided an well-integrated design, but even small file sizes created wait times beyond acceptable levels. While some downloadable files continue to be used for specialized purposes, streaming audio and video has been pursued actively. These audio and video resources can not only be integrated seamlessly into the web based course design, but they provide access to virtually unlimited amounts of instructional and informational audio/video resources in either a pre-recorded or live format through a link on the website.

Video Concept

Video is now conceived as an information destination, a place, among other places, where students can go to experience multi-sensory learning synchronously or asynchronously. The role of video as a destination, a place, has begun to transform the analog of website as classroom to website as learning community. Perhaps this is a subtle distinction, but one which is highly significant, because in a learning community people meet other people in information rich environments, they interact with one another and with the information itself.

Production Techniques

Digital video should produced with reasonably high production values emphasizing lighting and sound quality. Traditional television production techniques often have negative results. Fast pans, zooms, special effects and other techniques which change the screen information quickly; work against sending a high quality signal over the web. Camera work should be simple and oriented to delivering important information through both audio and video. Temptations to pursue the fun, but frivolous should be discouraged. Also, since the digitization and compression processes lose information by their very nature, it is best to start with a high grade of video source material. Typically, this means utilizing Beta format videotape or at least Hi-8. At present, the size of the playback area of a computer screen is typically small. Wide shots reveal very little detail, so close-ups or medium close shots work best. Emphasis should be on video production that conveys important information; even a single headshot can convey authority and credibility if it is the right head. Poor quality video, which doesn't transmit well, actually reduces the information that students can obtain, by distracting their attention from the audio channel. Even more important than the technical camera issues is the goal of producing video that really matters. The concept of video as information destination, as opposed to information vehicle, frees the producer to create video of any appropriate length necessary to communicate the desired information. Couple this with the ability to index and contextualize the video and the educational experience is moved from a teacher-scripted experience to a student centered one.

Outcomes

While this is the most recent of the historical phases for the use of video in the ETL program, it is without question the most exciting. The current use of digital streaming video and audio, coupled with real-time video conferencing, animations and more traditional video tapes has created a well-spring of creativity on the part of instructors and students alike. For the first time students are not only engaging learning opportunities in an authentic collaborative style, they are engaging the materials in the style of researchers. Students are no longer simply consumers of knowledge, they are producers. Instructors are no longer simply providers of knowledge, they are validators. The distinction between students and instructors is blurring as they engage one another in learning communities. The shift to the idea of learning communities is just beginning; it is expensive in terms of support, and it is imperfect, but it is growing idea. To date, the biggest problem is providing everyone in the program access to the learning community. Those students with the fastest computers and fastest Internet connections encounter a system which works well, those with less able systems and connections are frustrated by erratic performance and information transfer loss. Since this was and continues to be a predictable characteristic of our current technological reality, the ETL program continues to support more traditional video sources such as tape. The program's leading edge technologies are currently "added value."

Conclusion

Studying the development of video resources and their implementation in the ETL program has provided a useful focal point to begin understanding the dynamics of program evolution. As a result of the study, it is clear that the format of the video, the delivery system, and the production techniques were altered by the dynamic needs of the students and the program designers; but in turn, these changes brought about conceptual changes in the instructional methods and goals of the program.

Whether this kind of dynamic affects other programs is unknown, as is the question as to whether other technologies had similar effects in the ETL program. What is valuable to understand is that communications tools do have the power to redefine our intentions and our behavior through their actual use. Even the most careful plans are likely to give rise to the creation of meaning and behavior well beyond the original intentions of their designers.

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Web-Based Testing: A Form-Based Template for Creating Multimedia Enhanced Tests

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Abstract: Acadia University has completed year two of the Acadia Advantage initiative which involved 1500 students and 170 Acadia faculty using IBM notebook computers in the curriculum. By year 2000 all 4000 students at Acadia University will have notebook computers and will be taking part in technology-enhanced courses. To assist faculty, Acadia University developed a modular Automated Courseware Management Environment (ACME) which allows an instructor to easily create online courseware. The Online Testing Module (OTM) is one of the most successful modules, allowing faculty to prepare web-based tests that include multiple choice, short answer, and essay questions that incorporate formatted text, images, video, and audio. The module is template based and users create tests that can be randomized, graded, and results posted both to the students and instructor. Little or no computer experience is required to create a test. At Acadia University the package has proven so successful that we routinely have 1000 plus online tests taken and marked daily. Students using the testing package for tutorial assessment have responded very favorably to the ease of access, and the ability to monitor their own progress.

Introduction

There are many programs available for creating computer based testing, many of which allow users to create tests that can be placed on the web. The complexity of the tests is usually proportional to the complexity of the program used to create the test; simple multiple choice questions are easy to create using any number of programs. More complex tests using various forms of multimedia (images, sounds, and video), and short answer or essay questions, usually require expensive and difficult to master software packages. Adding the functionality of randomization, access control, and the ability to edit on-the-fly can add enough complexity to a package that it often requires the efforts of Instructional Designers to create the test or to work closely with the instructor requiring the test.

The AITT (Acadia Institute for Teaching and Technology) undertook the development of ACME (Automated Courseware Management Environment) in the summer of 1996. At the onset of development, instructors at Acadia University were clear about the requirements of a web-based testing and tutorial component. Allowing students to access databanks of tests for self-evaluation, and allowing instructors to view the results of these self-evaluation tests was critical. The Online Testing Module (OTM) in ACME solved this problem for the instructors by allowing them to easily create online tests that satisfied their immediate requirements. Every component of the functionality of ACME is available through any Internet connection, allowing instructors to prepare their courses from anywhere in the world.

Online Testing Module

OTM was designed as an enhancement to regular classroom courses, and not as a complete computer based training solution. At the onset of development the hardware and software of all users of the system was known, however a web browser is the only base requirement by both the instructor and student depending upon the type of multimedia used in the tests. Ongoing development is occurring due to constant feedback from the instructors using the system.

In the past, an instructor's first indication that a student was struggling in their course may have occurred only after the first midterm. Weekly tutorials and tests in OTM are providing instructors with the information they require to determine how well students are grasping the course information, and to allow early intervention when required.

In order to make use of web-based tests and tutorials instructors were insistent that OTM must allow them to create tests that went far beyond simple multiple choice questions, allowed the use of multimedia, were easy to create, and could provide instant feedback to the students. The online testing module, has been working for 4 semesters, and currently has hundreds of tests in the system. On October 15th, 1997, the Online Testing Module of ACME delivered, and marked 1309 individual tests in a 24 hour period.

Access Control and Security

Access to the ACME system is restricted to instructors and registered students by the use of usernames and passwords. Each individual with access to ACME has a profile on the system that indicates the courses they can edit as an instructor, or those that they can participate in if they are a student or guest. The administrator creates instructor profiles that link the individual with their course, and provide editing rights to that course. Student profiles are generated automatically from the university registrars' database. Guest profiles can also be created to allow individuals outside of the university to participate in a course. The instructor can also restrict access to individual test folders within a course.

Taking a Test

A student wishing to take a test simply authenticates into the ACME system, selects a course from their profile and goes into the OTM module by clicking the "TEST" button at the bottom of the course page (see figure 1).

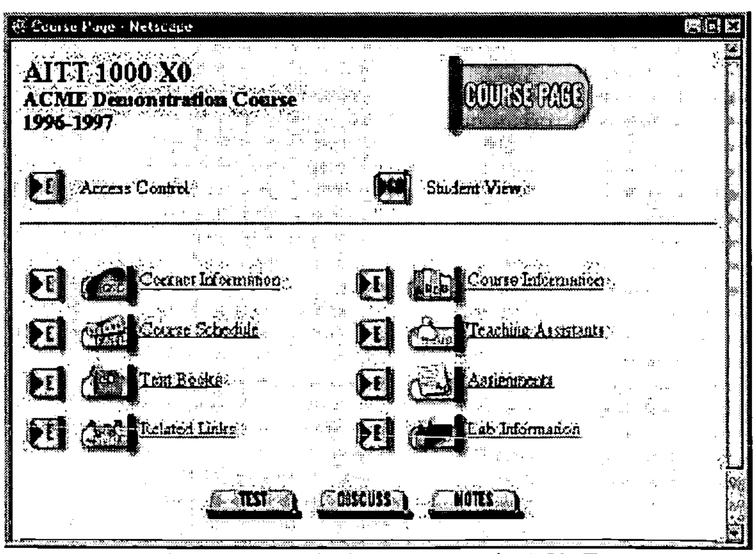

Figure 1: A typical course page in ACME.

From a student's perspective the OTM module has only one choice; select and take a test. The test presented to the student can be a combination of Short Answer, Multiple Choice and Long Answer questions (figure 2). After completing and submitting a test, students may be provided with instant feedback (if the instructor has enabled that option), with their grade and the answers to each question. The program grades multiple choice, true or false, and short answer questions. Long answer or essay questions are stored in a special marking folder to be graded later by the instructor.

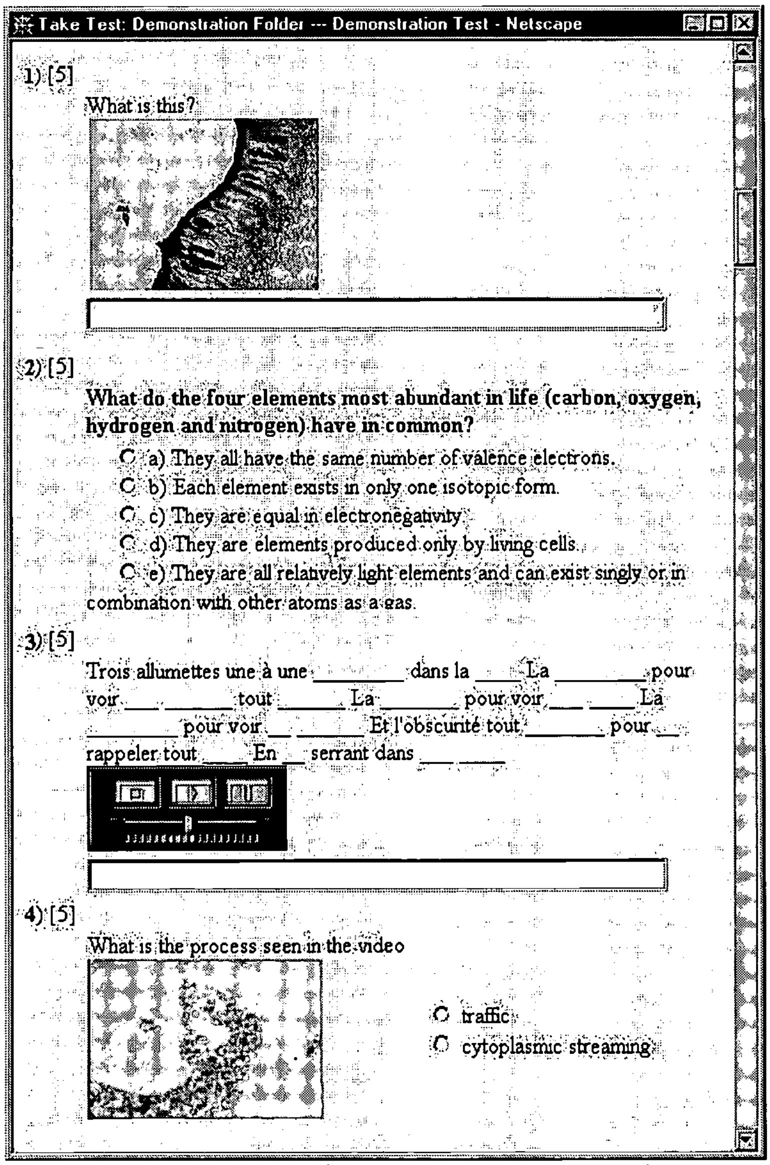

Figure 2: A student view of a test in OTM showing questions that include images, formatted text, audio and video.

Creating and Editing a Test

Instructors must first create a folder, then put a test in that folder. Any number of folders and tests can be created. After creating a test, content must be added. The user-interface for creating and editing tests is shown in figure 3.

After creating a test, the basic test information can be changed. The name of the test, a time limit for the test, whether the answers are provided to the students when they complete the test, and whether the test can be retaken are all in the control of the instructor. As a student could take a test from any location, passwords can be assigned to those tests that the instructor wants to give in-class. The student must then be in class to hear the password.

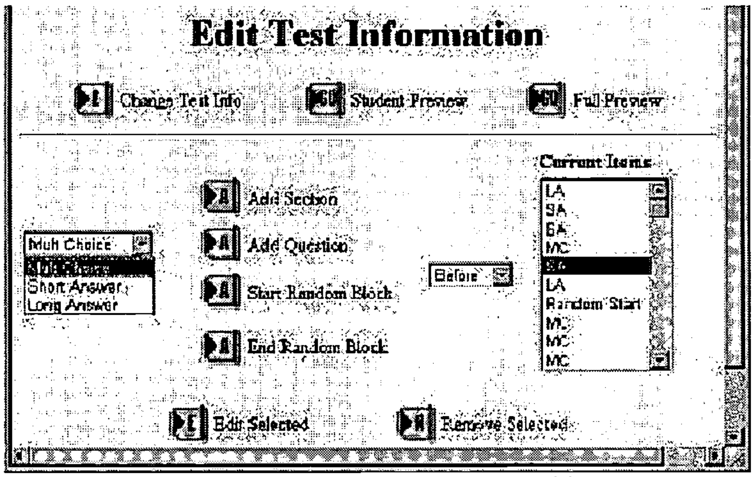

Figure 3: user-interface for creating and editing tests.

A current items window (figure 3) shows the number and type of questions in a test. Each type of question is shown by an abbreviation; MC, SA and LA representing Multiple Choice, Short Answer and Long Answer respectively. This window is empty if no questions have been added to the test. Individual questions can be edited or removed after selecting them in the Current Item window.

The number and type of questions added to the test determines the layout of a test. Section or title headings can be added anywhere throughout the test, and questions can be put inside random blocks. A random block allows a small number of questions to be randomly selected from a larger test bank when a test is chosen. Any number of random blocks can be added to a test, allowing for maximum test customization.

A full preview of all the questions in a test is available to the instructor, with the option to edit a question directly from that full preview. A student preview is provided also which differs from the full preview in that there is no option to edit each question. Also if the questions are randomized, the randomization will appear in the student preview.

Short answer, Multiple Choice and Long Answer Questions

Instructors create questions by completing a template (figure 4) for each question type, and can add a question anywhere within a pre-existing test.

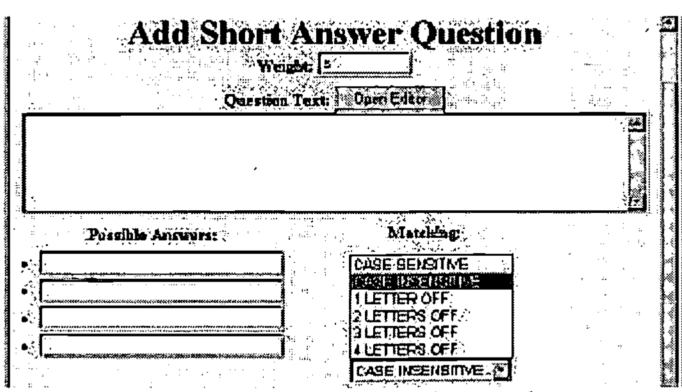

Figure 4: Short Answer question template.

The value of the question can be selected and the text of the question typed into the "Question Text" window. Short answer questions allow up to four possible answers. There is also an option to allow the answers to be case sensitive or case insensitive, or to have a variation in spelling. The selections of the possible answers and the case sensitivity determine how the ACME system will grade the question. Multiple choice and long answer questions are created in a similar manner, with the option of providing one or more correct answers in the multiple choice, and a comment to the student depending upon the answer they choose.

Formatting a Test

To add formatted text, images or other forms of multimedia such as sound and video to a test, an instructor clicks on an "Open Editor" button to open the AcmeScript editor. This semi-WYSIWYG editor was created to aid instructors in the formatting of their tests. The editor was written in JavaScript to be executed by the client. All forms of media, other than plain or formatted text, are located on a different web server to the one on which OTM resides. Links are made to these other media formats using the editor. Any media or file-type that can be supported by a browser plug-in will appear in-line in the test, other files will launch a helper application.

Test Management and Statistics

Instructors can view test statistics that are generated each time a student takes a test. The statistics include the number of times each student has taken a test, which students in a class have not taken a test (useful for large classes), and also statistics on each question. For multiple choice questions the statistics include the number of times the question was taken and how many times a student selected each answer. Short answer questions also include the number of times the question was answered, and the top five answers provided by students. This allows the instructor to quickly determine problem areas that the students may be having, or highlight poorly worded questions.

Tests are managed using the test management window (figure 5). The order of the tests and test folders can be changed by selecting the "ORDER" button, selecting a test by clicking on the radio button beside the test name, and then choosing to move the test up, down, to the top or bottom. Tests created in one course can easily be copied or exported to another course, at which time test information can be edited, and questions added or deleted.

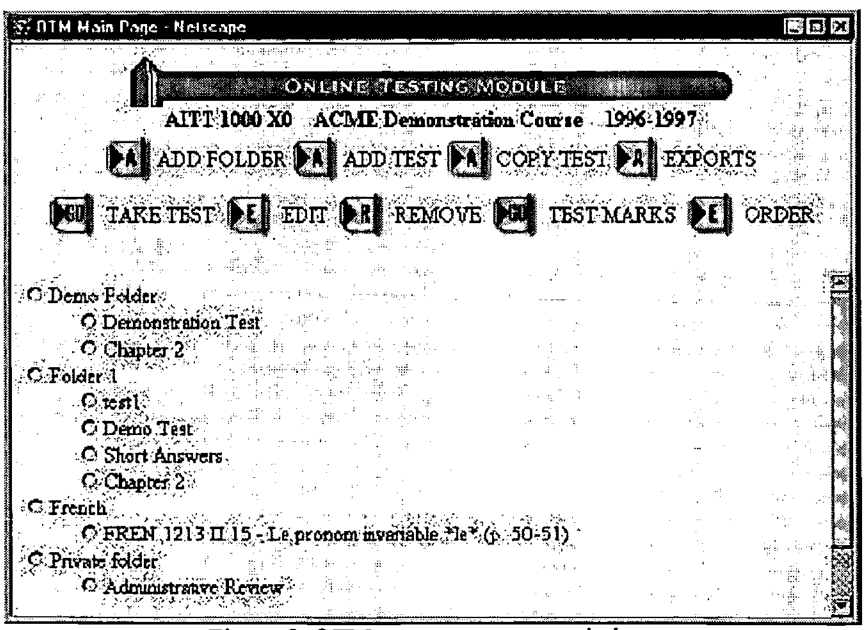

Figure 5: OTM test management window.

Programming

Combining all of the features of OTM with a transaction-based World Wide Web (WWW) interface and an operating system-independent storage and execution mechanism has proven to be a less than trivial task.

The languages used for development of OTM, were PERL 5, HTML 3.2, and JavaScript 1.1. As PERL is implemented on the vast majority of operating systems, it makes a very suitable environment for implementing the required programs and libraries on the server side of the OTM system. Currently, ACME and OTM are running on Solaris 2.5.1, Solaris 2.6, SCO OpenServer 5, and Linux 2.x. We are also now working on a Windows NT, and a Windows 95 port.

JavaScript was chosen as the language for writing additional client-side functionality because it is the native language for programming Netscape Navigator. Netscape is currently the most popular WWW browser in use, and is available for the majority of operating systems, thus increasing the platform independence of the client. To provide even further client independence, we are making an effort to ensure all our client code is compatible with the ECMAScript specification.

To further increase portability, all files are stored as plain text. Initially attempts to use database formats such as dbm/gdbm or SQL databases were made, but each format was problematic. The dbm databases are not entirely independent of the operating system. When an operating system upgrade is performed, or when ACME data is moved from one operating system to another, dbm style databases tend to break, due to different versions of dbm libraries used. SQL databases were rejected because many organizations wishing to use ACME may not have somebody trained in the administration and use of such databases. However, all file access in OTM is done using a small file access library to allow it to use a database with minimal effort, and will eventually be an option in the configuration of ACME.

The tests themselves are stored using a rather simple mechanism. Each course has its own directory in OTM. Inside each course are directories representing each test folder created by the instructor. Inside each folder are files containing the information for each test and the results of students writing each test.

The automatic test generation and the automated marking are the most complex functions of OTM. The advanced testing features permitted by OTM, such as randomization, fuzzy matching, passwords, and time limits, add to this complexity. To handle these problems efficiently, lookup tables and small separate files rather than one large file have been used to reduce search times, and the processing times of critical sections.

Separating Structure and Content: Authoring Educational WEB Applications

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Abstract: This paper describes a WWW server of a special architecture which clearly separates content and structure of educational materials. The server is based on so-called cluster concept. Clusters comprise a particular layout definition and a number of media objects (texts, still images, animations, etc.). A particular cluster is presented in a form predefined by its layout. There also exist a concept of cluster types which is essentially a definition of presentational aspects without any information content. The paper describes also a template-based authoring tool developed to support the approach.

1. Introduction

It is well recognised that authoring hypermedia documents is a very tedious and time consuming task. In this respect, we should clearly distinguish between a so-called "home page competition" where people implement a few fancy pages, and educational www sites containing hundreds of pages currently , and thousands in nearest future. There exist some specific features of educational WWW sites, which can be generically defined as a necessity to put reader's ability to construct a coherent mental representation of the information on the first place, even if some most fancy features of up-to-date hypermedia system are not used.

This situation was reflected in a number of www authoring guidelines which often recommend to use predefined layouts, one and the same heading styles, uniform notation for highlighted words and references, present still images and other media using an uniform techniques, etc.

Surprisingly, all the recommendations mentioned above are an inherent feature of so-called database systems. It results from a well-known meta-structuring concept which is a main feature of database technology. Conceptually, database management is based on the idea of separating a database *structure* from its *contents*. Quite simply, a database structure is a collection of static descriptions of entity classes and relationships between them. At this point, it is perhaps simplest to think of an entity class description as a collection of attribute labels. Entity contents can then be thought of as the values that get associated with attribute labels, creating data objects. In other words, the distinction between structure and content is little more than the distinction made earlier between attribute label and attribute value.

This concept can be easily applied to hypermedia authoring via a concept of clusters which is presented in this paper.

2. Cluster

Cluster is a family of different media objects which constitute an actual multimedia document. Thus , for example, two HTML documents, a still image and a Java animation (see Fig.1) can be combined into such a cluster. It should be especially noted that each cluster has a layout template associated with it. The layout templates control appearing of cluster members on the screen. Thus , for example, a cluster mentioned above may have a layout prescribing the media objects appear as shown on the Figure 1.

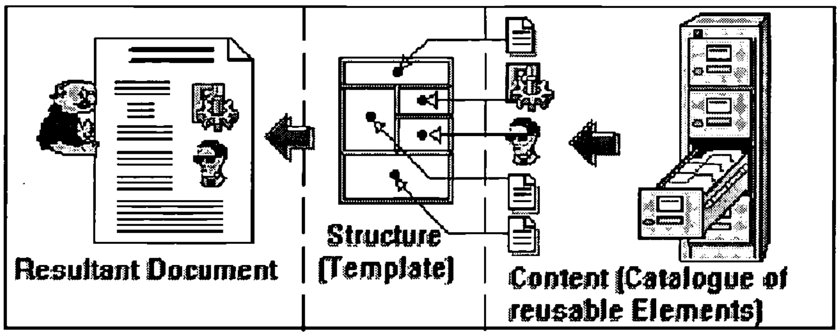

Figure 1: Assembling a resultant HTML Document

Actually, the concept of a layout template is not new at all. The tags "Embed", "Frame", "Table", etc. often play role of such layout definition in a conventional HTML authoring. Please note that authors are aware about the fact that HTML as a successor of SGML is not a layout oriented language, we just refer to a current practice where the tags are used to roughly define appearance of the document. Essentially, HTML do not distinguish between actual content and such layout information.

We content that hypermedia authoring for educational applications can be considerably improved by introducing an additional meta-level of such authoring. Simply speaking, there should exist a convenient possibility for authoring just document layouts without putting an actual content into such layouts, and for producing multimedia documents simply by filling out predefined layouts.

In this case, we consider a hypermedia authoring as a two stage process where an experienced designer prepare a number of layouts first, and then actual content providers fill such layouts with ready to run media objects. Of course, there also exists a number of systems supporting a similar approach on a stand-alone basis. We concentrate on implementing a „real" meta-authoring via introducing concept of „cluster types" which is very similar to a database logical schema (i.e. to static descriptions of entity classes and relationships between them). Thus, an author working on a meta-level predefines a number of cluster types, content providers are allowed to contribute with their information by calling up a particular cluster which guides them through the whole process.

The cluster type descriptions and actual content are stored separately what provides a reasonable flexibility in altering layouts without changing content and vice versa (see Figure 1).

In a cluster, one can combine documents which should be presented to a user as one indivisible HTML document. Once a cluster is accessed, all its elements (members) are combined together as a new composite document. The cluster pools together many single media items and presents them as a single "multimedia document". Text and images can then be shown together along with the simultaneous play of an audio track Thus pages can consist of small elements, separating an internal structure and content.

This authoring paradigm was especially developed for large educational organizations supporting catalogues of so-called reusable MM elements. Such elements can be developed by different authors, using different authoring systems, at different time and then registered in the catalogue providing a necessary "background library" for teachers to assembly their courses quickly and without spending much efforts on graphical design.

As an example, suppose we have a repository of small MM elements (D1 – D6, in this particular case) which, of course, may be composite documents themselves. In order to prepare a new document, we are simply selecting four documents: D2, D3, D5 and D6 to concoct a new document. We form now a new document just by selecting the four documents in the cluster. This is very useful for many applications.

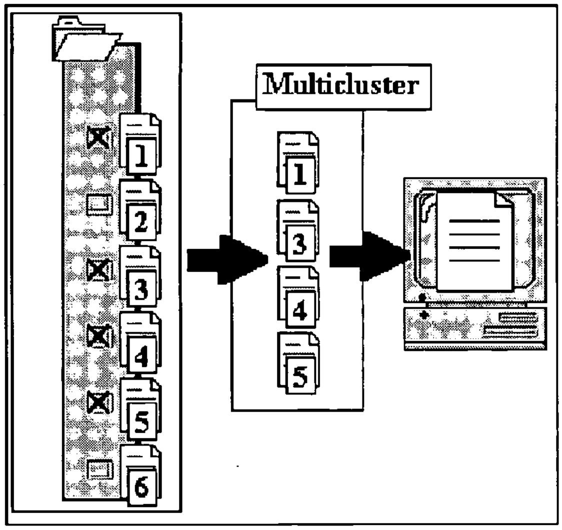

Figure 2: Generating a new document in a cluster

3. Authoring Documents

An especially designed *Page Editor* provide a convenient way for authoring pages (i.e. basic elements visualised on student screen as indivisible chunk of learning information) by means of reusing existing elements. It should be especially noted that the Page Editor is not designed as an alternative to any of existing HTML editors. It utilises a "template authoring paradigm" where existing HTML Editors can be seen as optional add-ons to provide basic elements. A final product is assembled of such basic elements via an advanced GUI.

The Page Editor works with a particular page template and page elements. The main way of authoring is filling the page template with existing page elements. Page elements are created with other editing systems. The following list of Page elements is currently considered for implementation:

- HTML Fragment;
- Still images (GIF and JPG formats)
- Movies (Mpeg and Vivo formats)
- Sound (AU, WAV and Vivo formats)
- Plain Text fragment (plain ASCII)
- MM Applet.

The Page Editor allows to combine the page elements into a valid HTML document by means of the following operations:

- drag and drop objects into a template cell,
- resize, delete and add a template cell,
- alter colours,
- edit content (HTML, texts and HMW format).

The Page Editor adds a value to textual page elements by means of:

- Defining relative positions of page elements on the screen;
- Assigning a type to template cells (ordered list, title, footnote, etc.);
- Assigning a desired colour and font attributes to text fragments.

Thus, informally speaking, creating a particular page is a two-stage process: First, the author selects one of existing templates from a supplementary template library. Second, the author simply fills predefined cells with elements taken from the catalogue.

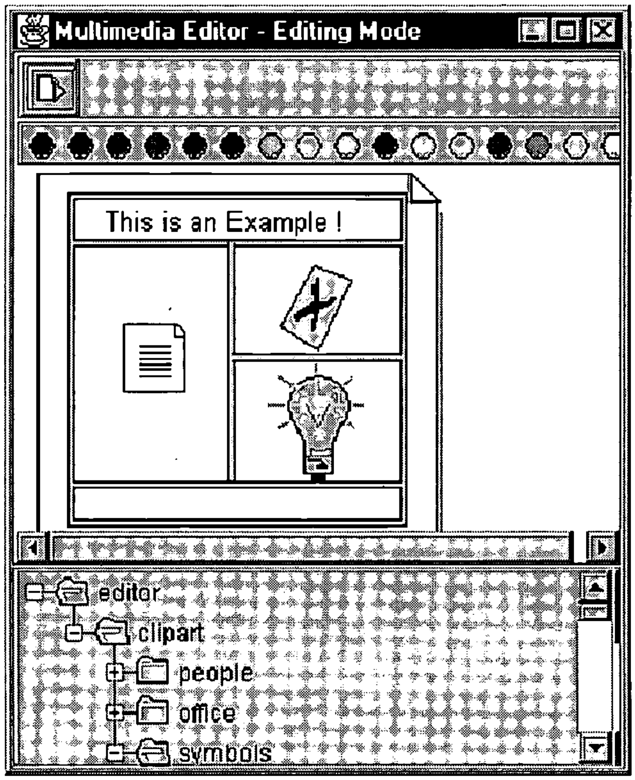

Figure 3: Editing Pages

Technical Details: the Page Editor is available in two forms - as Java Applet and Java Application. As a Java Application the Editor allows to select Page elements from a local drive or from a Hyperwave server using unified "treeview" browser (see Figure 3). Using Hyperwave search facilities considerably simplifies localisation of such elements. The application allows to save the resultant page on a local drive or upload it to a Hyperwave Server. The Page Editor allows to edit existing pages residing on a Hyperwave server as well.

As a Java Applet the Editor has considerable limitations on using local drive. It allows to select Page elements from a Hyperwave server only. The applet allows to upload resultant file into a Hyperwave Server.

4. Alternative Clusters

Another important structuring facilities is the *alternative cluster*. In an alternative cluster, one can combine documents with the same or similar content but different appearances. For example, different explanations (text, audio, video) of documents in different languages, etc.

Clusters can be referred to or embedded as ordinary HTML documents or media objects. Only one of such cluster members is dynamically selected whenever the document is presented to a client. To select a cluster object, the system uses special information defining a particular user's profile or preferences.

It may also be the case that the same contents must be presented in different languages or that a certain media type must be mapped into another type because the former cannot be visualised by a particular hardware/software configuration or cannot be perceived by a particular user.

A multilingual document can consist of a cluster that comprises some language-independent objects and some language-dependent objects of the same document type. When the cluster is displayed, all the language-independent members are displayed and, depending on the language the user chooses, one of each type of the language-dependent document is displayed. Any document with more than one title is regarded as language-independent. For example, a picture may have one title in English and another in German. Or, one title could be in "lay" language and the other in an "expert" language.

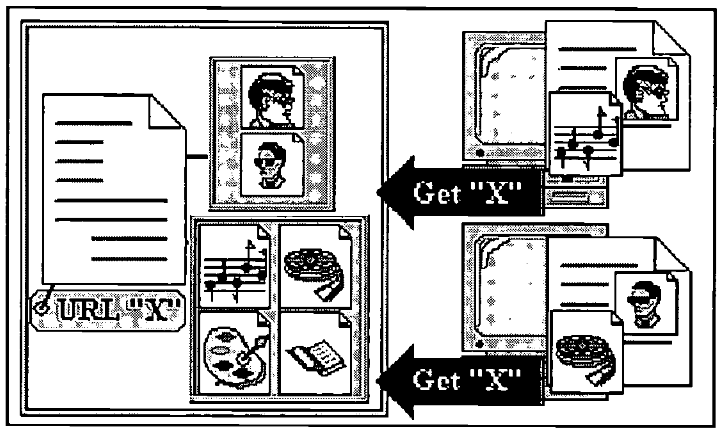

Figure 4: Only one cluster member gets selected

Thus, alternative clusters can be seen as page elements similar to any other element (text, HTML, picture, animation, etc.). The page Editor provide a possibility to embed alternative clusters into page cells. When an alternative cluster is embedded into a template cell, it obtains new properties, i.e. a number of alternative media objects may be assigned to such single cell (see Figure 4).

4. Conclusion

The Web is fast evolving both in quality of services and quantity of available materials. Currently, many organisations are switching from small hand-crafted hypermedia applications to fully-fledged, very large hypermedia databases available via Intranets or the Internet. Obviously, authoring such hypermedia databases cannot be carried out by enthusiasts armed with a good taste and an HTML Editor. The need for new, "industrial" methods of hypermedia authoring already exists and will grow tremendously.

In this paper, we just roughly define one possible basis for such "authoring technology" – separating structure and content of hypermedia documents. We have developed a special authoring tool supporting this approach and will report our experience with this approach rather soon.

Learning of Basic Concepts in Informatics Using Collaborative Hypertext: Does Collaborative Hypertext Support Learning as a Whole?

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Abstract: Hypertext appears to be a powerful cognitive tool supporting knowledge construction. A study was conducted to determine whether or not collaborative hypertext affects learning outcomes in the learning of basic concepts in informatics. We organized two courses about the basics in informatics using collaborative hypertext and two courses without collaborative hypertext. We analyzed learning and in this paper we present results utilizing the tests of structural knowledge emphasizing learning as a whole. The study found that collaborative hypertext does not improve cognitive learning outcomes in our context. This reflects the need for traditional uncomputerized learning methods at the start of learning informatics or the need to concentrate on improving the truthfulness of a collaborative hypertext-based learning environment. The result confirms our previous results. However, the structural knowledge has been learned better than single concepts in the groups using collaborative hypertext. Thus, collaborative hypertext supports learning as a whole compared with learning single facts.

1. Introduction

Computational hardware and software have found their way into schools during the last decade. However, the use of these has suffered from a lack of educational perspective. [Hawkins 1993] stresses that computational technology has been brought into schools in the wrong manner. It has been made into a part of traditional teaching emphasizing relatively passive absorption of information.

The same kind of problems have affected computer supported collaborative learning systems. [Wan & Johnson 1994] argue that current systems focus on improving shared access to information, people and media. They emphasize that meaningful learning is often forgotten in regard to collaborative use of computers in education. [Webb 1982].

One way to overcome these problems is to consider computers as cognitive tools, in other words, tools for knowledge construction. Meaningful learning is not simply information sharing but, more importantly, knowledge construction [Wan & Johnson 1994]. Generally, cognitive tools can facilitate cognitive processing and knowledge construction, hence they support a learning process [Jonassen 1992]. The use of a cognitive tool changes the role of a student into an active learner. However, hypertext and hypermedia have their own problems. They do not typically offer an explicit mechanism to help learners better interpret and assimilate information, the context surrounding its creation and use, or the perspectives on the information of the author or other learners. Simply improving information access without supporting learning leads directly to the problems of "information overload" and "lost-in hyperspace" [Wan & Johnson 1994]. The solution to these problems is understanding hypertext and hypermedia as a cognitive tool [Jonassen 1992].

2. Nature of Learning Basic Concepts

Since this study recognizes hypertext as a knowledge construction tool and learning as a knowledge construction process, we understand learning especially from the perspective of the constructivist view of learning (constructivism). According to it, an individual learns new concepts in relation to his/her prior knowledge [Risku 1996].

We often distinguish declarative and procedural forms of knowledge. Declarative knowledge represents cognizance or awareness of some object, event, or idea [Ryle 1949]. Declarative knowledge of ideas is often characterized as schemas [Rumelhart & Ortony 1977], which are ideational constructs that are defined by attributes that they inherit from other schemas. Procedural knowledge, on the other hand, describes how learners use or apply their declarative knowledge. [Ryle 1949] describes this type of knowledge as knowing how. An intermediate type of knowledge is structural knowledge, which mediates the translation of declarative into procedural knowledge and facilitates the application of procedural knowledge. Structural knowledge is the knowledge of how concepts within a domain (e.g. in informatics) are interrelated [Diekhoff 1983]. It describes how declarative knowledge is interconnected.

There are two kinds of learning concerning the basics in informatics. First, students must learn to understand the field of informatics and its basic concepts and facts. Second, students must learn to use computers and utilize instructions to facilitate the use of computers. These two goals emphasize the learning of both declarative and procedural forms of knowledge. Since both forms of knowledge are important, we argue that the structural form of knowledge is important. Structural knowledge enables learners to form the connections that they need to use scripts or complex schemas [Jonassen 1992].

For the basics in informatics it is typical that the basic concepts form structures and knowledge is in the structural form [Makkonen 1997a]. One way to understand why the basic concepts in informatics fall into the categories of both declarative and structural knowledge is a concept mapping technique [Novak & Gowin 1984] which facilitates a representation of meaningful relationships between concepts (for an example, see [Fig. 1]).

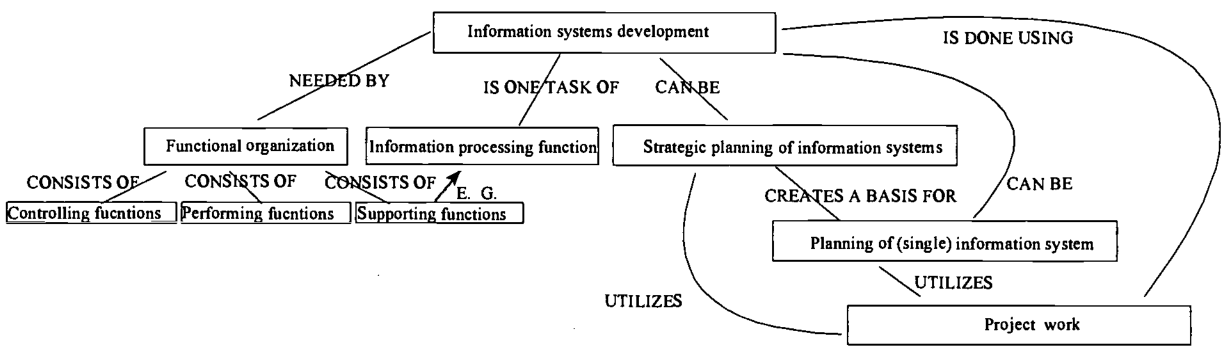

Figure 1. Simplified concept map concerning information systems development.

3. Hypercomposition and collaborative hypertext

Hypertext reflects a human's way of thinking and provides an opportunity to process information and interrelatedness between information cues [Bush 1945] [Jonassen 1993]. It can present a human's schemas concerning one event or idea. Thus, hypertext is useful as a cognitive tool. [Derry 1990] defines cognitive tools as both mental and computational devices that support, guide, and extend the thinking processes of their users. Collaborative hypertext permits hypercomposition and the benefits associated with it.

Hypertext can be called hypercomposition and hypercomposition supports instructional design in several ways [Lehrer 1993]. First, hypermedia-based composition involves the transformation of information into an n-dimension space, in contrast to the two-dimensional space of print. Second, because hypermedia composition involves multiple forms of media, students are confronted with decisions about the representational roles of each of the forms of media. Third, hypercomposition promotes a sense of authorship, if students are engaged in the production of a nontrivial product (a product that others are likely to use). Fourth, hypercomposition encourages the composer to be aware of the multiple voices of his or her composition because there is always more than one path through the hyperdocument. Last, on the social plane, hypertext focuses on the interactions of the authors.

[Rada 1991] has defined collaborative hypertext (grouptext) as "text that people create or access collaboratively". Grouptext systems can help groups create and access text in three phases:

1. The discussion phase occurs as people brainstorm and formulate plans as to how writing should proceed.
2. In the authoring phase, blocks of text are attached to a network of ideas and the network is traversed to generate a document.
3. The analog of reading in the collaborative sense is the making of notes by a group of people on a document. This annotative phase may also lead to a revised document as the annotators incorporate their comments into the original document.

Both hypercomposition and collaborative hypertext can be considered as cognitive tools, because they support knowledge construction. Cognitive tools support the constructivist view of learning because they actively engage learners in the creation of knowledge that reflects their comprehension and conception of information rather than focusing on the presentation of objective knowledge [Jonassen 1992]. This provides different opportunities for learning compared with traditional programmed instruction which is seen as the opposite of cognitive tools [Jonassen 1992] and usually emphasizes the passive role of a student.

We claim that hypercomposition can be used to organize knowledge structures, facilitating a more active role for the student. The basis for this as a learning tool in informatics is understanding concepts and facts which must be learned as structural knowledge. In the learning of informatics hypercomposition does not support learning that only facilitates knowledge construction. Additionally, the process where computers are used for hypercomposition helps students to learn basic concepts in informatics, because students encounter certain concepts in real life situations. To learn meaningfully, individuals must choose to relate new knowledge to relevant concepts and propositions they are already familiar with [Novak & Gowin 1984]. The concept of collaborative hypertext emphasizes knowledge construction. On the another hand this concept stresses social interaction and we suggest that hypercomposition must occur collaboratively, because according to certain research interaction is the factor which has the greatest influence on learning [Harasim 1989] [Webb 1982]. In spite of the promise of hypercomposition and collaborative hypertext they can be more distracting than beneficial, since students must also concentrate on learning a tool itself [Hay et al. 1994].

4. Study Design

4.1 Experiment

We utilized collaborative hypertext as a cognitive tool. Our framework was constructed on the basis of Rada's three phases of the use of collaborative hypertext as well as the idea of hypercomposition.

The themes of our course basic course in informatics are introduction (including the themes Meaning of Automatic Data Processing, Information Society and Problems Utilizing Computers), presentation of data in the PC environment, programs and programming, hardware technology, data communications, information systems development. Two courses organized for university students were based on collaborative hypertext (experimental groups). In order to compare learning based on collaborative hypertext with learning without it two other courses were organized for university students without collaborative hypertext (control groups) using uncomputerized teaching and learning methods. Thus, in the control groups we used contemporary learning methods, i. e., lectures, exercises based on the lectures and revision organized in a linear way as a typical university course based on programmed instruction. However, during the exercises the students were expected to work in collaborative groups as the students did in the experimental groups. All four courses lasted the same amount of time (36 hours in three weeks).

As a hypermedia software we used Toolbook which corresponds HyperCard for Macintosh computers in the Microsoft Windows environment.

4.2 Sample

Forty-six students, 32 females and 14 males, whose mean age was 24 years (range 20-42 years), participated in the experimental groups. 21 students participated in the first experimental group and 25 in the second. Thirty-nine additional students, 30 females and 9 males, whose mean age was 23 years (range 20-39 years), were involved in the control groups. 20 students participated in the first control group and 19 in the second. All students in all groups studied informatics as a minor. All subjects were recruited using the announcements on the notice boards of the university departments and were expected to attend the classes constantly during a selected course.

4.3 Measures and tests

We utilized the tests of structural knowledge to clarify learning outcomes and their quality, because they reflected the quality of a student's knowledge structures. Additionally, the results of these tests complete our previous results. In order to assess structural knowledge acquisition, we utilized two subscales of twenty questions to measure different aspects of structural knowledge: a) semantic relationship, and b) analogies. All of the structural knowledge test questions were developed to focus on relationships between important concepts. Based on these tests we organized both the pre-treatment and the post-treatment contained 20 items in one test. For all tests the items were selected separately.

Each semantic relationship treatment consisted of 20 multiple choice questions that required the students to identify the nature of the relationships between two concepts. These relationships were be paraphrased from the course material.

For example

Operating system...System software

a) is caused by

b) precedes

c) is part of

d) assists

Alternatives were produced based on the list of the most ordinary relationships between pairs of concepts [Jonassen et al. 1993]. According to this list most concepts are related in one of the following ways: Has part/is part of, has kind/is kind of, cause/is caused by, precedes/comes after, describes (defines)/is description (definition) of, assists/is assisted by, has example/is example of, justifies (rationalizes)/is justified (rationalize) by, has characteristic/is characteristic of, has opposite/is opposite of and models/is modeled by.

20 multiple choice questions of each test were given first for the laudatur level students of the information systems. In the questions for the laudatur level students all alternatives from the list of most ordinary relationships were presented. The purpose of this was to produce three different "wrong" alternatives for the tests both in the experimental groups and the control groups. The first alternative or the "right" alternative was produced based on the course material. Three other alternatives were produced based on the results of testing the laudatur level students.

Each analogies test required the students to complete 20 analogies consisting of four concepts from the course material. For example

Bit... Byte

RAM-memory...

a) Central Processing Unit

b) Processor

c) Field

d) Main storage

The alternatives were produced based on the course material. Two from three "wrong" alternatives were closely related concepts of the "right" alternative. One from three "wrong" alternatives was selected randomly from all concepts to learn.

5. Results

In our study we compared collaborative hypertext based learning (the experimental groups) and learning without collaborative hypertext (the control groups). The dependent variables were learning the semantic relationship and learning the anologies. Since the responses of the students agreed with the normal distribution, the T test was approriate for this experiment.

The semantic relationship pre-treatment T test did not show significant difference between the experimental groups and the control groups (p=.161). The mean for the experimental groups was 9.11 and the mean for the control groups was 10.00.

The semantic relationship post-treatment T test did not show significant difference between the experimental groups and the control groups (p=.507). The mean of the experimental groups was 10.93 and the mean of the control groups was 11.05.

The analogy pre-treatment T test did not show significant difference between the experimental groups and the control groups (p=.387). The mean for the experimental groups was 7.96 and the mean for the control groups was 8.33.

The analogy post-treatment T test did not show significant difference between the experimental groups and the control groups (p=.631). The mean of the experimental groups was 10.33 and the mean of the control groups was 11.18.

6. Discussion

Our results show that a basic knowledge of informatics can be learned as easily as utilizing uncomputerized methods without exploiting collaborative hypertext. The finding is consistent with the threats mentioned in [Hypercomposition and collaborative hypertext]. However, the result is promising compared with our previous results in [Makkonen 1997a] where we found that the single facts can be learned more easily using the traditional learning. Thus, collaborative hypertext supports learning as a whole compared with learning single facts.

We lose the benefits mentioned in [Hypercomposition and collaborative hypertext], because much time is used to learn the tool itself. However, we claim that some people can utilize collaborative hypertext as a powerful learning tool. [Mayes 1992] claims concerning the use of cognitive tools generally, that they will always be more effective in the hands of an experienced user. The fact is that the students did not know what our cognitive tool or hypertext was at the beginning of the course. This may impair the results of learning, because students who are not experienced with computers must concentrate more on the skill of using the tool itself than experienced students.

The area of informatics and opportunities to create realistic learning environments may affect the power of hypertext to assist learning. [Kendall et al. 1996] have studied teaching system analysis using a hypertext environment called HyperCase which presents an organization realistically. Their findings showed that those using HyperCase performed as well or better on the examination questions than those using the standard approach. From the perspective of our study, if it had been possible to increase the feeling of reality, the result of this study would have been different. Additionally, our previous findings regarding the engagement to learning in our context support the need of improving truthfulness [Makkonen 1997b]. The study found that the use of collaborative hypertext affects both external and internal motivation equally in learning most themes of the course.

Additionally, the development regarding the world wide web (WWW) may satisfy the need of the truthfulness. The possibility to make links may help learning, because links can be created meaningfully to any document on the WWW which will clarify an area to learn best.

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Guidelines for the Design and Development of Computer-Mediated Collaborative Open Distance Learning Courseware

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Abstract: Open and Distance Learning (ODL) substantiated by computers and computer networks and collaborative learning may provide an answer to the inefficiencies of the individualistic ODL which dominates present ODL systems. The successful integration of computer-supported collaborative learning in the development of ODL multimedia courseware necessitates an answer to the following two questions. First, under what conditions does collaborative computer-supported distance learning work? Second, how can we design multimedia distance courseware? This paper attempts to provide a set of guidelines for the design and development of computer-supported distance multimedia which reflect these two questions.

Introduction

Open and Distance Learning (ODL) has been witnessed an increased development, acceptance and recognition as an innovative and productive delivery mode of instruction and learning. However, most distance learning has taken place using an individualistic or self-study strategy, whereby the emphasis is placed on the distance and/or the learner, but not on the learning [Amundsen 1993]. The current widespread interest in the potential of collaborative or co-operative learning methods [e.g., Whipple 1987; Chung 1991; Mandl and Renkl 1992; Somervell 1993; Meloth and Deering 1994], on the one hand and of computer-supported conventional and distance learning [e.g., Nastasi and Clements 1993; Wild and Winniford 1993; Steeples et al.1994; Woodruff 1996], on the other hand, open up an interesting intersection. The concept of computer support implies the use of multimedia and computer networks as communication tools by learners and instructors to achieve certain teaching and learning goals and objectives [cf. Kaye 1991; McConnell 1991;1994; Riel and Harasim 1994]. The concept of collaborative learning is an umbrella term. Some people use the terms groups, co-operation and collaboration interchangeably. Others, try to see a slight but important difference. As pointed out in the editorial of the Journal of Computer Assisted Learning, «At a purely cognitive level, cooperation and collaboration may be quite similar but at an intentional and contextual level the processes seem to be distinct» [JCAL 1996, p.65]. Here, these terms will be used interchangeably. Group, co-operative or collaborative learning has been defined as learning that occurs through interaction with a peer group [Hiltz 1995], is based on learning principles relating to individuals within groups [Slavin 1995] and it involves the "active construction" of knowledge [Idrus 1993; McConnell 1994]. It has been researched and shown, that when collaborative learning is used appropriately, it improves student behaviour and attendance, increases liking of peers and of school, promotes positive interaction of learners in small groups [Lyman and Foyle 1990;1991]. It also improves student socio-cognitive achievement [Lyman and Foyle 1988; Mevarech and Kramarski 1992; Slavin 1995]. In a collaborative learning environment, both teachers and learners are active participants in the learning process, in which knowledge is not something that is merely transferred to students but rather something that emerges from active participation in the learning process. This view of collaborative learning is related to a constructivistic approach, which posits a view of knowledge as a construction based on previous knowledge or experiences, mental structures, and beliefs that continually evolve and do not exist independent of human experience. From a constructivist point of view, each learner actively constructs and reconstructs his or her understanding rather than receiving it from a more hierarchical and authoritative source such as a teacher or a textbook. The notion of the organism as "active" - not just responding to stimuli, or storing up information, is at the heart of collaborative and constructivist conceptions of learning. Active learning is when the learner takes responsibility for what he or she wants to learn - making decisions about the "what" and the "how" [Bentley and Watts 1989; Bruner 1986]. Only in groups it is possible to envisage pupils talking about their work to any significant extent" [Eraut and Hoyles 1989]. Cooperative learning while doing group problem solving can improve students' team work, mutual respect and better patterns of communication [Mittlefehldt 1991]. Successful implementation of cooperative or collaborative learning in a certain subject depends, to a great extent, on the climate of the classroom, which should be considered before longer cooperative activities are used [Lyman and Foyle 1991].

In a collaborative distance learning environment, the teacher's fundamental roles can be categorized into two categories: instructional roles and organizational roles. In the context of instructional roles, teachers act as reflective practitioners, as facilitators, and as scaffolders. While in terms of organizational roles, teachers act as resource, technology managers, and curriculum developers. Future teachers ought to analyze and reflect on (1) the pedagogical and curriculum means used to attain educational aims, (2) the underlying assumptions and consequences of pedagogical action, and (3) the moral implications of pedagogical actions and the structure of schooling [Liston and Zeichner 1987]. "When teachers themselves adopt a reflective attitude toward their teaching, actually questioning their own practices, then they engage in a process of rendering problematic or questionable those aspects of teaching generally taken for granted" [Smyth 1984 p. 60]. Implementing reflective inquiry based on critical theory is not a panacea to the problems faced in education [Ross and Hannay 1986]. In "critical reflection", the moral and ethical issues are considered along with the means and ends [Sparks-Langer et al. 1990]. The facilitating and scaffolding teacher's role is to have pupils regard each other as learning resources rather than as competitors and depend solely on the teacher as an instructor and leader. This does not imply that the teacher abandons all authority in the classroom. In fact, the teacher plays an important role as an information resource, as guide and as faciltator of the learning process.

In general, the strategic teacher's role in the "collaborative distance learning environment" is to provide a structured social environment in which students develop their capacity for self-regulation, cooperation, mutual respect and solidarity, critical and reflective thinking and engagement in the learning task to mention some.

The successful integration of computer-supported collaborative learning in the development of ODL multimedia courseware necessitates an answer to the following two questions. First, under what conditions does collaborative computer-supported distance learning work? Second, how can we design multimedia distance courseware? On the basis of the extended literature review outlined here and personal experience, a number of conditions and principles have been identified and appropriately modified to support the design and development of computer-supported collaborative ODL materials.

Conditions for Effective Collaborative Learning

- Students must see themselves as positively interdependent so that they take a personal responsibility for working to achieve learning goals;

- Instructors must be engaged in a facilitating, reflecting, and coaching role, teach the process skills necessary to work in groups and provide group rewards for engaging in cooperative interactions effectively. They must also specify instructional and collaborative learning objectives, usually in discussion with the learning groups.

- Introduce strategies that maximise student interaction and organise formal and informal testing to ascertain students' socio-cognitive progress.

- Identify which types of cooperative process are more effective than others and understand how students interact in a collaborative learning environment to advance their knowledge and skills.

- Ensure accessibility to the distance learning system and instructional material, stimulate the students' interest in the subject and their motivation to learn and respond to students' enquires and contributions.

- Plan before implement collaborative teaching, carefully explain the task, the goal structure and the learning activity and provide sufficient and meaningful feedback.

- The effectiveness of collaborative distance teaching and learning is highly dependent on how well the technology involved can be used, in terms of operation, understanding of its potentiality, and of the teaching and learning techniques associated with that technology.

Principles for Designing and Developing Computer-Mediated Collaborative ODL Courseware

- Consider the "lost in hyperspace" problem by organising the instructional material in an appropriate way and structure, avoiding unnecessary breaking of topics, grouping small topics whenever possible, limiting the number of links, providing standard links whenever possible and avoiding special links that seem to be unpredictable.

- Courseware should include questions for discussion or response, rather than simply representing one way transmission of "knowledge".

- Include a table of contents, an alphabetical index of key topics, questions and assignments that enable students to present, analyse, discuss and synthesise problems or issues. Connect the course materials to current events or to students' experiences.

- Decide what, where and how to display items. Special consideration must be given to highlighting items, text legibility and the structure of the instructional material in a coherent pattern and sequence.

- Avoid hyperinteractivity and cognitive overload. Do not overload the user with meaningless animation, video, pictures, in terms of learning.

- Balance the needs of multimedia effects (graphics, text, sound, video, animation, color etc.) by taking into consideration the nature and the priorities of the topic, the preferences, characteristics, styles, age, knowledge and perceptions of users, the instructional goals and objectives, the context of learning, the previous research and the costs of various media.

- Include on-line and off-line collaborative interactions that allow students to present drafts of written assignments to one another, critique one another's drafts, and then revise the draft on the basis of suggestions and reactions from the other students (peer-group assessment). Students may be divided into teams to present opposing viewpoints or conflicting views or different aspects on same topics or issues, perhaps with some members of the ODL class acting as respondents and "judges".

- Provide opportunities to students by giving them responsibility for monitoring and making judgements about aspects of their own learning (self-assessment). Students, for example, may be guided to prepare a self-assessment schedule. This is a document that students prepare towards the end of a course in which they summarise their learning and make judgements about it.

- Define overall and specific instructional and learning objectives clearly and measurable for each unit and sub-unit of the courseware.

- Include one or more "seminar" type segments in the courseware and let students do more than simply read instructional material. In other words, turn students as equal partners in the ODL collaborative interaction by giving them space to add links between existing topics, add new topics and annotations.

Concluding Remarks

Research on the use of collaborative learning in distance education mediated through advanced computer and communications technologies is not extensive. Evidence suggests that collaborative learning when properly designed, developed and implemented, has the potential for contributing to socio-cognitive knowledge and skills. As pointed by Mevaresh and Light [1992], co-operative or collaborative computer learning environments can function as a 'mirror for the mind' and thus, enable us to investigate the mechanisms underlying cognitive and social developments. Implementing computer-mediated collaborative ODL requires an understanding of the conditions that facilitate its operation and the principles for design and development of such learning interactions. To sum up, to deepen our understanding of designing, developing and implementing collaborative computer-mediated distance learning strategies, we are in need of innovative theories of teaching and learning. In this paper, a number of guidelines have been provided which stem from accumulated knowledge, personal experience from my teaching and research work in the field of new information technologies in education as well as my involvement in the project EONT (An Experiment in Open Distance Learning using New Technologies) which has been funded by the European Union [Papaspyrou et al. 1996; Makrakis et al. in press].

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Automated Content Synthesis for Interactive Remote Instruction

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ABSTRACT: At Old Dominion University, we have built IRI, Interactive Remote Instruction, a computer-based system to support distance education. We have used IRI to teach several classes at sites up to 200 miles apart. In this paper we describe the extensions we are making to use IRI in both synchronous and asynchronous modes. We describe the architecture used to support recording of all class activities for future replay, and describe the interface which can be used to steer an IRI session.

1. Introduction

In higher education, distance learning is becoming key as more nontraditional students take courses. Two successful distance learning methods are TV-based and Web-based courses [Fox et al. 1995]. In the first method a course is transmitted to remote sites. In Webcourses, material is placed in a multimedia, hyper-linked format which students access through the Internet at any time. Many such courses allow students to interact with the system for progress assessment or to execute tools for acquiring skills. In their pure form the two approaches are on opposite ends of a synchrony scale. TV courses have added asynchronous capabilities by providing videotapes of a lecture that can be viewed at any time. However, tapes do not provide an index that enables students to navigate the material easily. Webcourses can provide excellent maps of their contents and are ideally suited for review at one's own pace and abilities. The disadvantage of Webcourses is the high cost to create a good one. It may take $100,000 and six months for a team of web experts, content providers, and graphics designers to put together a new course.

We propose a new approach intended to combine the best of the two methods. It is based on the concept of a virtual classroom where students at different locations have the same synchronous class experience. Each student uses a computer as his/her window into the classroom. Students use networked computers to communicate through video and audio and tool sharing. IRI (Interactive Remote Instruction), a system we have developed over the past few years, supports this approach. In this paper we describe how IRI can be used for both synchronous and asynchronous participation. Current IRI capabilities are described more fully in [Maly et al. 1997]. IRI records all audio and video, who speaks, whose video is shown and what tools are running when. The concept is simple: during a synchronous session, record all individual streams of actions with timing points. This information is synthesized and presented as a set of Web pages that can be used at a later time to review any portion of the lecture using the Web navigation pages as an index to all class activities.

Section 2 of this paper provides some background on technologies including a summary of IRI. In section 3 we describe the architecture of the recording and the replaying features of IRI followed by the design and implementation of the synthesized Web pages in section 4.

2. Tools and Environments

In this section we describe how the learning paradigm is shifting as a function of technological advances. Since ours is a technological research perspective we present a characterization based on technology and educational theories. First we summarize the relevant technologies, followed by a characterization of learning paradigms and then describe how various application level tools and environments support learning. The ideal paradigm we propose, and believe current technology can support, is one which scales well, is symmetric, allows for both asynchronous and synchronous use, has high perception quality, is highly interactive, does not require students to be collocated, allows learning tools to be shared, is cost effective, and can be used in groups or individually as appropriate for a set of learning objectives.

The tools we describe in this section are the technology tools and environments, which enable new learning paradigms. We categorize tools by which feature in a learning experience they support; for example, a video conferencing tool supports group interaction. An environment is a set of integrated tools, which provide support for most of the learning experience of a student.

Collaboration tools allow learning tools to be shared among class members in the sense that anyone can operate them. In the Unix arena an example is XTV [Wahab 1991]. which allows the sharing of X programs. In the NT world, Netmeeting lets a group share win32 programs. These tools use TCP/IP and thus do not scale well and cannot handle large groups. No current tool allows the sharing of arbitrary learning tools across operating system platforms, but tools are being developed which will allow the sharing of specific tools across platforms. For instance, WEB-4M is a JAVA based tool, which allows the sharing of a white board and slide tool.

Video conferencing tools exists both over IP networks and ISDN based telephone networks. Vic and vat, a suite developed by van Jacobson, was developed for large audience as an asymmetric tool, i.e., for broadcasting to thousands with few sources. The tool is based on the Mbone and includes a whiteboard. SmartStation proprietary tool works over telephone networks with switched ISDN lines. It does not scale well and can become expensive because typically at least three ISDN lines (192K) are necessary for each participant to support an acceptable level of perception. None of the video conferencing tools support tool sharing.

Webtools are used to support Webcourses. At a basic level are the editors included with Netscape and Internet Explorer for creating multimedia web pages and groupware such as e-mail, chatrooms, newsgroups, and document managers. At an advanced level, Domino uses a secure webserver and provides a framework for writing applications that support group activities. Authoring tools help transform the educational content of a course into an interactive webcourse to the point that no specialists are needed. Other tools support the assessment part of the learning, for instance, QW (Oregon State University) allows teacher to create quizzes, administers and grades the multiple-choice components. Web-based whiteboards and specialized presentation tools are common. C-browsing is a coordinated browser, which allows a group of participants to visit the same page on the Web together. Anyone in the group can click on a link and all participants can see the result.

Cross-platform tools are being developed for the two dominating platforms NT and Unix. The identification of Unix with academe and NT with home PCs is steadily eroding, hence the need to run a tool written for one platform on another platform. The best known tool for running X programs on a PC is Exceed which basically creates an X server under NT and allows any X program running on a Unix box to be displayed and manipulated on the PC running NT. Citrix provides the opposite: it runs on an NT server and any program running under NT can be displayed and manipulated by a Citrix client running on a Unix box. All of these tools, however work on a one-to-one basis. That is, it is impossible for a group of users on Unix boxes to see a tool running on a PC.

A successful environment is one where the end user has to perform few operations to operate the environment. TV based distance learning is a good example in this category. The student has only to go to a site and learn how to operate the audio button to ask a question. The entire system is run by technicians who ensure that the sending, receiving equipment and the cameras operate smoothly. The teacher does have to be trained in what can and cannot be presented in this medium and how to make effective use of cameras and audio channels. Similarly, environments have been created for Webcourses that integrate administration tools, content generation, and monitoring of students' progress; WEB-4M and the environment at Virginia Tech are good examples. CU-Seeme is an environment that combines video conferencing, whiteboard, e-mail, document sharing and other tools into one environment.

IRI is an environment which is being developed with the goals of the ideal paradigm described above. Currently, this environment solves the scaling problem for up to an order of 100 users while maintaining tool-sharing capabilities by the use of reliable multicasting, specifically, RMP. IP-multicast by itself does not support reliable transport that is essential when transferring data. IRI in its current state does not support true interoperability, i.e., a user can be at either an NT computer or a Unix box. X tools can be shared to any platform but not PC tools. Because of its use of multicasting it is totally symmetric. IRI supports both synchronous and asynchronous learning by recording live synchronous sessions in their totality (audio, video, and tool traffic) and automatically synthesizes the content to the asynchronous viewer.

3. Recording Architecture

In this section we briefly describe the components added to the IRI architecture to support recording and playback of IRI sessions. Two servers were added to the architecture: a Recording Server (RS) and a Playback Server. In general both resembles the Remote Instruction Server (RIS) described in [Wahab et al. 1996]. The architecture for recording in IRI is made up of a web-based interface, a session recording control (SessRec), a recording process for each type of stream, such as audio, video, slide show tool, and a Reliable Multicast Protocol Server (RMPS), as shown in [Fig. 1].

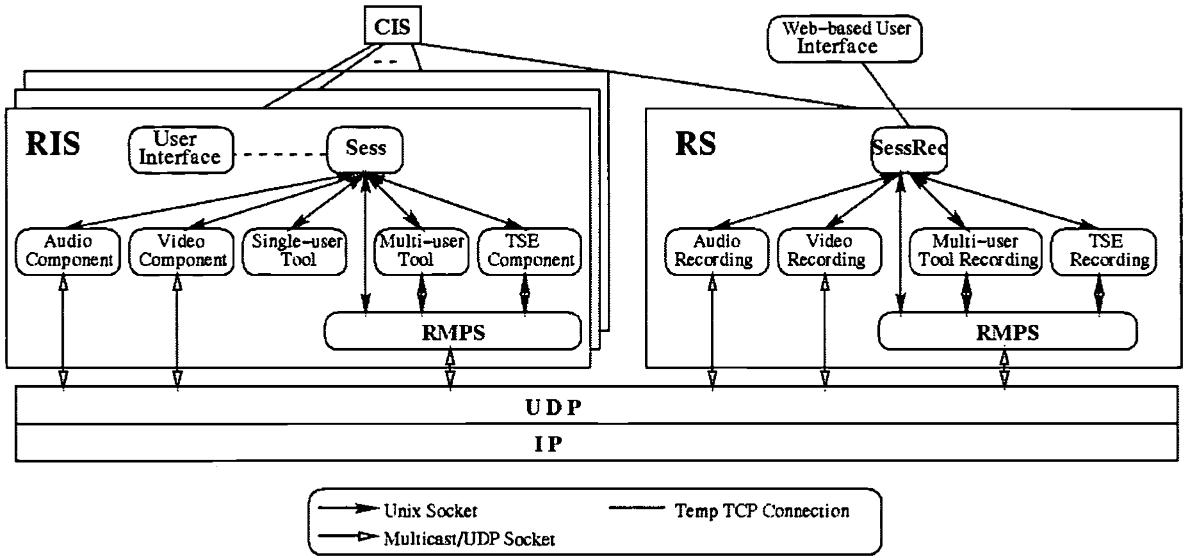

Figure 1: Basic IRI Software Architecture and Recording Server Architecture

A web-based interface allows the session leader to turn recording on or off at any time (for example during a class break). It establishes a TCP connection with SessRec and sends messages to control recording. The session recording control process is started like any other session control process of a RIS. Then it spawns the other recording components. As far as the rest of the IRI session is concerned, the recording server is a passive participant. SessRec does not bring up any interface, but waits for the connection of the web-based interface. In addition to the normal operation of an IRI session, SessRec stores the allocation of the media resources in a file, as the session progresses. The audio recording process joins the audio channels following the same protocol already implemented between session control and audio component of RIS. The major difference with the audio component of RIS is the redirection of the output to files rather than the audio device. In addition to audio streams that are stored in μ-law format, the audio recording process records timing information carried in audio packets to take into account silences and packet losses due to the unreliable multicasting.

The video recording process works like a video receiver process in RIS. However, instead of decompressing and displaying video streams on IRI windows, it stores them to a local disk using a video size of 320x240 pixels. There is no need for decompressing most of the video streams, but the presenter video (640x480 pixels) has to be decompressed, reduced, and then compressed again for storing. Like the audio recording process, this process also stores both the video stream and the necessary timing information to overcome gaps due to video frames losses. IRI has a number of specialized tools that were written especially for IRI. A modified version of each works in recording mode to store the important events associated to that tool. Later, during review, another version of this tool running in playback mode reads the events from a file and replays them accordingly to each tool operation. The Tool Sharing Engine (TSE) of IRI, based on the XTV system, allows sharing of X windows' applications collaboratively. The recording server runs a modified version of it, the tool-sharing engine-recording tool, to store the events related to any application running under this component.

3.1 Recording Files

Two layers of files are stored for each recorded media: a resource allocation layer and a data stream layer. The former is recorded by the session recording control process. It stores the users' names and times at which the resource was used. The latter layer of files stores the timing and data associated to each resource. One file keeps the timing information of the stream and pointers to the actual data that are saved in another file using standard formats, such as Sun μ-Law for audio files and GIF for slides. For example, in the case of audio, session recording control stores the time and names of those who have been granted an audio channel and those who release it as well. In addition, the audio recording process records the initial time of every recorded audio block and the offset where that block is stored within the data stream file. Thus, at review time a corresponding audio playback process can access the audio data and its timing to replay it as it was heard by the participants of the synchronous session. For video, we do not record individual user's video streams (whose total is of the order of participants) but the windows' videos seen by any participant (a total of 4 in the current IRI implementation). For each window's video, a session recording process stores when and who took over that video resource (video allocation file for that window), and a video recording process stores the video data stream and its timing information. Slide show tool events and slides are recorded with a similar scheme to audio and video.

3.2 Playback Architecture

The architecture for playback in IRI is similar to the recording architecture. For every process in the recording architecture, there is a complementary process in the playback. While recording processes receive and write media streams to disk, playback processes read these streams from disk and send them to an IRI session. A web-based interface allows participants to see recorded IRI sessions and the resources that have been recorded for each person. Then users can select the streams to be played back. This interface connects to a session playback control process (SessRep) and sends messages to initiate, resume, or stop playback. The communication between the interface and SessRep is via TCP sockets.

Session playback control serves requests sent by the review interface, allocates and releases resources for streams being played back, and communicates to each playback process to start and stop their operation. A session control panel (see Section 4) is used to start the session playback control process (SessRep) just like any other session control process. Then SessRep spawns the other playback processes following the same protocol that session control uses. As far as the whole IRI session is concern, SessRep is like another session control with an interface controlled by a review user. Like session recording control, SessRep does not bring up an interface, and it waits for messages from the web-based interface. SessRep displays labels and graphical indications for playback streams as opposed to live session streams.

The audio playback process operates like other IRI audio processes but reads recorded audio data. This greatly effects timing. While intra-stream synchronization during recording is controlled by a fixed sample rate of the audio input device, some mechanism needs to be provided for playback. The audio playback process inserts pauses to compensate the removal of silent periods and the loss of audio packets during recording. The video playback process works like a video sender of a normal IRI session, but instead of capturing video frames from a camera it reads them from a file and send them over the network. Like audio and video, there are other processes in charge of playback for each IRI multi-user tool, such as slide show tool, and a version of the tool-sharing engine tool for playing back the applications that run under this component, such as Netscape and emacs.

3.3 Recording Playback Synchronization

Timestamps are used for intra- and inter-stream synchronization. A data unit timestamp is the time in milliseconds since the IRI session begins. Video and audio streams are the most critical in terms of synchronization requirements. They carry timestamps, attached at the sender host to each application data unit (packets for audio frames for video). While video streams have a clear timestamp used for recording, it is not clear how to assign a timestamp to the audio stream coming out of the audio-mixing algorithm. Our approach uses the timestamp associated to the loudest audio stream being mixed. By doing this we keep synchronized the video/audio pair that has the attention of the participants.

In order to ensure that each RIS computes local timestamps from a common starting time for the class, we use the first leader's event sent reliably to synchronize the starting time of the class in every participant session. Another reason for a global synchronization is the need for a unique time line for resources allocation. Unlike video and audio streams, all other IRI resources set timestamps at the receiver, so we record what everyone sees as delivered by RMPS. Thereby, we need the recording server to be in sync with any possible audio or video stream generator (i.e., anybody).

Every playback process takes the local machine time and timing information associated to each data unit to synchronize the replying of its stream; thus intra-stream synchronization is accomplished. Inter-stream synchronization is achieved by letting session playback control send a common playback starting time to all the processes involved. This way specific synchronization techniques are not required within dynamically changing playback processes set.

4. Implementation

In this section, we focus on the technical issues involved in building a Web-based interface to steer an IRI session in which we replay portions of previously recorded sessions. In the past we have used a Motif interface to steer an IRI session and to add resources needed for a session. Since we are in the process of developing a cross-platform implementation of IRI we decided to switch to a Web-based controller as a first step. First we discuss how we enable multiple users to steer and monitor a session securely and how we integrate their browsers with the IRI interface. In the second part, we present the content synthesis and presentation to the user for selecting arbitrary points of starting a replay.

4.1 Multiple-User Steering

IRI is based on reliable multicasting because of the number of students participating in a session. However, we expect only a few people, typically the teacher and an assistant, to be involved in the steering and monitoring process. Therefore, we can use normal, TCP/IP based, Web server-to-browser communication to coordinate the browsers of the controller group. The entire interface is a set of CGI scripts/programs, JAVA scripts and applets that access a protected directory on the server side and communicate with IRI through Unix sockets and with direct access to the IRI file tree. Each Web page presented to the user requires a proper authentication token that is only obtained by password authentication.

To start a session a teacher goes to the appropriate web page and authenticates herself. After specifying on subsequent pages the configuration for that session (machines to be used, servers, lesson plan) and the location and identities of specified controllers and monitors (defaults are available for all of these), she starts the session by sending a set of messages to the IRI process. We use the interface button for "class management" of IRI to connect to these browsers and make them active for all the controllers and monitors. Thus, at any time of the session, the teacher, for example, can click on "class management" and bring the browser to the foreground and click on "start replay" and proceed from thereon as described below. Similarly, the monitor can bring up his Web page at any time and proceed to monitor the session using the pages provided.

4.2 Content Synthesis and Presentation

Assume that a group of students have started a session to review a previously recorded session. The group leader started the session on his PC in an office and has decided to steer the session himself on a machine in the IRI classroom that has no monitor. After logging on the machine, he uses regular IRI features to communicate with the other students. At some point he brings his control browser in the foreground and clicks "Activate replaying." A cgi script will ask him to identify what session to replay and when that is specified, present him with a synopsis of that session through JAVA applets as shown in [Fig. 2]. The JAVA applet knows already what session is to be replayed and presents a list of participants who spoke or had their image present and at what times of the session. In addition the leader can select the level of abstraction the presentations should be given. The choices are class, presentation, and slides. The first one implies that the applet will only show from which classes the leader of the recorded session used presentations. In the second choice, the applet will present the times each different presentation was on the screen during the session. In the example shown in [Fig. 2], the leader selected the third option and was given all the slides visited during the entire recorded session. The key is that each of these applets' windows can be left on the screen and at any time the leader can click on any of the time intervals to start replay at a particular point of time. These windows provide the synopsis of the session in different forms and depending on how a person remembers best, she can choose whatever stream is most appropriate.

Once the leader clicks on a particular time interval, at a spot estimated, the applet computes from the two shown endpoints of the interval the time the user intended and sends a message to the replay IRI process. This one in turn, computes which IRI process was active at that time and sends messages to activate the appropriate processes (audio, video, or presentation tool). The replaying process selects a window on the IRI interface, tags it as being a recorded window, and plays as long as the next event happens, e.g., stream ends or next slide is shown.

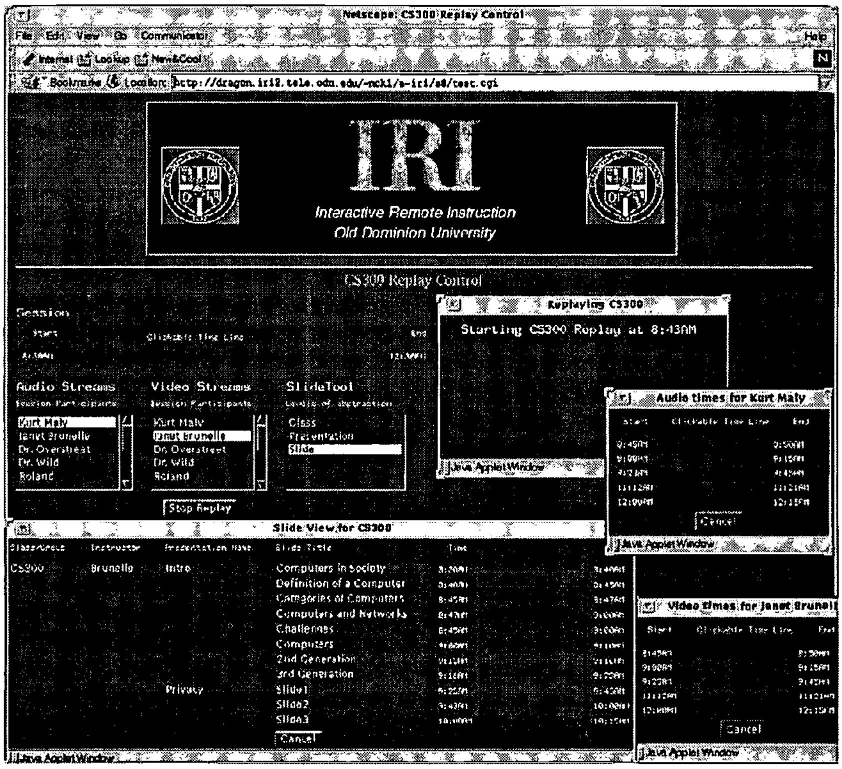

Figure 2: Replay Control Panel

5. Status and Future Work

At this point we have the first version of recording and replaying implemented and tested; it is not yet being used in an actual class environment because not all the features shown in [Fig. 2] are complete. At the next level we will use the same process for the remaining special IRI tools such as survey, exam, and coordinated browsing. The next major step will be to synthesize and abstract the recording of arbitrary X tools that were used in a session. Since we have no control over these tools, we will not be able to provide any summary information except screen images at selected time points. But even with these images as index to a time interval we have the problem of starting an X tool in the middle of its execution. We are investigating the concept of fast forward for the playing of X tools which will elide X commands which are not relevant after a certain time.

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Multiple Presentations of WWW Documents Using Style Sheets

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Abstract: We believe that complex documents can be better understood when the reader is able to choose a presentation style that suits the reader's task and situation. We have modified NCSA's WWW browser Mosaic so that it supports this type of user-centered presentation control. The primary change has been the addition of support for style sheets that specify the appearance of the HTML documents displayed by Mosaic. Our modified browser, called Multiple Presentation Mosaic or MPMosaic, supports a variety of presentation styles designed to address a wide range of user goals. Furthermore, it is capable of showing multiple presentations of the same document simultaneously. We conclude that the addition of style sheet support can add useful functionality to existing browsing and editing applications.

1. Introduction

We are interested in the presentation of information, i.e. how information can be displayed or played back on a computer. Specifically, we are interested in exploring the extent to which style sheet technology can be used to provide a variety of useful views of the same information. Our research is based on the premise that in order to understand a complex information artifact, that artifact must be presented in multiple ways and that sometimes it is very helpful to see multiple presentations simultaneously. Our focus is on providing multiple presentations of tree-structured documents, such as those represented by HTML [Raggett 97], SGML [ISO 86], or XML [Bray et al. 97]. This paper describes our work with Multiple Presentation Mosaic, a modified version of the NCSA Mosaic browser for the World Wide Web.

MPMosaic allows its users to control the appearance of the HTML documents it displays by choosing a *presentation style*. Presentation styles can vary in several different ways:

- Presentations of a document may vary in stylistic properties, such as font size or foreground color. One presentation might use the 12 point "Times" font while another uses 18 point "Helvetica."
- Presentations can differ in layout. For example, a journal article may be laid out in one column or two columns.
- Presentations can also differ in the content displayed. A presentation that provides a table of contents only displays the section headings of a document and omits the rest of the document. It is often useful to only display a particular element type, such as figures or images.

This work with MPMosaic grows out of a belief that readers will better understand complex documents when they are able to choose a presentation style that suits their varied tasks and situations. A *user-centered* presentation system provides the flexibility to meet the needs of different educational goals, different levels of intellectual abilities, and different physical abilities. Nearsighted and young readers may want to enlarge text. Color blind readers may want to adjust the colors used in a document. Researchers looking through many documents may want to limit their reading to abstracts and executive summaries. Authors may find views of a document's outline and structure helpful for writing and editing that document.

There are two basic approaches to providing multiple presentations of the same document. The first approach is to hard-code presentation choices in the implementation language of a browser or editor. This works well if the range of presentations that are useful is known in advance. However, it places the responsibility for designing and implementing alternate presentations on the program's designers, who often lack the omniscience necessary to anticipate the diverse needs of users. Examples of this approach can be seen in CAD applications and in commercial word processing and graphics software.

We prefer a second approach based on style sheets. A style sheet is a specification of appearance for a collection of documents with similar structure. Style sheets may be written in a specification language, such as CSS [Wium, Bos 96], DSSSL [ISO 96], P [Quint et al. 95], or PSL [Munson 97], or may be defined using a GUI (as is common in commercial software). Unlike the hard-coded approach, the use of style sheets embodies a useful separation of concerns. An editor or browser that uses style sheets can be built around formatting services that have no knowledge about the way that a particular type of document should look. Instead, the editor/browser gets all of its appearance information from the specifications in the style sheet.

Style sheets provide a number of benefits. Adding or changing appearance styles does not require changes to the source code or recompilation of the application --- only the style sheets need to be changed. Style sheets are generally much simpler to write than application source code, because of their restricted domain. This makes it more likely that sophisticated end users will develop new styles and views of documents in order to obtain presentations they desire. Furthermore, the application's formatter is generally smaller and more generic, which makes it simpler to implement and easier to retarget for new classes of documents or new uses.

Applications differ in how they approach style sheets. The Microsoft Word word processing application embeds all style sheet information in individual documents, though it does provide a limited sharing mechanism called "templates." We believe that it is much more beneficial to keep style sheets separate from individual documents because this allows a user to apply any style sheet to any document at any time and to apply multiple style sheets simultaneously to the same document.

2. Multiple Presentation Mosaic

Multiple Presentation Mosaic (MPMosaic) is a version of the NCSA Mosaic 2.6 browser for the World Wide Web that has been modified to use the Proteus style sheet system. While NCSA Mosaic provides a single hard-coded view of an HTML document (with some options for adjusting font size), MPMosaic supports a wide range of presentation styles, many of which are quite different from the standard browser view of Web documents. We have written style sheets defining the following presentations.

- *Standard view.* This style sheet mimics Mosaic's hard-coded view and produces a presentation similar to other graphical browsers.
- *Tree-structured view.* This presentation shows the tree structure of a document. The markup tags of elements are shown and each tag is indented further than its parent's tag [Figure 1b].
- *Embedded tags view.* The markup tags are displayed in the formatted document [Figure 1c].
- *Links view.* Anchors and their destinations are shown. PSL, our style sheet language, allows us to add additional information like the text of an anchor's target to the presentation [Figure 1d].
- *Table of contents view.* Shows only the headings (the H1 through H6 elements).
- *Reduced size view.* All fonts and images are shown at half size.
- *Alternative view.* The document is shown as it would appear in an ASCII-only browser.

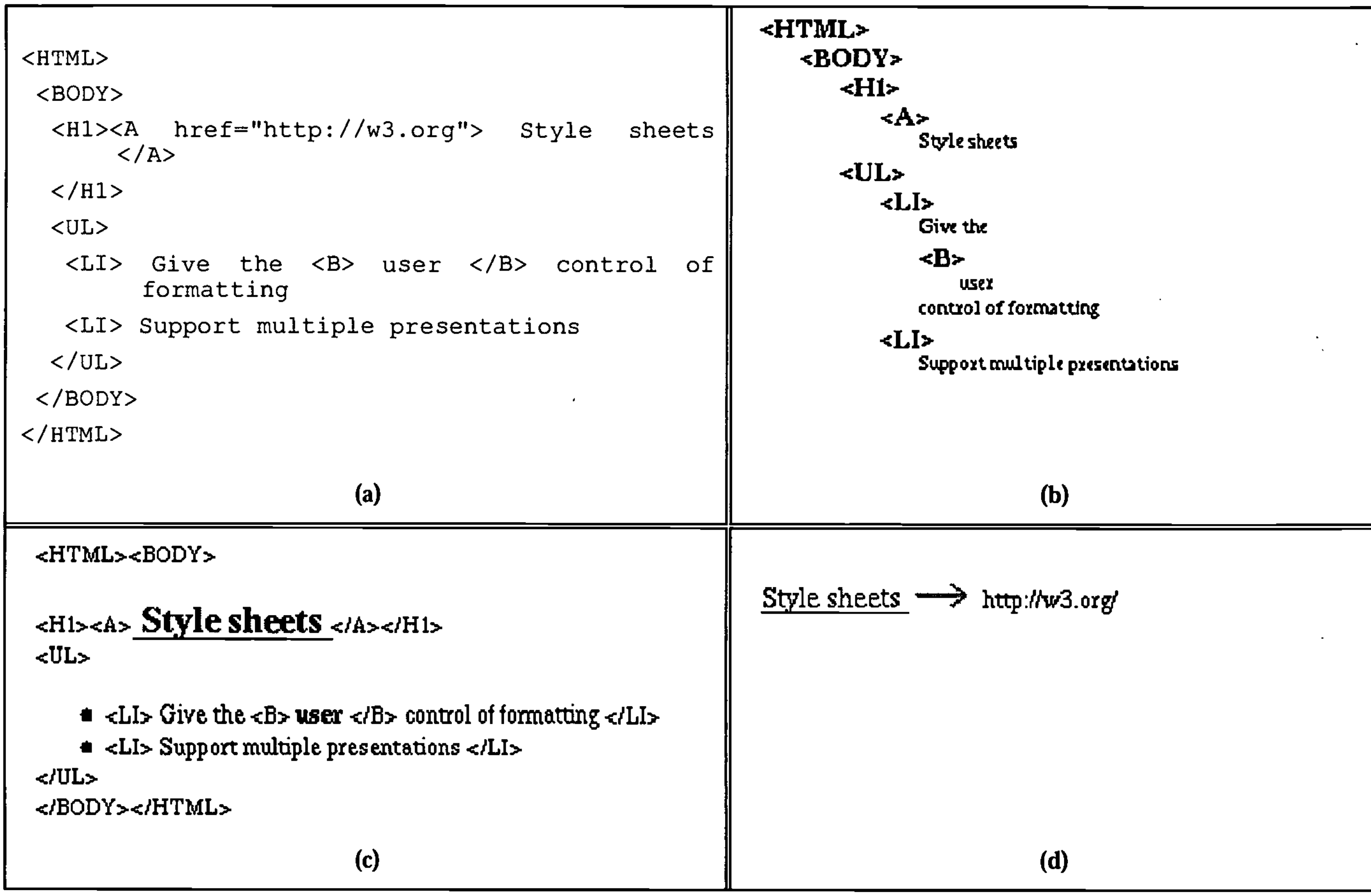

Figure 1. Three views of the HTML document shown in 1a: Tree-structured view (1b), Embedded tags view (1c), and Links view (1d).

There are many other useful views. For example, we can write style sheets that only show the elements of a particular type, such as images or tables.

In MPMosaic, a style sheet controls the appearance of a document without altering the document itself. Through a file selection dialog box, users can select their own style sheets to control the appearance of a document regardless of the document's origin or authorship. MPMosaic also supports multiple presentations --- users can open multiple windows displaying the same document with each window using a different style sheet. Multiple presentations are synchronized: when a new document is selected (i.e. a link is followed), all views associated with that document are updated.

Multiple presentations can also be synchronized to display the same part of a document. The user can specify that a view is a *display synchronization* view: clicking on an element in that view automatically updates the other views of that document to display the same element. For example, clicking on a section heading in a "table of contents" view will scroll the other views to the corresponding section of the document.

Using display synchronization, MPMosaic can generate pseudo-frames that act like HTML frames [Raggett et al. 97]. A pseudo-frame is an alternate view of the document shown in the main view of the browser window. A pseudo-frame is displayed as a side bar in the window [see Figure 2]. When a user clicks on an item in the pseudo-frame, the main view is updated to display the same item. The contents of pseudo-frames are generated from style sheet specifications. Thus, pseudo-frames have two advantages:

authors do not need to write the cumbersome HTML markup for frames and readers can easily add frames to any document.

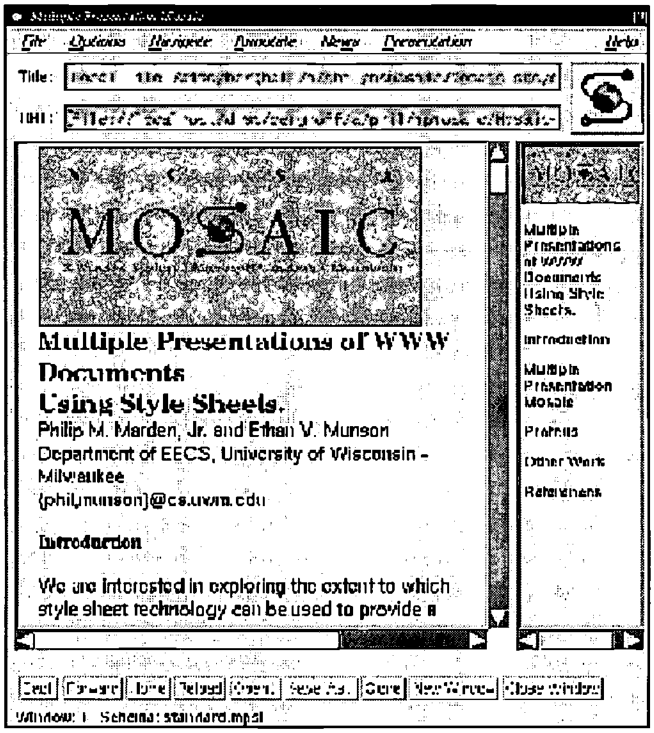

Figure 2. Pseudo-frames. MPMosaic is shown displaying the online version of this paper with an additional image. The pseudo-frame (the side bar) contains an outline of the document.

3. Proteus

Proteus [Graham et al. 92] is a portable style sheet system for documents in any medium. It is designed for use with tree-structured documents, such as those defined using SGML, but can also be used with list-structured documents. Style sheets for Proteus are written in the PSL language [Munson 95], which is a declarative, constraint-specification language.

Mosaic's formatter was not significantly altered when we added the Proteus library to Mosaic to make MPMosaic. Approximately 600 lines of C++ code were added to the 8000 line formatter in Mosaic. There were two major changes.

1. The internally representation of an HTML document was changed from a linked-list (in Mosaic) to a tree (in MPMosaic). This was done because Proteus requires the document to be represented as a tree. In addition, a tree data structure more accurately represents HTML documents (since HTML documents are tree structured), and it provides a more flexible representation for controlling presentation.
2. The values for style properties, such as font size and foreground color, are hard-coded values in Mosaic whereas in MPMosaic the formatter queries Proteus to retrieve these values from a specified style sheet.

4. Other Work

While commercial software has only recently adopted style sheet control, style sheet systems have existed in research for over 10 years. Amaya, which developed out of the Grif system, is perhaps the most prominent research application [Quint et al. 95]. Amaya has a different philosophy than MPMosaic and Proteus concerning style sheets; Amaya is author-oriented rather than user-oriented. In Amaya, all presentation views are described in a single style sheet for all users at an installation, and views require associated C functions. Thus, end users of Amaya in a multiple user environment are not free to add their own styles. Amaya provides partial support for CSS style sheets. However, Amaya embeds the style information in the document whereas MPMosaic does not alter the document.

In contrast to other systems, Proteus is an independent library that can be added to existing applications without much re-engineering. Our research has shown that interesting, non-trivial presentations can be created using style sheets. We conclude that the addition of style sheet support can add useful functionality to existing browsing and editing applications.

Our plans for MPMosaic are to continue to explore interesting presentations, to support multiple style sheets per view, and to use PSL's fine-grained layout specification [Munson 95].

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Support Units for University Teaching based on WWW[1]

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Abstract : We are living a new "Information Age". The massive use of the new information and communications technologies is producing important changes in our society, with respect to the way we live, work and communicate. The paradigm of it is the already omnipresent Internet.

One of the university's teaching objectives is to form the professionals for the future. The students, we have today in our classrooms will meet tomorrow the necessity of knowing and using these new instruments when they attain the labour market. At the same time, if used properly, these tools can help to innovate and improve the university teaching and learning process.

At the University of Girona, an interdisciplinary group has started the project to create an integrated platform where teachers can create and publish new dynamic and interactive teaching materials that make profound use of all the new possibilities offered by the information technologies. The platform will also be used by the students to access these materials in a decentralised way from anywhere on the Internet, and at the same time by the teachers to keep track of students' utilisation. It also improves and facilitates communications between students and teachers, at all levels.

1. Introduction

Among all the services that Internet can offer, the World Wide Web [W3C] (WWW or simply "web") provides an excellent platform for publishing and disseminating a wide variety of curriculum materials. These can go from textual resources that resemble traditional linear class notes, to highly dynamic and interactive non-linear materials, including multimedia resources (text, images, sound, video, animation sequences and interactive simulation applications). All these web-based materials can be available world-wide from the Internet.

The capacity of presenting multimedia information has made the web an effective tool for education. The interactive nature of this medium can enhance the teaching and learning process. It can be a fantastic tool for a constructive approach of this process, in which the educator and the learner are active agents in their respective progress. Moreover, it can be used as a mean to understand complex systems and ideas.

Internet based communications services such as electronic mail, news, Internet Relay Chat or videoconferencing tools, allow the collaboration between students and teachers. A student can communicate with its teachers and peers without the relative constraints of having to meet at specific places and times. Students can work on learning materials at own pace and discuss them with other people when they have questions, sharing experiences with others. They can learn individually but not alone; they can be physically separated but study together through computer networks.

2. The Project : the Teaching Support System

Based on the above argumentation an integrated platform is proposed. Basically, the objectives of the project are:

- Make possible for any teacher to create dynamic and interactive multimedia teaching materials, using the new standard information presentation techniques. These materials can be created from predefined templates by using imported resources made with any standard text, graphics, sound or video tool, or using specific tools such as web creators. The tools that enable this objective must be designed to be used by teachers without any previous computing knowledge.
- Enable teachers, students and authorised persons to access all resources in a decentralised manner, speaking both in terms of space and time, and with the benefits of the hypertext concept. Since all the materials are created around HTML and put on the web, they can be easily accessed from the web using any standard browser like Netscape or Internet Explorer, from anywhere and at any time. The information is structured in a non-lineal basis, and therefore each student is able to access it according to his own learning patterns, needs

[1] This work has been partially supported by the University of Girona [S-UdD97-197]

and initiative. Moreover, the use of associated technologies will make several types of multimedia and interactive units possible.

- Improve and facilitate communications and collaboration between students and teachers at all levels. The Internet gives services that facilitate the communication. The platform will make full use of these communication services in an integrated way with the materials.
- Provide an well-dimensioned environment to students in order to access the huge amount of resources available on the Internet, besides own local cites and incentive them to be active members of the net in all aspects, but also instructing them to make a wise and effective use of it.
- Give the training and advise university teachers will need in order to be able to construct didactic units for their courses, not only using the tool but making wise and effective use of courses and the Internet. Also, the collaboration between them for creating better materials is encouraged.
- This project doesn't intend to substitute the traditional teaching in the class room, but to complement it.

In order to achieve these objectives, our platform need two different main modules. One of them is used by teachers to make the units, and the other one to make it possible for the students (and other people) to use these units. We will call them Units Creation Module (UCM) and Units Navigation Module (UNM) respectively.

The main function of the UCM module is the creation of the didactic units by teachers. But it is important to highlight that we are not only speaking of computer science teachers but all teachers. Therefore, the UCM must be easy to use and it must not require any programming skills nor a lot of new tools to learn. To achieve the last goal, the UCM will be able to make use of materials created using most common standard programs, like word processors, graphics packages, etc. Importing them into predefined templates, the UCM will generate the materials ready to publish. A lot of templates will be provided to adapt to many types of materials.

The complete implementation of the UCM module will be in a further phase of the project. On the first phase, a first version of the UNM module is designed and implemented. We use already existing standard tools (under a set of basic guidelines) to make the first test units to evaluate and tune the UNM. The current performance of these standard tools have partially covered the initial objectives for the ACM module.

The UNM module is the tool used to access the materials which are created by using the UCM module. Being the units created using HTML, it could seem that using an standard HTTP client and server would be sufficient, but our project goes beyond what is achievable using the standard browser controls and common HTTP server features.

The functions of the UNM module and its utilisation are shown in the following section, the variations of the initial proposal [INET96] are also presented.

3. Navigator module description

The materials offered to the users will be structured around "units". A unit would be a lesson about some topic.

To access the units, the user needs a standard WWW browser supporting JavaScript and Java. After connecting to the starting URL [WAO], the user get a login dialogue, where the user have to identify himself by entering a login and a password. Without completing this process, the user will not be authorised to use the materials.

This login procedure shown above has two major purposes:

1. Be able to identify single users in order to keep track of them when using the units, and customise it for each of them if needed. Also, prevent unauthorised users to access the materials.
2. Be able to distinguish users categories with different privileges. The units can behave differently according to the privileges of the user. Some user categories may have access to features others will not.

Related to the above points, there are four user categories: Supervisor, Teachers, Students and Guests. The Supervisor acts as the system manager and, therefore, has total control over the UNM. He is responsible for assigning a login and password to the users, install units and keep the system running correctly. Teachers have full access to all the materials, including control and supervision features. Students will be able to fully navigate the units contents and make use of all features that the teachers prepared for them, but not the control or supervision functions. Finally, guests will have limited access to some of the units contents according to the teachers' criteria. A login and password is assigned to teachers and students by the system manager, while guest users will only have to enter "guest" as login name.

It is interesting to record, the whole process that all users carried out. All sessions corresponding to an user are added to a log-file. The units which this user has visited in this session are booked. Therefore, at the beginning of each session the user can examine its previous work.

Figure 1 shows the aspect of the main screen that the users will face after login to the system and selecting one of the available units. Note that it is only a suggestion, and the final aspect may differ or even be user-customisable, but we will use it to describe all the functions.

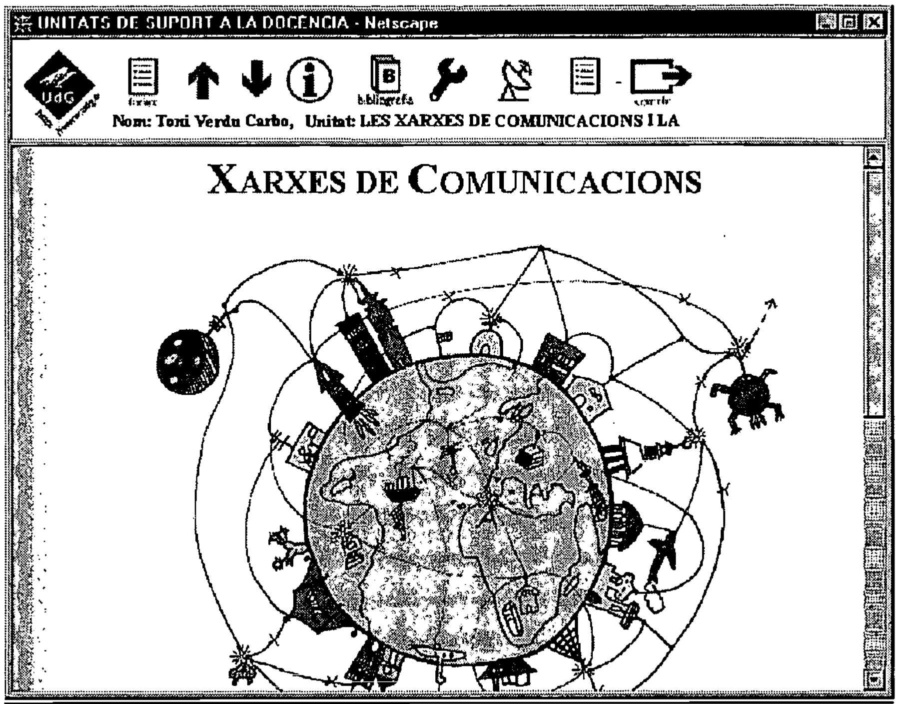


Figure 1 : Main Navigator Screen

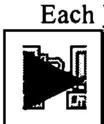
This screen has two main elements: the header and the body. In the header, is the information about the unit used (course, author, name of the page, etc...) and the buttons. These buttons give additional features to complement the basic unit contents shown in the body window, and to enhance the navigation process. The body window is where the basic contents of the unit is displayed. All the menus and toolbars from the standard browser could be disabled, so all the navigation functionality is done by using these buttons.

Initially, the body was designed as a central window rounded by several buttons. The functionality of the buttons was focused on the navigation and the interactivity between users and teacher. Each button will add a different complementary function to the basic unit contents. The buttons on the left are associated to general functions (for all content pages and even for all the units), and the ones on the right are for specific functions (the author can decide if they are active or not, depending on the content page or unit being used. Note that some of the buttons may behave differently (or even be inactive) for some user types.

During the implementation of the test bed, to experiment with the first didactic unit, the navigation module was tuned. Training with eleven users in the class room, the drawbacks of this first scheme were detected and corrected. Moreover, new features and a new distribution of the buttons were proposed. This modification process is also presented in the following section.

The major modifications have been carried out on the main presentation screen for navigating. The necessity to include more text and graphic information leads to augment the visualisation area. Therefore, from a buttons-rounded central area we changed to a single header, to identify the user, the unit and the essential buttons to active the remainder functionality.

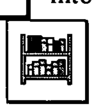
Each button is briefly described hereafter:



(Button "Navigation") First, we have the navigation buttons. Besides the common "back" and "forward" features found with all browsers, we have "previous", "next" and "up" buttons that will make possible to navigate the unit following a hierarchical order predefined by the creator of the unit.

(Button "Information") It will give information related to how the tool works, how the buttons work, etc. This is the always useful poping-up HELP window we can find in most applications. It will also include guidelines and advice to make a good use of the tool.

(Button "More information") In this case, new knowledge about the current lesson can be achieved by the user. This is the extension and consolidation of the knowledge about the unit which the user is into.

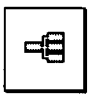


(Button "Bibliography") It shows the bibliography of the unit and links to related documents on the web. Although bibliography could have been integrated with the whole unit, we have considered that it would be useful to have it easily accessible. When a student clicks the button he will get a new window with the recommended bibliography (including books and Internet resources as well). But teachers will have additional functionality to modify the bibliography online, in a similar way as the FAQ function.

(Button "Questions") This button presents the student with complementary questions to help him know if he has learned the basic concepts explained in the unit, and make a self-evaluation. It also will give access to a set of complementary activities proposed by the teacher, like tests, exercises, concept associations, etc. The student will get automatic feedback. So he will be able to know automatically if the answers he gives are correct or not. Teachers will be able to consult students' answers over time, and get various reports like "the most incorrectly answered question" and the likes.

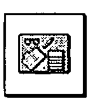
These activities are created using the UCM, and consist of a set of predefined activities. For instance, to create a test teachers will be asked for a set of information like the title of the test, the number of questions, the number of options for each question, the text of the questions and the options, the score, etc. From that input, the UCM module will generate all the necessary items in order to put the test on the server and make it work and available to the students. The same procedure will be used for all other activities available.

(Button "Tools") A set of tools are accessible to the user through this module. Utilities to seek information into the unit are provided. This information can be used by the user in the future.



(Button "Map of Contents") This button shows the user a complete tree of the unit being used, showing all pages and how they are linked. This tree will be based on the directory tree function we can find in Windows 95 Explorer, with similar capabilities. It will be possible to "fast jump" to any page of the unit by clicking on it on the tree. Moreover, this tree will inform the user about which pages have already been visited by him (and how many times, how much time he has spent there, etc.), and which ones not. It also will help the students to make a better idea of the layout of the unit and to easily locate important pages or nodes. This is a useful feature because hyperlinked documents are not lineal and therefore it is very easy to get "lost in cyberspace", or forget to visit a whole set of pages only because some link has not been followed. The teachers will be able to look not only at their own tree but at the particular tree of each student, and then warn them about any contents they may be missed.

Using that tree function it will be possible for the user to see and modify the printing order of the unit, or select a subset of pages to print.



(Button "Note book") This opens an external text editor where users will be able to take notes about the unit they are using. The objective is to give the "piece of paper and pencil" to the users who surely will need to take notes according as they study the unit. It is basically an external editor, and as with the dictionaries above, it can be either a local one or a Java applet downloaded from the server.

(Button "Print") This one is meant to solve one of the most important inconveniences people using the web are facing: how to print a whole site, or a set of pages. Browser's printing capabilities make possible to print only one page at a time (the page that is being viewed). So if anyone wants to print a set of pages he must go and download one after another and print them separately. Trying to print a whole hypertext document can be a nightmare. With the printing tool we are able to print all the pages of a unit, following a predefined order stated by the unit creator. Moreover, with the use of the "tree" function it is possible to print only a set of pages, or even change the printing order.

(Button "Progress information") Teachers will have another button that will give them access to the reports window. From there, teachers will be able to ask for a set of reports about student activity. For instance, they will be able to know all the information about any student activity, know which pages are the most and less visited, to know which question in the test is the most incorrectly answered, etc. Also, students could optionally have access to this button to get reports about their own progress.

(Button "Communications") The communication among users and between the unit's authors and users is allowed.

(Button "Synchronous communication"). This function requires communication parts to be on-line at the same time. When a user clicks this button, he is transported to an space where he is able to meet other people using the unit at the same moment, so being able to start a text-based conversation, debate, etc... It's meant to be a sort of IRC, complemented with shared blackboard, but again very simplified and with much more control by the teacher. In the future, it will be enhanced to support not only textual communication, but audio and video, thus becoming a videoconferencing tool. Using this function we can get benefits equivalent to the study in group, but without the need of people being in the same place. Virtual classrooms can be also possible.

When clicking this button, a new window will open and will put the user in the "General" conversation area. Here he will find other people and start some conversation, or he will be able to locate other conversation areas already created. The objective is to transform the General area in a meeting-point. From the general area, users will be able to join other specific topic areas, or create their own area for the topic they are interested in. Many other functionalities as connected users lists, area and users managing, etc., will also be present. Some control functions will only be available to teachers.

(Button "Teacher's mail") This button gives access to the Frequently Asked Questions (FAQ) document creator. Using some of the communications functions described later on, the students will be able to ask questions to the teacher, and this one will be able to answer them. Over time, some questions will be repeated over and over again. So, if the teacher thinks it is recommendable doing it, he will include both question and the corresponding answer into a database where other students will be able to consult it. Over time, the database becomes a very valuable document to help students for better understanding the unit contents, and the teacher finds most common questions already answered, thus saving time.

When clicking on this button, a new window appears. The students are confronted with a database consulting tool, while teachers have editing capabilities. The editing capabilities are usually restricted to a small set of teachers, or even only one of them. The FAQ documents are maintained this way just because we think that they are updated much more frequently than the unit pages.

(Button "News") It opens an space for asynchronous communications, where students and teachers are able to debate about any aspect of the unit being used. Note that asynchronous communication can take place without needing that communicating parts be on-line at the same time. This is an integrated "e-mail" and "news" feature, but controllable by the teacher. It communication also possible by using only the web and without having to have an e-mail standard account.

Clicking on this button a new window is opened. Students are able to read (and organise) their private mail, or read the messages sent to public addresses associated to any topic related to the contents of the unit. He is also able to send private e-mail to other students or teachers, or post public messages to the public addresses. All the messages are stored on the server. This scheme gives the functionality of both e-mail and news services, but with less complexity. Users will not need to have e-mail account nor e-mail and news clients, and will not need to configure anything. Teachers will be able to create public addresses and organise them, and will have total control over the whole tool.

This button makes it possible for students to ask questions privately to the teacher, without having to do it during the class, leading to better time saving and helping timid students to participate. Also, the use of the public addresses enables the creation of asynchronous debates. Teachers can promote the use of this functionality to incentive collaboration among students.

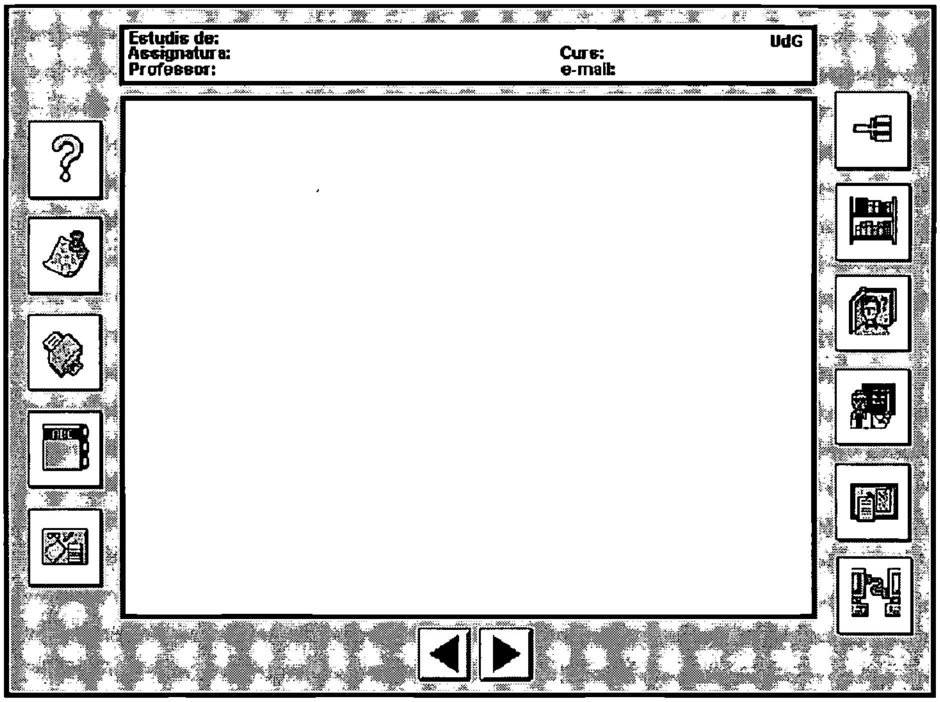


Figure 2 : The First Main Navigator Screen.

4. Conclusions and future work

This inter-disciplinary work is developed from both the first experimental unit and the users estimation, which will allow us to modify and improve the initial design. Moreover, this is a work in progress. The members of the project positively appreciate the inter-disciplinary environment to carry out the different components of the project : UCM, UNM and units contents. From initially different points of view about the matter, a more global vision that enhances the task of all members is achieved.

Note that this is a dynamic work. The design and implementation for future units also allow us to modify and evaluate the current proposal. This sort of work leads us to a true interactive platform that improves the communication between users and teachers, which is a major goal of the project. The current URL of the project is : http ://eia.udg.es/~usd.

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[W3C] W3C - The World Wide Web Consortium. http://www.w3.org

[WAO] Web Addressing Overview. http://www.w3.org/pub/WWW/Addressing

User Identification And Tracking In An Educational Web Environment[1]

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Abstract : Open Distance Learning is an emerging paradigm where students, teachers, and equipment may be at different geographic locations. The WWW provides an excellent platform for publishing and disseminating a wide variety of curriculum materials. To evaluate the impact of these materials on the teaching and learning process, user identification and tracking is needed. Current HTML clients and HTTP servers are limited in these aspects. In this paper, a solution is described based on an educational web environment. This proposal uses a server program, called Custom Server, that processes HTML pages before they are sent to the client and inserts user identification within hypertext links.

The Custom server takes also the following responsibilities : user identification and validation, HTML-document customisation, database maintenance, translation of database information into reports, control of private working documents, asynchronous and synchronous communications, and other similar capabilities.

1. Introduction

The World Wide Web [1] (WWW or simply "web") is an Internet service that provides an excellent platform for publishing and disseminating a wide variety of curriculum materials. The web is an effective tool for education because of its capacity of presenting multimedia information . Also, the interactive nature of this medium can enhance the teaching and learning process. It can be used as a means to understand complex systems and ideas. It is also a fantastic tool for a constructive approach of this process, in which the educator and the learner are active agents in their respective progress.

Internet communications services such as electronic mail (e-mail), news, Internet Relay Chat (IRC) [2] or videoconferencing tools, facilitate the communication and make the collaboration between students and teachers possible. Individual students can communicate with their teachers and peers without the constraints of having to meet at specific places and times. Students can work on learning materials at own pace and discuss when they have questions, thus sharing experiences with others. They can learn individually but not alone; they can be physically separated but study together through computer networks.

To effectively make use of these materials and evaluate their impact on the teaching and learning processes, user identification and tracking capabilities are needed. Every user must be perfectly identified, and every step he makes must be stored into a database. This database must include for each user which documents have been retrieved, how many times, how much time has been spent within, which have not been visited yet, the responses to proposed tests or exercises, etc. Based on this information the system must generate reports to provide a feedback, to both teachers and students. This information will no doubt help to improve the teaching-learning process.

As we will see further on, current standard Hypertext Transfer Protocol (HTTP) clients [3] (browsers [4]) and servers [5] and HyperText Markup Language (HTML) [6] are limited in user identification and tracking capabilities . The aim of this paper is to provide a possible solution to the user tracking and identification problem within an educational web environment. The presented solution uses a Common Gateway Interface (CGI) [7] program that processes HTML pages before they are actually sent to the client. The CGI program encodes user identification within hypertext links, enabling the server to identify users from modified links passed back from the client. In this way, it provides tracking across a series of HTTP requests while it offers a way to overcome the stateless nature of HTTP sessions without changing the underlying nature of the protocol.

2. The Teaching Support System Project. Objectives

An interdisciplinary group, at the University of Girona, has started the Teaching Support System project [8] and [9]. The main objective of this project is to create an integrated set of tools where teachers can create and publish new dynamic and interactive teaching materials that make good use of all the new possibilities offered by the information technologies and the Internet. The tools are also used by the students to access these materials in a decentralised way

[1] This work has been partially supported by the University of Girona S-UdD97-197 and Spanish Government CICYT TEL97-1054-C03-03

from anywhere on the Internet, and at the same time by the teachers to keep track of students use. It also improves the communication between students and teachers.

Several objectives of the teaching support system project can be identified. A major goal is to allow teachers to create dynamic and interactive multimedia teaching materials (from now on, "units"), using the new standard information presentation techniques (HTML, Java [10], javascript [11], complemented with Common Gateway Interface programs (CGIs), Server Side Includes (SSI) [12], etc.). The tools are designed to be used by teachers with any level of computing knowledge.

Teachers, students and authorised persons access to the available resources in a decentralised way, speaking both in terms of space and time, and with the benefits of the hypertext concept. The information is structured in a non-linear basis, and therefore each student is capable to access it according to its own learning patterns, needs and initiative. The communication and collaboration between students and teachers is enhanced. The Internet gives us several services that facilitate this communication. The platform must make full use of communications in an integrated way with the materials.

However, this project does not intend to substitute the traditional teaching in classroom, but to complement it. In order to achieve these objectives, our approach has two different main modules. One of them is used by the teachers to make the units, and the other one makes it possible for the students (and other people) to use these units. We call them Units Creation Module (UCM) and Units Navigation Module (UNM) respectively.

The main function of the UCM is the creation of the didactic units by the teachers. But it is important to highlight that we are not only speaking of computer science teachers but all teachers. So the UCM must be easy to use, and it must not require any programming skills nor a lot of new tools to learn. To achieve this last goal, the UCM can make use of materials created using most common standard programs, like word processors, graphics packages, etc. Importing them into predefined templates, the UCM generates the units ready to publish. A complete set of templates is provided to adapt to many types of needs.

The implementation of the UCM module is postponed to a second phase of the project, although some parts are already being developed. In the first phase, we design and implement a first version of the UNM module, and we mainly use already existing standard tools (under a set of basic guidelines) to make the first test units to evaluate and fine tune the UNM. After the UNM is evaluated and validated, the final design and implementation will be made. Then, the UCM module will be designed and implemented.

3. The user tracking and identification problem

The UNM module is the tool used to access the units created using the UCM module. But many of the UCM functionalities require a perfect identification of every single person accessing the system, and must be able to completely track each action this person is performance. For instance, the UNM needs to perfectly know who is accessing which document at any moment, or the answer he gives to any exercise. It would also be interesting to keep some kind of "state" about the user's navigation through the materials, for instance, to enable users to start any new session where they left their previous session. Some of those UNM functionalities that require user tracking and identification are:

Personal Working Space. By clicking a single button, users have access to a personal document with editing capabilities. The objective is to give to the users the "piece of paper and pencil" they certainly need to take notes according as they study the unit. The editor can be either a local one or a Java applet downloaded from the server. In the first case, users are responsible for their documents (name, location, saving it, etc.), while in the second one, the document resides on the server machine, and thus, is automatically loaded and saved when starting or exiting the working space tool.

The Navigation Tree. This tool shows the complete structure of a unit (all their pages, and how are they linked). It makes it possible to "fast jump" to any page of the unit by clicking on the tree. Moreover, this tree informs the user about which pages he has already visited (and how many times, how much time he has spent there, etc.). The Navigation Tree is a useful feature that helps to solve the main hypertext inconvenient: hyperlinked documents are not lineal and therefore it is very easy to "get lost", or forget to visit a whole set of pages only because some link has not been followed.

Complementary Activities, Tests and Exercises. The units can contain complementary activities proposed by the teacher : multiple choice exercises, concept associations, etc. are classical examples. The student gets automatic feedback, being able to immediately know if the answers he gives are correct or not. These activities are created using the UCM, and consist of a set of predefined activities.

Reports. At any moment users can get reports about how the unit is being used. Teachers can ask for a set of reports about the student activity. For instance, teachers will be able to know all the information about any student activity. Also, students can get reports about their own progress. A complete set of activity reports is available.

All these functions, and obviously asynchronous-synchronous communications, have to be implemented with users identification. But current HTTP protocol is very limited with respect to this topic. Therefore, some of the features needed for the UNM are difficult (or impossible), when standard browsers and servers are used. It can be said that the HTTP is an stateless protocol, that is, every request to the server is treated independently, thus a request has no information of previous related requests. In particular, two consecutive accesses made by some students are not related at all from the server point of view. Moreover, a web browser user does not need to identify itself in order to navigate the web, since an HTTP request carries no information about the user, so the server cannot track users.

Therefore, to add identification and tracking capabilities to the basic HTTP client-server scheme is necessary to make all the above functions possible. Moreover, a major design objective is the UNM portability; that is server and platform are independent, and accessible by standard web browsers. We considered some previous possible solutions which are briefly described in the following:

Using the standard log files generated by the server. When a user selects an HTML page link, the browser requests some contents from the HTTP server, (see Figure 1). The server gets and sends the HTML document to the browser. The server keeps several logs for each transfer, but these logs keep only track of content items requested (pages, images, etc.), time, date, the client machine name and IP address. As with most popular operating systems, the use is not identified onto the machine, and the browser does not send any user identification on requests; different users on the same machine generate identical entries into the log file. In this case, whenever different students use the same machine, to keep track of each different student activity is impossible (see Table 1). The server logs only register accesses from the computer, but it is unable to know if they are from a single user or not, and even who is making the requests.

```
pc1.udg.es - - [22/Oct/1997:18:00:38] "GET /~usd/CS.CGI?2WuJ1uJ1uJdxwqaZSKaCaoM HTTP/1.0" 200 511
pc1.udg.es - - [22/Oct/1997:18:00:38] "GET/usd/Prog/Users/guest.tmp.html HTTP/1.0" 200 1743
pc1.udg.es - - [22/Oct/1997:18:00:39] "GET /~usd/CS.CGI?504J1uScfwnuA11Z3o1ZWZ7 HTTP/1.0" 200 1834
pc1.udg.es - - [22/Oct/1997:18:15:32] "GET /~bueno/ HTTP/1.0" 200 4477
pc1.udg.es - - [22/Oct/1997:18:15:34] "GET /~bueno/graficos/es0.gif HTTP/1.0" 200 1259
pc1.udg.es - - [22/Oct/1997:18:15:34] "GET /~bueno/graficos/en0.gif HTTP/1.0" 200 1491
```

Table 1 : standard log file contents

Some entries from a standard log file are showed in the Table 1. Each line represents a request made to the HTTP server. The information shown is relating to the client machine (for instance pc1.udg.es), date, time, the type of request (usually GET), the URL requested (for instance /~usd/Icons/logo.gif). Note that it is impossible to know if requests made from pc1.udg.es (a computers room machine) at 18:00 and 18:15 are from the same user or not. Since standard logs do not save the information that is needed, and they are not a valid solution under our design strategy.

Modify an existent HTTP server in order to adapt it to the tracking and identification needs. Most of standard servers have some Application Programmers Interface (API) that would enable to carry out tracking and identification functions. However, the applications produced for a specific server API are rarely usable by a different server. Moreover, APIs link the application code into the server core, hence, a bug in one API-based application can corrupt other applications or the server, or some malicious application could steal security information from the server. Furthermore, APIs are tied to the internal architecture of a particular server, hence, changes on the server also imply changes on the API, and consequently to the applications which are using the API. In [13] a solution based on APIs is proposed, the client is modified, therefore, similar problems are found. This solution was definitely against our design objectives.

Using Cookies [14]. Netscape proposed Cookies as a mechanism to enable the server side of an HTTP connection to store and retrieve information on the client side; this task is usually carried out by a CGI process. When returning an HTTP object, the server may also send some state information to the client, this state can be stored. The state information includes the range of URLs for which the state is valid. Hence, any future HTTP request made by the client within this range will include the state information, and thus will be passed back to the server. This allows to carry out an identification information within the HTTP requests. Common practice would suggest using these cookies to carry out state and identification information. We discarded it because cookies are not a standard feature, and need non-standard extensions for clients and servers [12]. Moreover, with most common operating systems and current browsers, cookies on a particular client browser are shared by all users who are using the browser, consequently leading to security and identification problems. Cookies can also be easily disabled, copied, modified or erased. Finally, cookies are stored in the client machine, thus the users, who use different computers to log into the system, finish with different state information on each of these computers. For instance, if a user logged in the system using a different client machine would appear in the system as "new" user, since his previous history is ignored. The method to prevent that problem is storing the state information on the server, cookies cannot serve this purpose.

Using standard HTML forms [15]. The forms can contain user identification or any needed state information within hidden variables. The HTML pages that include these forms would be generated dynamically on the server by

CGI programs. When the user pushes the submit button on his browser, these variables are sent back to the server, a CGI could process the information within the hidden variables, and then generate new forms with the new state information into the hidden variables. All served pages should be based around an HTML form, and users should submit them every time they use the application, this is the major limitation of this method. This approach constrains the format of the pages beyond an acceptable limit, as using normal HTML pages would be impossible.

Client-server application using Java. It would also be possible to build a custom client-server application using the Java language. In this case, the user downloads the client from a standard browser; from now on the transfer is carried out using a custom protocol which is designed to support full user identification and tracking. The main drawback is that Java applications are still very slow and resource-consuming at the present.

In [16] a solution is proposed. The major drawback is that an special dedicated client viewer is needed, which must be downloaded and installed by the users before they can start the educational process.

4. The Adopted solution: description of the Custom Server

To overcome the drawbacks of those proposals, while standard browsers and HTTP servers can be used, we propose the utilisation of a CGI compliant program running on the server machine called Custom Server (CS). This approach uses any standard HTML browser running on the local (client) machine and any standard HTTP server running on the remote (server) machine, which support CGIs (see Figure 2). The contents (i.e. the pages including images and Java applets) is written in the HTML format, therefore, any standard editing tool can be used.

The CS is placed between the standard HTTP server and the contents. Consequently, the requested HTML documents are not directly provided by the HTTP server. The information is adequately conformed by the CS by inserting user identification within hypertext links, and redirecting them again to the CS.

In general, the modification of URLs pointing to local HTML files is needed. Note that not all local URLs need to be transformed; most images (and other contents items like Java applets, etc.) do not need to be tracked, hence their URLs are not modified. Therefore, the HTTP server must also be able to access the contents without passing through the CS.

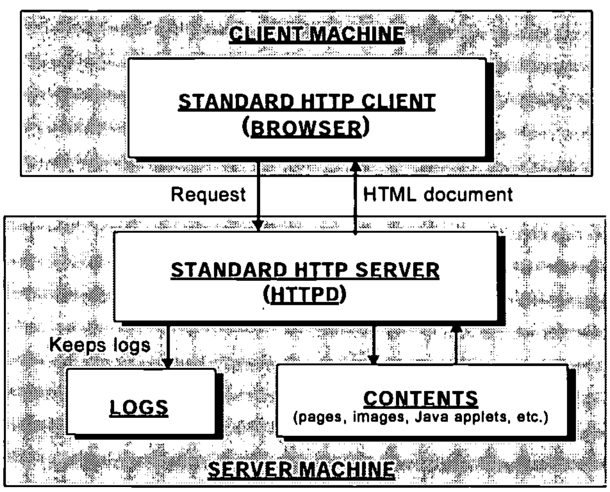

Figure 1 : HTTP Architecture

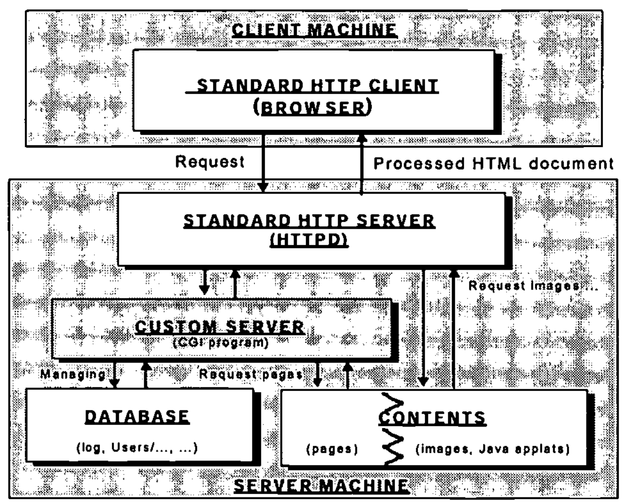

Figure 2 : Proposed Architecture

The contents is stored as HTML pages with "normal" links, and the CS is responsible for the customisation of these pages before they are served according to each user, meanwhile storing information about his navigation steps. Each single page request passes through the CS, thus the CS is able to have a entire control on the accesses mechanism. Any necessary information can be computed, stored and then retrieved at any time.

To store all of this state information about users, the CS maintains a database that overcomes the lacking of default log system which is offered by the Standard HTTP Server. This database includes not only the accessed pages and from which remote machine, but also the information needed to track the user navigation, i.e. which users log into the system, what materials he has accessed, how many times, how much time he spent on it, the responses to proposed tests or exercises, the last pages accessed, etc.

The creation of HTML reports containing the information stored into the database is an important function of the CS. Several reports that users and teachers may need can be easily implemented from this database. Finally, the CS is responsible for another UNM functionality, that is: FAQ accessing and FAQ maintenance, control of working documents, asynchronous and synchronous communications, etc. All of these functions are implemented in the CS.

4.1 The identification process

At the moment of starting the connection, by opening the entry URL [17] using any browser, the user is faced with a login dialogue where, by entering login and the password, he is identified. Without completing this process, the user will not be authorised to use the units on the teaching support system.

The above login procedure has three main purposes : a) to prevent unauthorised users to access the units, b) to be able to identify single users in order to keep track of them when using the units, and customise the context if needed, and c) to be able to distinguish between user categories. The units can behave differently according to the privileges of the user. Some user categories may have access to features others would not.

Related to the third purpose, there are four user categories: Supervisor, Teachers, Students and Guests. The Supervisor acts as the system manager, therefore he has the entire control over the UNM functions. He is also the responsible for assigning login and password to new users, install the units and keep the system running. The teachers have full access to the units, and they can control and supervise their own ones. The students can fully navigate contents of the units and make use of all features that the teacher have prepared for them; but they only can control and supervise their own personal information. Finally, guests have limited access to some units contents, according to the teachers' criteria.

The description of how the identification process is implemented, is explained by an example in the following. First, a user has just entered the login (Enrique) and password (K3db21) on the initial identification page, that is made in a HTML form. By clicking the submit button, the following URL is requested to the remote HTTP server:

http://eia.udg.es/~usd/CS.CGI? Function=ID& User=Enrique& Passwd=K3db21

When the HTTP server gets this request, the Custom Server CGI program (CS.CGI) is invoked. Three parameters (after the "?" and separated by "&" chars) are passed to the CGI on the URL. The first parameter ("Function=ID") informs the Custom Server about an identification request. The first parameter is the function that the Custom Server has to perform. The next parameters are the user name identification (or login) and password that the user just introduced.

4.2 Inserting user identification within hypertext links

The CS must check this login and password in the database. If this is correct, the CS gets the default root page from the contents. Before passing the page to the HTTP server, which will serve it to the browser, the local URLs are customised as is shown in the following. Suppose the starting (root) page contains the following HTML expression:

<A HREF="subject1.html">SUBJECT 1</A>

then the CS explores the HTML source to locate such a local URL, which is transformed to:

<A HREF="http://eia.udg.es/~usd/CS.CGI? Function=PR& User=Enrique& URL=subject1.html> SUBJECT 1</A>

The served page has the modified URL containing the user identification. After some time the user may click on that link, then a new request is passed to the Custom Server. In this case, the value of the function parameter is "PR", that is a page request, the second parameter identifies the user requesting the page, and the third parameter is the name of the page requested.

The CS gets the desired page (subject1.html) from the contents pool, and customises this page in the same manner as before. Subsequently, the CS passes the modified page to the server which actually delivers it to the browser. The CS also reflects on the database that this user is getting this page, and any other needed information.

To simplify this presentation, aspects as parameters encryption to avoid security problems, or questions related to more complex URLs, are omitted. In the current implementation, parameters passed to the CGI are encrypted. URLs contain security information to avoid URL copying and pasting into other browsers that could lead to several problems. The encryption algorithm contains time-out information, hence URLs expire after a reasonable amount of time. It also contains information about the client machine. Consequently, copying URLs from one browser to another on a different machine, the mechanism does not work as desired. Finally, a "request-sequence" information is also used, hence, copying the URL to another browser on the same machine will also fail, preventing the user from "parallel navigation" which could confuse de Custom Server.

4.3 Database management and HTML Report documents

By the user identification, the Custom Server can maintain a database that overcomes the stateless nature of the HTTP protocol. The database consists of a set of log files, similar to the standard HTTP-server log files, but also storing the complementary user information. Mainly, a general log file where users login and logout are stored; but another particular log file associated with each user is also maintained. In this case, the requested pages and the time spent are saved.

The contents of general log file (Table 2), and user Enrique's log file (Table 3) are described in the following.

Date	Time	Action and Usemame	Client Machine
9/Sep/97	(20:29)	Loginusuario:enrique	(morgan.udg.es).
9/Sep/97	(20:33)	Loginusuario:toni	(atreides.udg.es).
9/Sep/97	(20:42)	Usuario:enrique logout de lacuenta.	

Table 2 : Custom log file contents

Requested HTML-document	time spent in seconds
*Unidad: LES XARXES DE COMUNICACIONS I LA INFORMÀTICA	
teleinfo/index.html	9 (00:00:09)
teleinfo/repercusions/comunicacio.html	227 (00:03:47)
teleinfo/index.html	330 (00:05:30)

Table 3 : One session tracking information.

The Custom Server analyses these files and translates the information into HTML reports. By consulting these reports, both teachers and students may be able to evaluate how the materials are being used, and to improve the teaching-learning process. In [12] a similar solution is proposed for similar objectives. But, since all state variables are embedded into the URL, the state cannot be preserved between different sessions at the application level.

5. CONCLUSIONS AND FUTURE WORK

In this paper, a solution to the user tracking and identification upon a educational web environment is proposed. This approach is implemented into a wide project that needs to keep complete track of users who access to a set of contents published on the net. This approach is relatively easy to implement, it also gives enough flexibility and it is compatible with any standard HTML web browsers and HTTP servers.

This is a work in progress, consequently, some parts are still being implemented. Therefore, some above aspects may change in the future, new functionality may be added, like new reports, according to the suggestions of the actual users. The adopted solution gives sufficient flexibility to adapt the platform to future needs.

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The Design of Recursive Programming Exercises Based on Behavior of Programs

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Abstract:It is very important task for a student to compare problems in exercises. To design the learning support system which assists novices to compare two problems, it is necessary to definea problem representation and control the comparisons by using the representation. In this paper, we described a method to compare between two problems based on the U-behaviorwhich is a representation for simple recursive programs and we described facilities of comparing between problems which are (a) generating explanation of differences and similarities between two problems, (b) searching problems for comparisons, and (c) generating exercises of grouping problems. And we have also described implementation of a learning support system which helps a student to compare between two problems. Finally, we described an experimental evaluation of the facilities.

1. Introduction

Novices can't solve a problem no matter how similar problem they have solved. One reason is that they understand a solving depends on the problem. They don't understand it as a strategy can be used for many problems. In this case, it is very important to provide them with not only instructions about each problem but also with instructions regarding similarities and differences between problems.

In educational situations, comparing problems is very popular. Polya made a representation for comparing problems [Polya 54], and Hirashima proposed a model of mechanical problems based on the process of problem solving [Hirashima 94]. In this paper, we designed functions for guiding novices in understanding similarities and differences between two problems in learning recursive programming by using a description of program behavior. Our system aims to help students, who have learned a programming language, to learn a behavior of recursive programs. And it also provides with a programming exercise. The functions we designed are required by such a system.

Most studies of programming instructional systems assist novices to solve a problem [Timothy 92][Ueno 94][Itoh 94]. They implicitly deal with comparing problems. We have already proposed a desription of a recursive program behavior and a solution for novices to write recursive programs. We called them U-behaivor and U-solution. And we confirmed the effectiveness of the U-solution in an experiment which compared it with a programming textbook.

Programming instruction requires an explanation about specifications and about behaviors of programs. But recursive programming is very difficult for novice programmers to understand a behavior of a recursive program. One reason is that there are differences between the order of statements and the order of the excution of those statements. In this paper, we discuss an instructional system which assists novices in understanding and designing the behavior of recursive programs.

We have already proposed a representation of behavior of simple recursive programs [Matsuda 95]. The U-behavior is representation for recursive algorithm and The U-solution is a procedure for nivices to make simple recursive programs with the U-behavior. In this paper, we described a method of comparing between two problems based on the U-behavior and facilities of comparing between problems which are (a) generating explanations of differences and similarities between two problems, (b) searching a problem for novices in order to compare problems, and (c) generating exercises of grouping problems. The system goal is that novices understand the U-solution. We have also described implementation of a learning support system which helps a novice to compare between two problems. Finally, we described an experimental evaluation of the facilities.

2. A representation for recursive programs

This section discusses the U-behavior and the U-solution which help novices understand and design a simple recursive program.

2.1. U-solution

A number of simple programs (or program specifications) have a common structure; we have derived the common structure from some programs to use the structure as a template. To describe the recursive algorithm, we have identified 4 components of the simple recursive program. We currently deal with simple recursive programs which include one recursive call, and one terminating condition for recursion. For example, Figure 1 is the U-behavior of the factorial program. Factorial is the product of all the positive integers from 1 to a given number.

The first component is the statements which are above the recursive call are repeatedly executed. In this case, the subtraction is repeatedly executed (Figure1 (1)). We call it Pre-recursion sub-procedure. The second componet is condition to terminate the recursive call. This condition must be placed before the recursive call. In this case, the terminating condition is that the input data is equal to zero (Figure 1(2)). We call it Terminating Condition. The third componet is the initialization fo return value when the recursive call terminates. In this case, the initialization is to set output data one (Figure 1(3)). We call it Return Value Initialization. The Last component is the statements which are after the recursive call are repeatedly execulted (Figure 1(4)). In this case, the multiplication process is repeatedly executed. We call it Post-recursion sub-procudre.

2.2. The U-solution

The U-solution has followin three steps:

(1) Novieces fill in parts in the U-template to complete the U-behavior from a program specification.

(2) Novices check the U-behavior. (They can use the algorithm visualization tool(**Figure 3**).)

(3) Novices fill in parts in the program template to complete the recursive program from the U-behavior.

The U-template consists of four blanks. Novices can fill in four parts in the U-template to write the U-behavior. Currently we prepare the U-templates and parts for Prolog and C.

3. Facilities of comparing two problems

We described the system which assists the novice programmer to learn recursive programming. Especially, we described the facilities of providing novices with the differences and similarities. We realized the learning support system with the U-behavior. The U-behavior is a representation for recursive programming problems.

3.1 Representation for the differences and similarities between problems

We used the U-behavior as a representation of a problem. The U-behavior consists of four parts. The similarities are represented with parts which are common in two U-behaviors and the differences are represented with parts which are different in two U-behaviors.

Figure 2 shows an example of representing similarities and differences between the append program and the re-

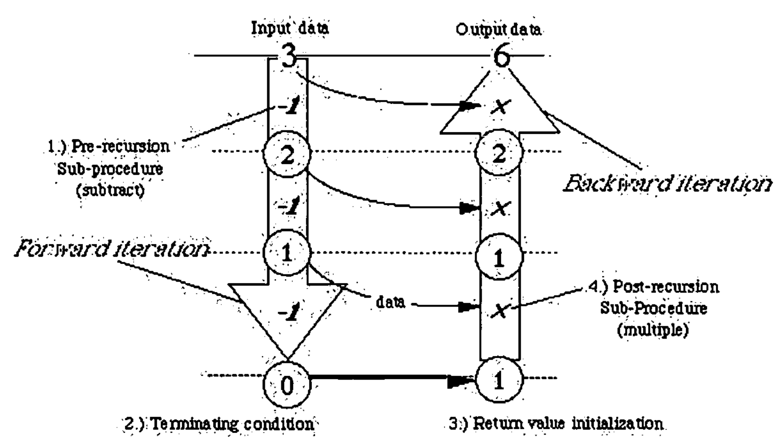

Figure 1: The U-behavior of the factorial(3)

verse program. Append program is to connect two input lists and Reverse program is to reverse the order of the input list. The similarities of these U-behaviors are to eliminate the first element in the first input list until the list becomes the empty list, ton keep the second list, and to combine the element with the output list. The difference of these U-behaviors is the time of combining the element with a list. The append program combines the element at Post-recursion Sub-procedure. The reverse program combines the element at Pre-recursion Sub-procedure. These similarities and differences between two U-behaviors can be represented with parts of U-behavior.

3.2 Facilities to compare problems

We designed the facilities to compare problems based on the U-behavior. The facilities are (1) generating explanations about differences and similarities between two problems, (2) searching problems for comparisons, and (c) generating exercises of grouping problems.

3.2.1 Facilities to generate explanations about differences and similarities

The basic facilities in the exercise to support comparing problems is generating explanations about differences and similarities of problems. Our system automatically provides text and animations for explanation. The text and animations are generated by parts of the U-behavior.

First, we described the method to generate a text for explanation. The system generates a text to combine a text of a program specification and a text of a U-behavior part which is written by expert (programming teacher). To combine two text, the system uses a text template . Text for similarities is combined the text template with text of parts which are the same in the two U-behaviors. Text for differences is combined the text template with text of parts which are the different part in the two U-behaviors.

Figure 2 (C) shows the example of the representation for similarities and differences between the append program and the reverse program. To generate a text, the system combines a template with text of these parts. Text of a U-behavior for the append program is "The **1st_Input_List** was eliminated the first element by a element until it was the empty list. The **2nd_Input_List** was not changed. When recursive process terminated, the **Output_List** was initialized the **2nd_Input_List**. The **Output_List** was added the element as new 1st element from the **1st_Input_List**." The underline shows text for parts of the U-behavior. Text of a U-behavior for the reverse program is "The **1st_Input_List** was eliminated the first element by a element until it was the empty list. The **2nd_Input_List** was added the element as new 1st element from the **1st_Input_List**. When recursive process terminated, the **Output_List** was not changed." Text for similarities between them is "The **1st_Input_List** was eliminated the first element by a element until it was the empty list. When recursive process terminated, the **Output_List** was initialized the **2nd_Input_List**." Text for differ-

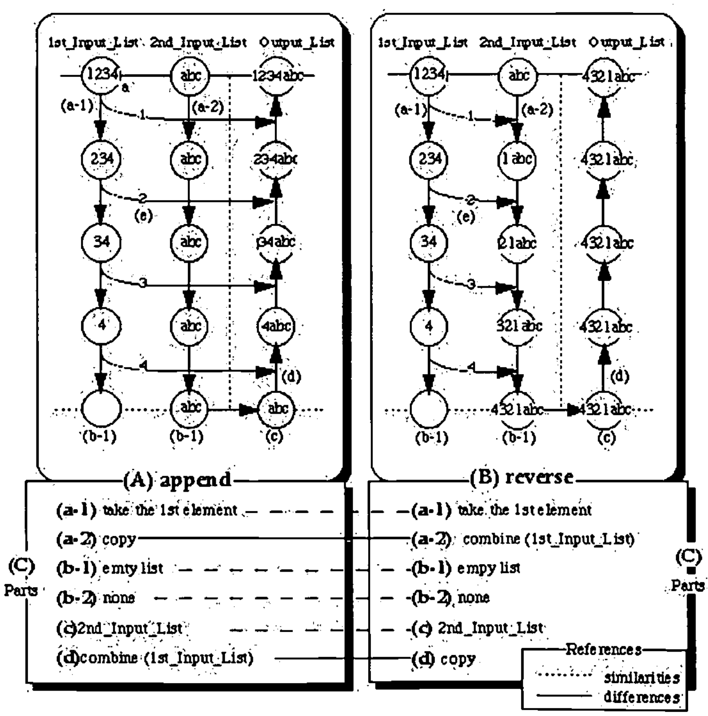

Figure 2. The similarities and differences of the U-behavior between the append and reverse.

ences between them is "In the append program: at the Pre-recursion Sub-procedure, the **2nd_Input_List** was not changed, and at the Post-recursion Sub-procedure, the **Output_List** was added the element as new 1st element from the **1st_Input_List**. In the reverse program: at the Pre-recursion Sub-procedure, the **2nd_Input_List** was added the element as new 1st element from the **1st_Input_List**, and at the Post-recursion Sub-procedure, the **Output_List** was not changed." Furthermore, the system provides text of program specifications which is written by experts in order to explain the references between the U-behavior and a program specification. A specification of the append program is "The **Output_List** is made to connect the **1st_Input_List** and the **2nd_Input_List**." And a specification of the reverse program is "The **Output_List** is made to reverse the order of the **1st_Input_List**, and connect the list and the **2nd_Input_List**."

Next, we described the method to explain with animation of the U-behavior. The U-behavior is representation for the behavior of recursive program. Then, Animation is very effective representation for novices to understand the U-behavior. Figure 3 show the example of explaining with animation of the U-behavior. In Figure 3, the downward movement of The **1st_Input_List** represents the process of eliminating the first element form the **1st_Input_List**. Hence, the **1st_Input_List** divided in two lists, the first element moved the right, the rest of the list moved downward. In the append program, the first element of the **1st_Input_List** which moved the right is added to the **Output_List** by the glove icon. In the reverse program, the first element of the **1st_Input_List** which moved the right is added to the **2nd_Input_List** by the glove icon. Therefore, the difference of the location for the glove icon shows the time when the first element was added to the list. And these animations specified the difference of the order of the **Output_List**. The effectiveness of these explanation based on the U-behavior specifies the U-behavior as the representation for problem to compare problems. We described it in section 4.

3.2.2 The facility to search a problem

Our system has two searching conditions which are divided by the contents of explanation.

(A-1) Explanations for parts of the U-behavior

The system selects a problems ***Ps*** in order to explain the role and behavior of the U-behavior parts b through comparing with the problem ***Po***. In this case, the condition to find the problem ***Ps*** is that the problem ***Ps*** has the part b and the problem ***Ps*** has more same parts which are included in the problem ***Po*** than any other problems.

(A-2) Explanations for types of U-behavior parts

The system selects a problem ***Ps*** in order to explain the role of the type ***t*** of parts through comparing with the problem ***Po***. In this case, the condition to find the problem ***Ps*** is that the problem ***Ps*** has a different part in type ***t*** from the

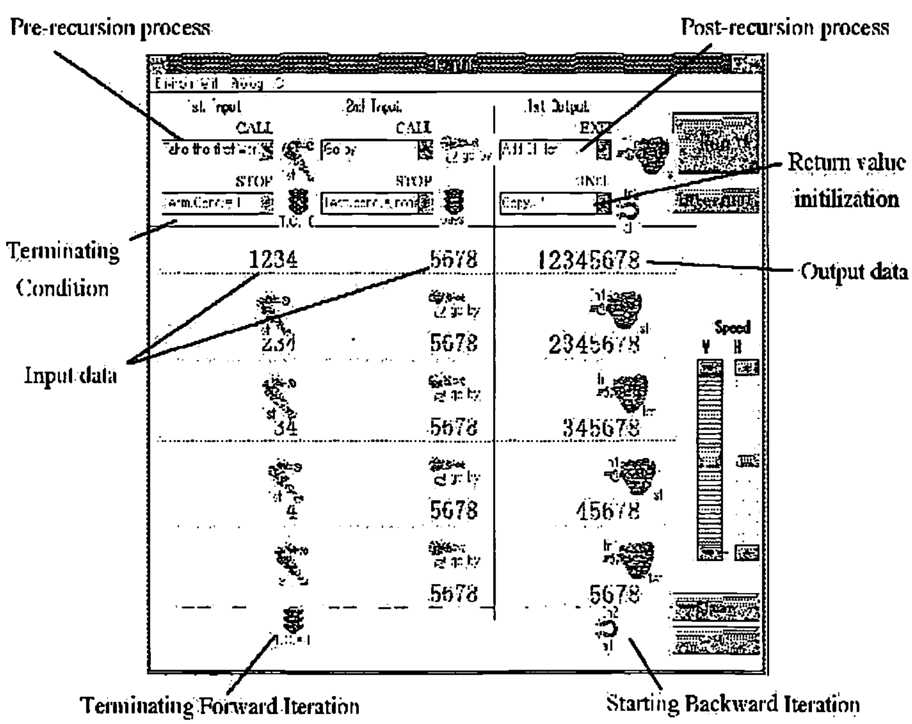

Figure 3. The U-behavior of the append program

Table 1. Evaluation value by experienced times

	same part	different part				
		more 4 times	3 times	2 times	1 time	first time
Evaluation Value	1	0.8	0.6	0.4	0.2	0

Table 2. An example for searching problems

problem sequence	Pre-recursion Sub-procedure		Terminating Condition		Return Value Initialization	Post-recursion Sub-procedure
	1st_Input	2nd_Input	1st_Input	2nd_Input		
select	C_2	C_1	S_6	S_1	I_2	E_3
last	C_2	C_0	S_3	S_0	I_1	E_1
append	C_2	C_1	S_2	S_1	I_1	E_3
append_del	C_2	C_1	S_3	S_1	I_1	E_3
suffix	C_2	C_1	S_5	S_1	I_0	E_0
current problem reverse_app	C_2	C_3	S_2	S_1	I_1	E_1

problem ***Po*** and the problem ***Ps*** has more same parts which are included in the problem ***Po*** except the type ***t*** than any other problems.

And the system has two situations which divided by the problems for searching.

(B-1) Searching a problem for example

The system searches problems which novices solved. In this case, the problem which are found was provided novices as an example.

(B-2) Searching a problem which novices should solve as next problem

The system searches problems which novices didn't solve. In this case, the problem which are found was provided novices as next problem.

The system searches for all problems which satisfy the condition. If the result of searching is two more problems, we need the condition for conflict resolution. The condition in our system is that the problem has more parts which are experienced many times in exercises than any other problems in different parts between the problems. To find a problems which satisfy this condition, we use the evaluation value which shows how many times a novice used a part of the U-behavior in his/her exercise. Talbe 1 shows the evaluation value by experienced times. When the same part between two problems, the value is the highest 1. When the different part between two problems, the value v is in the rage of $0<v<1$, and when the part is the first time in exercise for a novice, the value v is 0.

We specified an example of explanation for part ***I1*** of Return Value Initialization by comparing the append program. The system searches for a experienced problem. Hence, this example is (A-1)(B-1). In this example, a novice solved problems shown Talbe 2. First, the system retrieved problems which includes the part ***I1*** are the last, the append and the append_del program. Next, searches the program which has more same parts from the reverse program. In this case, the append program was retrieved as an example problem.

3.3.3 The facilities to generate the grouping problem

To help novices understanding the U-behavior, it is very important to learn the similarities and differences between two problems. Our system provides novices with the grouping problem. In grouping problem, the system provides novices with the figure of grouping programs, and novices put a given program into appropriate group. When novices put a program into groups, they must consider the similarities and differences between a given program and programs in groups. We can expect novices to learn the role of parts and the type of parts through solving the problem.

To generate the grouping problem, the system select a program at random and make a figure of grouping problem with the rest of the program. Next, the system decide the order of the type of parts. For novices can group programs any order of the type, the system decide the order at random. And programs which have the same parts at the first type in the order belong to a group.

4. An Experimental evaluation

To evaluate the method to generate an explanation based on the U-behavior, we held an experiment. In our experi-

Virtual Reality Hypermedia Design Frameworks for Science Instruction

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Abstract: This paper develops a framework to categorize virtual reality applications in science education. Examined are the implications of VR in science instruction, components to integrate VR into hypermedia presentations, and considerations when utilizing VR in classroom settings. The framework explores methodologies for the processing, collection, examination, classification and presentation of multimedia information within hyperlinked virtual reality environments. The analysis is intended to help assess whether children can use VR to supplement their traditional education and learn concepts in science.

1. Introduction

This study conceptualizes a research framework to aid software design and development for virtual reality computer applications for instruction in the sciences. The framework will provide methodologies for the processing, collection, examination, classification and presentation of multimedia information within hyperlinked virtual reality environments. Referenced are traditional teaching and virtual reality instruction. The analysis will also provide a framework to help assess whether children can use VR to supplement their traditional education and learn concepts in science. The framework will thereby help justify VR instruction is a viable supplement for standard teaching methods in science.

2. Virtual Reality Environments

Virtual Reality (VR) is a new way to use computers. It offers the possibil ity of becoming immersed in, and interacting with, a computer-based environment that engages visual, auditory, and tactile perceptions. It features a "high-end interface" that involves real time simulations and interactions through multiple sensory channels [Mikropoulis 1996]. Virtual reality is currently in the very early stages of development, but has the potential to be a highly effective method for training people who learn and remember best by doing. The two most popular environments are immersive VR and VRML.

2.1 Immersive Virtual Reality

Virtual Reality is currently used to describe an extensive gamut of technologies. Within the genre are semantic and technical breakdowns--including virtual reality, artificial reality, and cyberspace [Helsel 1992]. Herein, we will specifically focus on the technology of virtual reality and its commonly associated characteristics. From a technological standpoint, virtual reality may be defined as a form of human-computer interface characterized by an environmental simulation controlled in part by the user [Springer 1991]. Virtual reality typically features hardware and software that furnish a sense of: (a) inclusion or immersion, (b) navigation, and (c) manipulation [Mikropoulis 1996]. In a comprehensive implementation, a virtual reality configuration consists of a head-mounted display, a data-glove, and a tracking device. The viewer wears the head-mounted display that contains sensors to track the position of three-dimensional coordinates of the head as it moves. The data-glove provides hands-on interaction within the virtual world by registering finger and hand gestures using fiber-optic cables that act as sensors to detect the flexing of fingers. Electromagnetic sensors then report the positions of the goggles and glove. The computer calculates what the artificial world looks like from those angles, draws it in 3-D, and shows it on the LCD screens mounted in the headset in front of the user's eyes.

2.2 Virtual Reality Modeling Language (VRML)

Simpler VR implementations mimic the immersion effect and VR hardware to enable user navigation through a 3D world simulated on a 2D computer screen. Navigational and interactive capabilities are essentially the same, albeit the sense of immersion is partial. Still, for instructional applications the designs and objectives are essentially the same. Limited immersion VR is currently being popularized in non-immersive arcade-style computer games, and in advances with the VRML computer language for creating VR on the World Wide Web. Technically, VRML is a universal description language designed to support 3-dimensional environments on the WWW—complete with multi-participant interaction, and real-time user defined simulation [Ames, Nadeau & Moreland 1996]. As such, it provides a WWW-based VR user-interface to online media. VRML is used to create virtual reality environments (worlds), which are networked through the Internet, and reside as an application or functionality atop the WWW. These environments are fully compatible with the hypermedia linkages characteristic of Web interactions. VRML specifies all aspects of virtual world display, interaction and internetworking.

The technology consists of a language specification and a software browser—which is generally integrated into other Web browsers to form a comprehensive utility. In perspective, HTML describes documents and their layout in two-dimensional space, while VRML describes three-dimensional environments and their interactive capabilities [Maule 1997]. The specification provides for worlds with multiple levels of detail, dependent on the chosen rendering resolution of the user, and the display capabilities of the browser. As a graphics composition language, it enables a structured display to be composed on the screen from a number of items, each of which may be local or remote. Elements may be identified by their network, local, or URL addresses. If properly cached, operations are quite rapid since screen refreshes only invoke a reissuance of the specifications—which the machine would draw using its internal capabilities (as opposed to downloading images). [Note that this is similar to Postscript wherein a description language alleviates the need for the loading of bitmaps, with the output devices than able to process and represent the data to the ability of that particular system.]

VRML 1.0 adopted the Open Inventor file format from Silicon Graphics (SGI) for its ability to support complete descriptions of 3D scenes with polygonal rendered objects, lighting, materials, ambient properties, and realism effects. Extensions to support networking were added and became the basis for VRML. The VRML file format was then released into the public domain. As such, VRML is not an extension to HTML, but is compatible with HTML, and in typical applications both HTML and VRML will exist. Generally, VRML requires more finely tuned network optimizations than HTML, is composed of many more inline objects, and involves many more servers than typical HTML documents. The VRML 1.0 specification enables the creation of virtual worlds with interactive behavior via objects with hyperlinks to other worlds, HTML documents, or other valid MIME types. When the user selects an object with a hyperlink, the appropriate MIME viewer or display routine is launched. Similarly, when the user selects a link to a VRML document from within a correctly configured WWW browser, a VRML viewer is launched or routine activated. Thus, VRML viewers are designed to be integrated into standard WWW browsing as a means for navigating and visualizing the Web. Evolving versions of VRML, and compatible software developed by independent programmers, support animation, motion physics, and real-time multiuser interaction.

The Moving Worlds standard, developed by Silicon Graphics, with important contributions from Sony Research and Mitra, became the VRML 2.0 specification in March of 1996. Moving Worlds is an event- or message-passing system dependent on a scripting language, such as Java or JavaScript. Because Moving Worlds is simply a file format, other languages can also be used. It uses a platform-neutral open architecture and file format to support the 3D animation, behaviors, and interactivity. VRML 2.0 also accommodates dynamic object behaviors, multiuser interaction, and multimedia components such as animation, sound, and streaming video. In operation, VRML 2.0 navigation within the virtual spaces is through a mouse, trackball and/or joystick. Control keys can be used to provide more advanced navigation. When encountering an interactive object the cursor changes to a hand symbol to provide the user with the capability to grab the object. Joysticks provide additional tilt and turn controls. A SeekTool is to enable quick and easy movement toward a selected target. Of course, the display and interactive capabilities depend on the hardware and software components available to the user. The better the equipment, the better the graphics and interactivity.

3. VR Science Instructional Designs

Science has been defined as a way of “knowing”—a derivative of the Latin scientia, meaning "to know, or having knowledge." One acquires knowledge through various intellectual activities concerned with the physical world and its phenomenon." Even more essential than knowing about the physical world is the curiosity, the urge to discover, and the need to know that motivates students to pursue knowledge and seek truth. Science education is thereby discovery learning, the teaching of meta-reasoning, with emphasis on the intuitive perspective. Selected topics generally reflect fundamental problems, and fundamental concepts in biology, physics, chemistry and earth science. VR may ultimately be the most natural artificial interface to discovery learning.

3.1 Science Instruction

Many nations are at a crisis stage in science education. Students are graduating from high school with limited knowledge in science, and little understanding of the application of science in the real world. In the U.S., the science abilities of elementary and secondary students has been declining for several decades [ETS 1988]. Internationally, in a survey of 17 countries, the United States was ranked near the bottom in achievement in science and math [IAEEA 1988]. Many believe this inexperience with science may have negative impacts on society. Nations are either directly or indirectly impacted by the astuteness of their citizens in science. Modern societies demand technically literate, informed, involved and proactive citizens. Organizations are dependent on workers for their ability to understand scientific concepts. Without an educated public, politicians and voters will make their decisions based on ignorance, or an unhealthy reliance on others to make their decisions for them. In the U.S., the National Commission on Excellence in Education argues that a scientifically literate public is essential for the United States to remain economically competitive in the world market [NCEE 1984].

A major problem faced in science education results from the way science is taught through rote learning and memorization. In many instructional settings, students acquire only "facts" rather than "tools" for problem solving. They do not experience the kinds of problems that make information relevant and useful, so they do not understand the value of this information [Bransford, Sherwood, Hasselbring, Kinzer & Williams 1990]. Thus, many students consider that science is boring, irrelevant, or a fragmented collection of knowledge. VR technology may help.

3.2 VR and Science

Educators are slowly becoming exposed to the theories and ideas of constructivist philosophy, which emphasizes building children's own categories of thought about the world and encouraging students to construct their own knowledge. "Virtual worlds" are constructive environments in which participants can create, manipulate and edit any form of digital information. Objects, processes and programmed inhabitants of the "virtual worlds" are elements for active problem solving. Thus, virtual reality programming can be used to facilitate an awareness of problems and encourage the personal seeking of solutions. Students can develop important science-process skills rather than just rote learning. Virtual reality curricula may engage students experientially in scientific investigation and application. Students may participate in responsive environments in which they become engaged in full body-mind kinesthetic learning. Studies have shown that students and users are able to benefit when given the capability to shape their personal learning environments [Maule 1991]. Ideally, such learning may combine cognitive, affective, and psychomotor skills as students pursue their own learning strategies [Walser 1990].

Investigations into the potential of virtual reality to enhance children's learning of science may have far-reaching consequences. VR instructional designs can provide structures to help ascertain whether or not critical multimedia variables in virtual reality programming are effective in the learning and teaching of specific science concepts. Through this testing and analysis, important information design variables appropriate for virtual reality programming may be documented. Collectively, these variables, consisting of information designs, systems and processes, will provide critical insight into the potential for multimedia virtual reality programming to improve children's achievement, interest and motivation in science.

4.0 VR Hypermedia Component Integration Frameworks

There is certainly no substitute for actually performing scientific experiments in real world and laboratory settings. Of course, the time, money, technology and expertise for real world science is rarely available, especially at an elementary school level. Students generally experience textbook explanations and examples. The increasing availability of computers and the Internet in elementary school classrooms means that VR and VRML resources may be a viable supplement to traditional textbook instruction. They may experience science more safely, in less time, and with less expense than field or laboratory work.

4.1 VR and Classroom Integration

Virtual reality systems will provide a less formal experience than a true laboratory or field trip, but they may be equally fun, and certainly more "realistic" than mere pictures in a textbook when considering the wealth of experiences that may be generated. As learners begin to work, study and communicate in virtual environments, whether singularly or collectively (through computer networks), they learn not only the subject matter, but new ways of thinking and structuring information [Maule 1992, 1993]. The customization and interactivity may permit users to shape their interpersonal and collaborative electronic experiences. Stand-alone and networked virtual reality technologies thereby offer the potential to not only change the way students learn, but also the way teachers teach and interact with technology [Wolsey 1996].

4.2 VR and Learning Objectives

In the past, the costs of virtual reality technology limited use to specialized fields of research and study—such as those found in higher education and corporate and military training. Today, VR technology is finding its place in public elementary schools. The learning objectives of VR are becoming adopted by school systems and standardized [Pantelidis 1996]. In one of the first research studies on K-12 virtual reality applications, Sherman and Judkins [Sherman & Judkins 1992] studied virtual reality in educational curricula for five groups of children, aged 9 to 15. The children were able to design and create virtual worlds of their own. Although technical assistance came from the HITLab at the University of Washington, initial predications actually underestimated the children's ability to understand and assimilate the virtual reality technology. Children worked cooperatively and collaboratively. Moreover, they were highly motivated. Children completed the project, plus, they learned programming, networking and design. The technology had a short learning curve, and children could easily retrace their steps. This was a very successful educational program for both teachers and students.

4.3 VR and Hypermedia Components

Studies have not fully researched information designs for virtual interaction, nor the interplay among highly complex media variables. Studies of media interactivity within programmed environments have generally isolated and tested simple, controllable variables [Maule 1991]. Virtual reality presents highly complex interactions. While complex authoring environments have been tested for their impact on learning and perception [Maule, Gregg & Petry 1991], the impact of complex multimedia within virtual environments, and issues stemming from information designs for complex multimedia learning systems, have not been adequately addressed [Maule 1994]. Frameworks are needed to structure variables to help determine the overall effectiveness of the virtual reality instructional experiences.

Previous studies have drawn insight from working applications of VR in education [Pantelidis 1994]. From the integration of traditional instructional objectives, and VR capabilities, primary content design initiatives may be drawn to address the integration of the media components—including the graphic, video, audio, and animation elements, and the linkages between the media. Linkages, and the arrangement of media, then become the design framework for the instructional objectives. For purposes of analysis, the following schema has been developed to represent primary media and instructional design variables for science instruction in hyperlinked virtual reality:

- o VR Collection Variables: psychomotor skills(explore, navigate, look, manipulate)
- o VR Examination Variables: cognitive skills (assess, determine, calculate)
- o VR Classification Variables: spatial skills (arrange, sort, structure, inference)
- o VR Processing Variables: affective skills (interact, feel, associate, participate)
- o VR Presentation Variables: interactive skills (links, relationships, associations)

The VR evaluation variables would then determine the degree to which the above schema accurately convey the needed information and deliver the appropriate learning experience. Secondary assessment would address the effectiveness of pertinent information design and multimedia interaction variables. The virtual reality programs may use hypermedia branching to customize and target both advanced and disadvantaged students. For example, it may be relatively easy to develop applications for above average students because they may have an easier time comprehending the subject matter. It is more difficult to develop a program for the average learner or uninitiated learner who may have difficulty concentrating. Multiple testing formats may determine if motivation has increased for each level of interaction, for each individual student, and for each class of student. Knowledge retention may be tested cumulatively with each interaction.

5. Conclusions

In anticipation of the widespread availability of virtual reality technology, frameworks are needed to help structure VR and hypermedia designs to enhance the experience of children learning science. Secondary issues would involve the effectiveness of the virtual reality teaching process, supporting VR information design issues, and the interactions of complex media variables which may not be available in traditional teaching. Hopefully, VR instructional designs will demonstrate that the knowledge acquired from interactive, virtual reality experiences will enable children to retain knowledge and appreciate the importance of science. This will occur as children "live" the experience. Moreover, different levels of learning may be programmed into the environments. Further frameworks can be developed to help structure the branching necessary to provide different levels of science to different levels of students.

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On Two Aspects of Improving Web-Based Training*)

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Abstract: In this paper we discuss two ideas that might help to improve teaching in certain situations, and could also provide better means for information transfer between persons in general. The first aspect is centered around proposing to use the "Tamagotchi craze" for teaching purposes, the second deals with new ways of unobtrusively collecting data on the subjective satisfaction of persons with information and teaching material offered on the Web.

1. Harnessing the Tamagotchi Craze

The Tamagotchi craze that started in 1997 has driven many kids, teachers and parents to the brink of desperation. An estimated 20 million Tamagotchis or clones thereof were sold within one year, resulting in hundred millions of hours spent on keeping the virtual beings happy. It is the aim of the first part of this paper to propose to harness the appeal of caring for such virtual beings for teaching and training purposes: rather than taking care of Tamagotchis by "feeding", "cleaning" and "entertaining" them we propose to implement what we call VR-Friends (virtual friends) that differ in three crucial ways from traditional Tamagotchis: (i) they are kept happy if their owners answer questions correctly; (ii) they are implemented in software, not hardware and (iii) they live on the Web, in WWW servers. In a way, VR-Friends can be considered to be special types of Avatars [Damer 1998] (as often mentioned in connection with VR games), or intelligent agents ([Riecken 1994], [Maes 1994]).

Psychologists have not been able yet to fathom the real reason why Tamagotchis have been successful in such an unprecedented way. But no matter what the explanation is, it seems worthwhile to exploit what are seen as major reasons for the success for the education of primary and secondary school children.

1.1 Introduction

VR-Friends are implemented as programs that run on WWW servers and can be accessed by ordinary Web browsers from e.g. Netscape or Microsoft. They come in various behavioral and knowledge domain classes in the sense that they act as instructional agents for different ages and subject matters. Their success as "teachers" is assumed to come from the fact that they are seen as live beings that thrive only if continually "fed" with correct answers to questions they keep asking. I.e. VR-Friends want to "learn" and in doing so - it is actually their owners that learn!

In what follows we present the basic ideas of how such VR-Friends will work. We do this in three subsections. In section 1.2 we describe a typical scenario. In section 1.3 we explain the main implementational aspects. And in section 1.4 we argue why VR-Friends have indeed a chance to be successful yet why they may fail, and what practical use and further developments might look like.

1.2 A Typical Scenario

So far, twelve year old Mark has shown very little interest in learning basic geographical facts: Although the importance of factual knowledge and rote memorizing has been much challenged by educationalists over the last few decades there is still a wide-spread feeling that some basic facts have to be stored inside our brain (rather than on easily accessible storage devices) as basis for "associative" and "intuitive" thinking.

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To improve Mark's performance and following a counselor's recommendation, the geography teacher has activated an appropriate (i.e. certain level of geography) VR-Friend on the school's Web server. Mark has chosen the name Nick and certain features (like a special T-shirt and trousers) for his VR-Friend Nick when first logging in. Now, whenever Mark logs in on the school server for whatever activities the first thing Mark sees is Nick. Nick's appearance, his attitude, and what he says (yes, Nick might be able to talk in certain situations) depends on Mark's past performance and on how much Mark has "cared for" Nick. Sometimes Nick will be smiling, "Hey, great you are looking me up again", or may be sulky or even tearful ("You are really neglecting me"). Overall, if Nick is treated well he stays healthy, becomes more and more friendly, will show Mark a cartoon, a joke, or tell him some tidbits (e.g. pointing him to an interesting URL on the Web, see section 1.3); otherwise, Nick will look more and more sick, he will sit in a sad posture (potentially in a not so good-looking neighborhood) and, if seriously "neglected" will actually die. On the other hand, if Mark learns well (treats Nick well), Nick will eventually congratulate Mark and tell him that he has to move on, but will stay in contact with him: and Nick will once in a while (with a decreasing tendency) briefly show up when Mark logs in, tell him some tidbits, and disappear again. Note that Mark may have a growing number of VR-Friends that way, that entertain Mark a bit here and there as he does other Web stuff.

The actual heart of the conversation between Mark and Nick (who was after all created to teach some geographic facts) consists of questions asked by Nick that have to be answered by Mark. (Mark can exit "no time right now" any time he wants). A typical "geography" VR-friend may help the student (Mark) to learn about the location of cities, countries, etc. on the globe. Questions that Nick might ask are "show me the location of xxx" (where xxx is a city, a country, a mountain, etc.) Mark's reaction is to click at the right place on the globe or map shown. The system is very patient: if Mark clicks on Antarctica when asked for the location of Vienna, the system (NOT Nick) will explain that this is Antarctica, some facts about it, and will show the real location of Vienna and information on it and Austria. However, the system records the information ("Vienna, totally wrong") in such case. A second totally wrong answer to Vienna's location would give a somewhat more stern reply to Mark, and the system would record again ("Vienna, totally wrong"). A third complete failure of Mark would result in the system storing ("just fooling around"), etc. Thus, the system basically records for each session between Mark and Nick five numbers (a,b,c,d,t). Here a is the number of correct answers, b the number of totally wrong answers, c the number of approximately correct answers, d the number of times Mark just seems to have been fooling around; t is the point of time when the session takes place. The "development" of Nick depends on how often and lengthy sessions between Mark and Nick take place; it is up to the teacher to set parameters like: "at least one session with 10 questions every second school day and all questions answered correctly twice within a total of three months".

Above is clearly just one typical scenario. Other questions (requiring e.g. text input or such) are of course conceivable. Finally, Nick has always some surprises "up his sleeve": like instead of VR-Nick appearing, Mark finds a sign "Out right now. Back in 2 minutes", or finds some other VR-Friend, etc.

The main point is that although Nick forces Mark to learn (unless Mark accepts that Nick deteriorates rather than prospers) this learning is fun and full of surprises.

1.3 The Implementation

The main idea of the implementation is to have two completely separate modules called *development* and *learning*.

The learning module is clearly domain dependent, i.e. differs from subject to subject and takes the age of the learner into account. However, learning modules are created readily with *teaching wizards*: the most simple form of a teaching wizard just helps preparing *problems* as follows: each problem consists of a question and possibly a picture (image), and the answer is a click in a certain position, where a click is recorded as "correct", "close" or "wrong" dependent on how far from the current position the clock occurs. Note that the system will keep track of "close" or "wrong" answers to be able to decide if a student is seriously trying or just fooling around. Other teaching wizards that e.g. allow textual answers can also be used.

The main point is that the teaching module communicates to the development module only five numbers (a,b,c,d,t) as explained in section 1. The reaction of the VR-Friend as carried out by the development module only depends on the sequence of "answer-quintuples"(a,b,c,d,t) obtained. To keep the system simple there is no substantive data-flow from the development module to the teaching module.

Depending on the answer-quintuples the *state* of the VR-Friend (and hence its appearance and utterances) within the development module are changing. A random element makes sure that the VR-Friend behaves somewhat unpredictably. A number of VR-Friends (age, looks, clothing, ...) with certain developmental paths can be built into the system, so new subject domains *do not* necessitate changes or additions of the development module, although tools to introduce new VR-Friends may well be provided in the future.

The development module and its functionality is clearly very much open ended. On a first and primitive level for each "state" of the VR-Friend one of a number of facial expressions, gestures, background images and utterances are combined in a random fashion. This leads to a fairly complex "behavior" at moderate development cost.

It remains to mention that both teachers and students can set certain environmental parameters as mentioned in passing: the teachers can define time intervals that are "acceptable", students will choose sex, name and age of their VR-Friends.

It is clear that a good part of the success of the VR-Friend scenario will depend on the quality of the implementation of the development model.

In a first experiment, we have implemented a close approximation of a Tamagotchi in software [Kernbauer]. This implementation was based on DINO [Freismuth et al. 1997], hence was called Dinogotchi. While it did show the viability of the approach as such the solution cannot be deemed sufficiently appealing to promise success.

Clearly other ways to implement the VR-Friend are necessary. One obvious idea is to use avatars [Damer 1998]. Another one is to use synthetic actors, like the famous Marilyn Monroe model that is continuously being improved by the group around Nadia Magnenat-Thalmann in Geneva [Magnenat-Thalmann and Thalmann 1994]. Indeed, much work in the area of synthetic actors [Trappl and Petta 1997] could be used for VR-Friend implementation.

For simplicity's sake we are opting for a simpler model in our first real implementation: each VR-Friend will be in one of 50 "happiness" - states (static pictures obtained by morphing a number of photographs of a real person) and - to avoid boredom - will appear with a background picture selected at random from a database of some 10.000 geographical pictures whose copyright was obtained for another project. Although not ideal, we believe this is a first viable approach that can be later enhanced by more and more "intelligence".

1.4 Other Issues

The most burning issue is certainly if VR-Friends will be interesting enough to indeed motivate students to learn. There are strong arguments both pro and con, and only experiments can answer this question.

On the one hand, Tamagotchis have been amazingly successful, and VR-Friends are similar in a number of important ways: once "born" they cannot be "stopped" but either develop well (if treated well) or else they visibly deteriorate, even to the extent that they die. On the other hand, while Tamagotchis are "omnipresent" and keep reminding users of their existence by beeping at appropriate or less appropriate times, VR-Friends only show up when a user logs into the correct server, typically the main server of a school or school-district.

There is another crucial issue. Kids who love to play and love to learn all kinds of irrelevant information seem to loose interest in games once they realize that they are actually learning useful information (!). It has been theorized that the association "learning is work, work is unpleasant" (a product it seems of our less than optimal school systems) is sufficiently strong to turn kids off. A typical case supporting above arguments is the huge success of the "Space Quest" adventure games vs. the meager sales of the "Goldrush" adventures game, all by Sierra: all have the same interface and the same kind of story: users have to help the hero to discover certain facts: Those facts are "useless" in "Space Quest" but contain real historic information in "Goldrush". It is vexing to see that sales of Space Quest have been hundred-fold better than those of Goldrush!

However, there have been some educational games that have been successful (like the classic arithmetic learning game "How the West was won" or the geography/history games "Where in the world (where in history) is Carmen San Diego".) Thus, the final verdict whether playing cannot be combined with teaching is still out!

There is also another, rather opposite issue that can only be settled experimentally: can it happen that kids get attached to their VR-friends to an extent that their departure, let alone death, will cause serious emotional turmoil? Note that even Tamagotchis have turned out to be fairly addictive: What will a more human-like, reality-like VR-Friend do? Whatever the answer is it is clear that VR-Friends programs have to make sure that users will not develop guilt feelings, e.g. when a VR-Friend gets sick or dies since its owner was sick, on vacations, or such.

The most interesting aspects of VR-Friends is the fact that they are on the Web. We leave a detailed discussion of the implications of this for the future. But observe that VR-Friends can potentially communicate, compete, or temporarily be taken care of by "Baby-sitters" via the Web. Note further that VR-Friends can use and point out relevant information (i.e. URL's) on the Web, lead to discussion forums, on-line chats between owners of similar VR-Friends, etc. Indeed the dialogue of users and their VR-Friends may lead to questions posed by other VR-Friends to other users. It should be clear that the complex interaction of VR-Friends will have to based on what has been learnt and developed in the area of intelligence agents as mentioned earlier.

The notion of Web-based VR-Friends used for educational applications opens a new and potentially very powerful way to communicate factual knowledge - and maybe even more. Experiments will have to demonstrate the viability of the approach. At the time of writing no polished version of VR-Friends software exists, but we expect to have one ready by the end of 1998.

Note also that successful implementations of VR-Friends will be much eased by using powerful Web-servers such as Hyperwave [Maurer 1996], [Maurer 1997].

2. Unobtrusively Collecting Data on Web-Based Material

When offering educational material on the Web it is of crucial importance to obtain feedback on effectiveness and user satisfaction. In this section we focus on one sub-aspect, obtaining data on subjective user satisfaction. We discuss "traditional" techniques, none of which has worked well in the past. We then present novel techniques that we believe could provide effective tools desperately needed to assure continuous quality improvement of Web based training material.

2.1 Classical Ways to Collect Satisfaction Data

There are three main classical ways to collect data on user satisfaction with educational material available on the Web: (a) the use of questionnaires; (b) evaluation of log files; (c) explicit user observation.

The problem with questionnaires is that there is much user resistance to filling them out carefully, thus creating lots of statistical "noise". Even "willing" students are often at a loss of how to answer questions properly that refer to material that was worked through some time back.

The second approach, the evaluation of log files is problematic for two reasons: the HTTP protocol used on the Web is "stateless", i.e. it is not possible to record the "trail" of users but only how often each page has been hit. Using more sophisticated techniques such as session oriented protocols, or simulating them by using "cookies" or "session keys" as is done e.g. in Hyperwave ([Maurer 1996], [Maurer 1997]) it is possible to keep more detailed records of usage of educational material. However, such detailed records have already been kept in non-Web based systems as early as in Plato [Bitzer 1976], but have rarely been terribly helpful. It seems that efforts to extract interesting information from a huge mass of log files have never been entirely successful. The third approach, hidden or overt user-observation has been used quite successfully but is very labor and cost intensive.

Thus, it should be clear that new techniques to judge subjective users satisfaction are needed for use on the Web which is becoming a major tool of teacher-student communication and course administration. We propose three such techniques in the next section.

2.2 Novel Ways to Judge Subjective User Satisfaction

The first alternative we suggest to use instead of questionnaires is the use "questionnairelets", Q-lets for short. Such a Q-let consists of a single question that can be answered within a few seconds. Q-lets are presented to users in a random fashion but never more than a few per session. As little bonus for answering a question an optional cartoon or joke is shown to encourage answering the Q-let. Cartoons or jokes shown must be chosen so as not to disrupt the flow of learning. Note that an option "skip question" is presented, i.e. the answering of Q-lets is not enforced. However, clicking at the Q-let "skip" button will often be the same amount of work as clicking at one of the choices (e.g. radio buttons) offered in the Q-let.

Observe that users in a Q-let environment do not even need to fill out a complete questionnaire in total, yet may actually answer the same Q-let more than once. Different answers will thus be a good indication of the (un)reliability of user answers. Users ca be "anonymously identified" across session boundaries in the sense of [Flinn and Maurer 1995], i.e. users have (self-chosen) names and passwords, so that a detailed record can be kept for each "anonymous" user, yet the system does not know the real identity of any of the names chosen. Experimentation on the distribution and frequency of Q-lets used will have to be carried out.

An alternative to Q-lets (or an additional feature) is a so-called "Feedback Button ". When clicked at, a form appears where users can click at any of the presented checkboxes to voice their opinion about the current "page" presented, or even about a certain part or aspect of it.

We feel that collecting individual answers at points where they are relevant is both less bothersome for the user, and leads to more reliable results at the same time.

The second alternative to evaluate subjective user satisfaction comes from the approach used in GENTLE [Maurer and Dietinger 1997] to questions posed by students: at any point while working through some material students can "ask a question" by inserting a question mark anywhere on the screen. This action triggers the sending of an appropriate message to a certain user group (i.e. tutors), who will answer the question (synchronously or asynchronously) at which point the question mark turns into an exclamation mark; also, the answer is mailed to the person having asked the question, and other users seeing an exclamation mark can retrieve the "question/answer" dialogue that occurred earlier by just clicking at the exclamation mark.

By evaluating pages with such question marks and exclamation mark much valuable feedback can be collected. In first experiments it was observed that questions were not only asked when material was badly explained but actually even more frequently when the material interested the users to the extent that they wished further explanations!

The third alternative is called "sensitive button". After all, each "page" of courseware or some Web information usually leads to one of a number of further pages by clicking at some navigational button. Users are informed that the position *where* they click the button will be seen as the expression of an opinion concerning the current "page" at issue. There are many alternatives. However, to be specific, here is one scenario: clicking at a button on the left could mean "I don't like this page", while clicking on the middle of the button may mean "my feelings are neutral" and clicking on the right "I like this page". Clearly many alternatives are possible and need careful testing.

We feel that sensitive buttons (although they will generate some statistical noise) will work well after some initial period (during which the user may be asked "do you really mean xyz?"): some "click" to navigate is necessary anyway, so users "may as well" signal their level of satisfaction.

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Scaffolding Higher Order ThinkingIn A Telelearning Environment

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Abstract: Throughout Australia, audiographic conferencing is widely used as an instructional medium to link schools in rural and remote areas with urban schools which have curriculum and teaching expertise in particular subject areas. This technology involves a two-way audio link via telephone, and a computer link up via modem. The computer acts as a shared visual link between teacher ad students. Several schools may simultaneously link up with a "host" school which delivers instruction.

The physical absence of the teacher from the classroom often results in forms of teaching which are didactic and asymmetric, with the teacher striving to control all elements of "the invisible classroom". The present research was an in-depth investigation of telematics classrooms in Western Australia, with a deliberate focus on changing the teaching-learning environment in order to develop higher order thinking skills in learners.

The creation of conditions for higher order thinking was orchestrated through an action research approach entailing successive interventions in the learning environment by teachers as they conducted lessons. Each stage in the process was monitored and analysed with a focus on fostering students' thinking processes through dialogue.

The framework adopted for analysis investigates types of talk which are indicative of higher order thinking skills. Results indicate that students' capacity to display higher order thinking increased as a result of changes in pedagogy, in particular, the scaffolding role of the teacher.

Introduction

The use of interactive communications technologies in education is becoming more widespread as learners can now access courses at a distance or learn via networked communications. Many classrooms and open learning environments depend on a range of technologies, from computers to electronic whiteboards, e-mail, video and audio components as part of the educational process. While new technologies are much in evidence, in themselves they have not transformed pedagogies, and the communicative, socially oriented nature of learning is still intact [Laurillard, 1995].

Throughout Australia, audiographic technology is used to reach students at a distance. This technology can be defined as: *electronically based equipment and the processes and strategies used to enable interactive teaching and learning between two or more geographically remote locations.* In audiographics teaching there is a physical and geographic separation of students and teacher, and student participants are distributed over several sites rather than physically present in the same classroom. Three forms of technology enable the interactive link to be set up and maintained: telephone, computer and fax machines. The telephone provides a two-way audio link and the computer is used to share visuals and graphics. The screen can provide a number of interactive supports for learning, including:

- immediate feedback to students when used as a blackboard;
- visual stimulation;
- a flexible, editable page;
- shared reading and writing; *and*
- a record of written work that can be shared and printed.

When computers to two or more sites are linked, teachers and students have views of the same information on the computer screen, and an audio link is used to establish and maintain dialogue. The development of effective communicative and listening skills is therefore essential to both teachers and students participating in telematics lessons. The audio and visual qualities of telematics environments are conducive to communication and verbal reasoning skills, as dialogue and a high level of interaction are required to sustain the teaching-learning relationship.

A Focus on Learning or on Technology?

Discussion of how to support learning in technology supported environments where spoken language mediates the interaction between teacher and students is still widely debated [Kozma, 1994; Jonassen, Campbell & Davidson, 1994]. Two distinct approaches to the question of how learning is best achieved are now emerging. One, of these approaches called the "cognitive tool" approach [Jonassen & Reeves, 1996; Lajoie & Derry, 1993] indicates that if technology is reconceptualised as a "mindtool" and an "intellectual partner" [Salomon, Perkins & Globertson, 1991] then learners will develop higher order cognitive processes. Jonassen & Reeves [1996] believe that the capacity of technology to transform learning and support higher order cognition lies rests on its power to enable learners to become designers of their own knowledge, and that media will enable the expression and representation of knowledge. At the heart of this approach is the constructivist approach to learning, where the individual discovers, invents and creates knowledge from available resources.

The second perspective, upon which the empirical research in this paper is based, regards learners and the teaching-learning process as paramount, and in this perspective the technology becomes part of the social fabric of learning. This perspective is based on sociocultural theory, which regards cognitive development as culturally based, and a social rather than individual process [e.g., Wertsch & Toma, 1995]. Based on a socio-cultural paradigm, a pedagogy for learning in technology supported environments would recognise that technologies are educational resources and mediational devices, but cannot replace the interpersonal and social dynamic of learning.

Language and Learning

The perspective adopted in this research can be described as socio-cognitive developmental theory based on Vygotsky's [1978] to approach to learning in social environments. Otherwise known as *cultural psychology* [Crook, 1991], its main orientation and central tenet is a concern for the interpersonal processes in development. For Vygotsky [1978], language and thought come together and are combined as a cognitive tool for human development, and children undergo profound changes in their understanding by engaging in joint understanding and conversation with other people. Talk and spoken language are central to this view of learning which has been extended and applied by researchers in a wide range of disciplines [Bruner, 1984; Moll, 1990; Nastasi & Clements, 1993; Pea, 1993; Chang-Wells & Wells, 1993].

Another important facet of Vygotskyan theory is that instruction is but one form of social interaction, and is not a one-way activity but a partnership, or form of collaboration requiring active involvement by all participants. Through participation in social practices children learn how to construct ideas [Rogoff, 1990], and learn the norms that guide thinking in different subject areas [Richmond & Striley, 1996; Pontecorvo, 1990]. Higher order thinking according to this definition involves the explicit statement of reasons, with justification and citation of evidence for views held [e.g., Resnick, 1987; Weinsein, 1993]. Applying this conception of learning to the technology supported classrooms of the study meant recognising that language plays a vital role in sustaining learning and thinking and that learning involves socially organised activity where the teacher supports learning by orchestrating social experiences for learners through which they can engage in communicating, reasoning and argumentation.

Aims of the Study

Studies have found that a great deal of teacher talk occurs in telematics environments, sometimes to the detriment of student initiative and opportunities to question [Oliver & McLoughlin, 1997]. Overall, the interactions and learning activities that have been observed to occur in these environments are usually low level exchanges and expository talk, with teachers displaying a didactic and controlling pedagogy. In response to curriculum requirements that students achieve higher order thinking outcomes, it was imperative to change the pattern of teaching and learning that have characterised such classrooms in Western Australia [Oliver & Reeves, 1994; McLoughlin & Oliver, 1995].

This study was conducted with a group of teachers using telematics in subjects where the curriculum specified that students develop higher order thinking skills, in the form of generic competencies such as information handling, problem solving, analysis and synthesis skills, and critical evaluation. An action research partnership was planned between the teachers and the researchers in order to develop an understanding of higher order thinking could be fostered and enable teachers to plan for thinking in their own classrooms. The study was based on actual teaching encounters and events over the duration of one academic year, and traced the evolving skills of the students at expressing ideas, reasoning, explaining and engaging in collaborative discourse.

Method

The participants in this study were five teachers in different subject areas, Mathematics, Science, English, Italian and Social Studies. Each teacher taught a small class of students, and the students were distributed across several distant sites. All students participating in the study were in the first year at secondary school and aged between 12.5 and 13.5 years. The study focussed on two important aspects of teaching for higher order thinking, *teacher planning for higher order thinking,* though specification of lesson formats and teaching strategies that would support these outcomes, and *the adoption of pedagogies* that would facilitate the development and maintenance of higher order thinking and students' awareness of their own thinking.

Teachers utilised the curriculum guidelines to develop programs to meet the needs of their students, while exploiting the technology to achieve an appropriate level of communication and create a context where higher levels of cognition could flourish. The research involved both naturalistic observation of classrooms and diagnosis of teachers' pedagogies and students' learning processes.

Research Phases

The research was conducted in three phases.

Phase 1: During this stage classes were simply observed and teacher and student behaviours were monitored and recorded on videotaped. Two hours of classroom teaching were videotaped for each subject. Lessons were then fully transcribed to include activities, technology use and interactions of students. At the end of this ten week phase, the nature of each classroom environment was analysed and teachers were able to consider the appropriateness of strategies they had employed.

Phase 2: In collaboration with the researchers, a training session was planned to enable teachers to develop strategies and language protocols in their classrooms which would substantially improve students' independent thinking skills. Teachers were then videotaped and interviewed for 2 lessons during another term of 10 weeks as they sought to implement their changed teaching practices and foster more occurrences of higher order thinking.

Phase 3 : Teachers were shown the outcomes of their changed practices and caused to reflect on their achievement of increased higher order thinking and how this could be further enhanced. Once again, two lessons of each teacher were videotaped during a third term of teaching in order to explore the nature of the teaching and learning environments.

Instrumentation for Analysis of Data

A classroom observation instrument that served as an indicator of teacher pedagogy and to provide descriptors of the teaching and learning environment. A number of approaches have been proposed for analysing interactions in classrooms and learning environments, such as discourse analysis, systematic observation and coding schemes [McLoughlin & Oliver, 1995]. Discourse analysis of communicative interactions was chosen for the present study because of its potential to provide a multilevel understanding of the learning process. A framework of seven forms of interaction and discourse was chosen for the present study because of its potential to provide a multi-level understanding of the learning process. Table 1 presents an overview of the categories used to code teacher-student talk.

For analysis of talk, the categories of non-task, procedural and expository talk were used, as these were reciprocated by students when teacher initiated the dialogue. The other major category of student talk was higher order thinking, which was coded according to whether higher order thinking was evident in the data. Four dimensions of higher order thinking were identified through language indicators of reasoning [Perkins, 1997] where students cited evidence for views held, demonstrated inquiry and reflective skills and interpreted concepts throughout the lesson.

Table 1. A framework for investigating interactions in classrooms

Type of Interaction	Description	Example
Non task talk	participants engaging in social or administrative talk not relevant to the learning task	T: Hello Vicky how are you? S: Very well thank you. T: good. So how was your homework ?
procedural	teacher/student dialogue involving information exchange on course requirements or homework and procedures	S: Teacher can you tell me how many pages you want us to write? T: I'm looking for about 2 pages in total. S: Can we do more?
expository	student or teacher demonstrating knowledge or skill in response to a direct request from another.	T: Can any one tell me word for ice-cream in Italian? S: Is it gelato? T: Fantastic
feedback	teacher using student responses to give feedback, praise or reinforcement	T: This is how we place our fingers to play the note A. Can you play for me Mandy? S: plays the note on her recorder T: That was good but you have to blow a bit harder
cognitive support	teacher providing constructive feedback to a student response causing the student to reflect and to consider an alternative perspective/reality.	T: Can you tell me what you think was the main reason for his actions? S: He was angry and wanted to get even. T: But was that all? What about his wish to improve his position and standing? S: I suppose but he did but I though that he would done it differently.
control	teacher issuing a directive or instruction to students that would limit interpretation of the task	T: OK everybody, write "speech " in your graphic outline of culture.
reconstruction	teacher repeats the student's response, but changes the wording so that it is more correct	T: So why are trees useful to us? S: They are home for animals T: Yes , good. They are the natural habitat for animals.

Classroom Observations in Phase 1

The initial observations of teachers working in classrooms showed that much of the talk that occurred was expository, procedural and control based. Didactic patterns were evident in the data, where teachers asked the questions and students responded with short factual answers. Descriptive statistics on each of the categories are displayed in Table 2.

Table 2: Mean percentages of teacher talk by category in phase 1

Lesson	non task %	procedural %	control %	reconstruction %	cognitive %	feedback %	Total%
Maths 1& 2	14	34	15.5	3.5	22	11	100
English 1 & 2	13	25	30.5	3.5	18	10	100
Science 1 & 2	14.5	45	15	2.5	17	6	100
Italian	12	36	17	2.5	16	16.5	100
S. Studies 1& 2	7.5	45	23	2.5	15	7	100

Table 2 illustrates that much of the teacher talk that occurred in the observation phase was to do with non-task, or procedural matters, such as management, roll call, disciplinary issues and homework. The proportion of teacher talk that related to cognitive support and development of conceptual understanding was relatively low, with the maximum being 22% in the Mathematics classes.

Initial observations of the classrooms in phase 1 of the study also revealed that students had:

- dependent roles in the dialogue where they responded but did not initiate;
- limited opportunities to talk and practice skills, and engage in social talk;
- lack of meaningful activities to enable them to express personal views, opinions and engage in informal reasoning about their own educational experiences.

Phase 2

To overcome these limitations, teachers and researchers planned to develop strategies to assist their students to become independent thinkers and develop rational forms of talk in the classroom. All teachers made the decision to :

- be explicit in stating the goals and objective of each lesson;
- develop a lesson plan for each lesson stating student thinking outcomes;
- build into the lesson opportunities for students to respond to classroom experiences and reflect on these;
- encourage learners to judge the purpose and effect of their own learning, and make personal statements about their classroom experiences.

Teachers were encouraged to adopt a variety of strategies based on modelling, scaffolding and encouragement of analysis, questioning and critical thinking. Instructional approaches were based on the provision of supportive social contexts for learning. Videotaping of lessons continued during the second semester, following the intervention.

The principal changes that occurred from phase 1 to phase 2 phase were that :

- there was an increase in cognitive support for students across all subject areas;
- the proportion of feedback also increased;
- the amount of non-task talk and procedural talk decreased.

The types of teacher talk which decreased were those related to non-task or routine, and management issues [Table 3].

Table 3: Mean percentages changes in teacher talk by category from phase 1 to phase 2 in all subjects

Stage 1-2	non task %	procedural %	control %	reconstruction	cognitive	feedback
Maths	-4	-7	-3	-.5	+7.5	+4.5
English	-5	-3	-21.5	+1.5	+23	+4
Science	-3	-10	0	0	+9	+4

Italian	-2	-8	-6	-1	+10	+3
Social Studies	-4	-20	-9	+2	+18.5	+2.5

Phase 3

Following the intervention changes were observed to occur in the pattern of teacher talk and student talk.

In phase 3 the pattern of pedagogic support was that teachers continued to support thinking skills in students by offering a range of scaffolds, such as asking reflective questions, encouraging discussion, promoting reflection, and asking questions which enabled students to reflect and elaborate on their own thinking processes.

Table 4 shows the mean percentage changes in teacher talk from phase 2 to phase 3, when teachers were implementing their process-based strategies for higher order thinking.

Table 4: Mean percentages change in teacher talk from phase 2 to phase 3

Phase 2-3	non task %	procedural %	control %	reconstruction %	cognitive %	feedback %
Maths	+7	-4	-2.5	+.5	+.5	0
English	+1	-1	-2.5	-1.5	+2	0
Science	-1.5	-1.5	0	+6	+1	-3
Italian	-1	-3	-1	+2	+3	+1
S. Studies	+1	+3.5	-4	-.5	+4.5	+1.5

The data clearly showed that for teachers, the proportion of cognitive talk devoted to supporting thinking and reasoning improved from phase 1 of the study and remained reasonably stable for the two terms following the training program. Student talk also showed increases in higher order thinking from phase 1 to phase 3 [Figure 1].

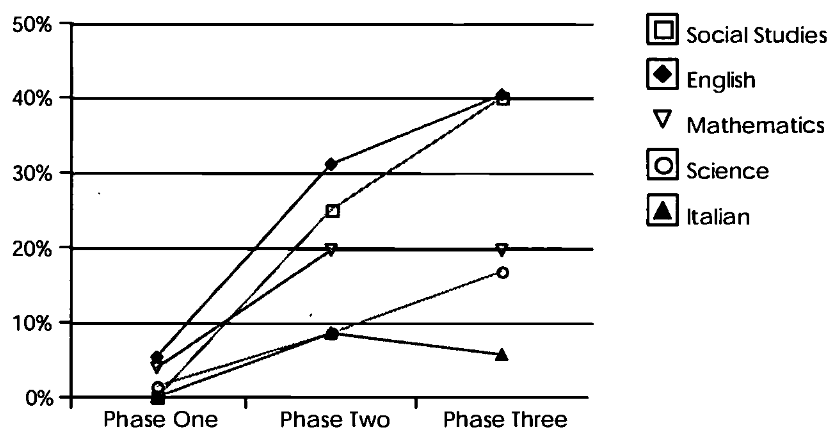

Figure 1: Percentage of higher order thinking in student talk from Phase 1 to Phase 3

Conclusions

The changes in the quality of teacher pedagogy and student and talk following the training session confirmed our belief that telematics environments could be designed to foster higher order thinking as a pedagogical goal and provide a supportive context for learner engagement.

Teachers created the social conditions in the classroom conducive to thinking and expression of ideas, so that students could become independent thinkers. In particular, the role of scaffolding was shown to be of great importance, and this was reflected not only in teacher pedagogy but also in learners' increased capacity to demonstrate thinking at higher levels.

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The Best of Both Worlds: Redeveloping a Multimedia Project for the Web

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Abstract: The paper describes a redevelopment of a successful Veterinary Bacteriology and Mycology multimedia project at The University of Melbourne into a Web-based format. The design of the initial project is described, together with learning benefits that short-term evaluations revealed. The positive benefits were not sustained in the long term, as this was a once-off experience for students. Several needs and opportunities emerged:

- We sought a more adaptable model which veterinary (and other) colleagues could use in their own discipline areas, so that the overall nature of the student experience was changed.
- An international consortium of over 30 veterinary bacteriology and mycology teachers was formed in January 1996.
- We wanted to respond to, and take advantage of, new communication and information technologies (CIT) being packaged together in a Web environment.

These needs have led to the VetSource project, which uses the Creator engine. The evaluation during the first year of this Web-based project is described.

Original Veterinary Bacteriology and Mycology (VBM) Project

The Veterinary Bacteriology and Mycology (VBM) project at The University of Melbourne was begun in the early 1990s. It set out to use computer technology to overcome some of the current problems of subject presentation and integration in overcrowded veterinary curricula. It involved the development of interactive, multimedia databases of veterinary curriculum materials, linked to a revised set of educational objectives, a range of other learning situations and more appropriate assessment procedures. The expanded set of learning objectives required students to acquire information management and problem solving skills, as well as understanding bacterial and fungal diseases of animals. The development of group learning skills and communication skills were also explicitly built into the course. The curriculum rationale is explained in detail in [Whithear, Browning, Brightling & McNaught 1994]. In this computer-based, case study learning system (CB CS LS), 24 lectures, 40 hours of laboratory sessions and course notes were replaced by:

- few formal lectures;
- course material in multimedia databases;
- case studies with associated quizzes, 6 of which were intensive laboratory exercises (10%);
- short essays (20%);
- seminar (5%);
- literature review (15%); and

- 'open computer' examination (50%) (assessment percentages in brackets).

This has been well evaluated with findings like the following [McNaught, Whithear & Browning 1994]:

- Students took more responsibility for their own learning. They were expected to acquire new information from a variety of sources, including primary sources, and to develop skills to control their own information using a computer.
- There was no requirement to memorise by rote. Learning was predominantly contextual, using simulated, problem-based case studies.
- Higher order cognitive skills were sought and demonstrated in the presentation of seminars and essays, and in the 'open computer' examination answers.
- More opportunity was provided, and emphasis placed, on collaborative learning.
- More opportunity was provided for students to develop written and oral communication skills.
- Continuous monitoring and feedback (both quantitative and qualitative) of student progress was provided.
- Increased awareness of, and interest in, the subject and improved practical skills were demonstrated in this class compared with previous experiences with classes taught in the conventional manner.
- Students acquired familiarity and skills with computers and computer networks.

These students were followed through into their clinical years. A focus group interview with clinical teachers and some individual interviews with students were conducted. The teachers did not think the students were noticeably better at clinical diagnosis than in previous cohorts, or knew more microbiology. Several of the teachers had looked at the VBM material and valued its intentions and design. However, they felt that this approach was not integrated into the whole veterinary course in a way which would make any real differences. It was an isolated experience. These views were echoed in students' comments; one recalled the VBM experience as "a fond memory". So, the evidence the project team has it that these initial positive shifts were not sustained by students in their work in later years in clinical settings. This is hardly surprising; one eight-week experience is unlikely to alter students for long when other subjects encourage information reproduction. We wanted a more adaptable model which veterinary (and other) colleagues could use in their own discipline areas to encourage a genuine change in the nature of veterinary students' experience.

The Emergence of Creator

The emergence of new communication and information technologies (CIT) being packaged together in a Web environment has resulted in a much higher profile being given to the use of CIT in T&L within Australian universities. There is also a growing international awareness of the potential of Web-based technologies to facilitate the development of long distance collaborative projects. Both of these factors have resulted in an international consortium of over 30 veterinary scientists working with a team of software engineers from Melbourne Information Technologies Australia (Melbourne IT)—the commercial Information Technology subsidiary of The University of Melbourne—to develop a Web application which satisfies the requirements of the VBM project as well as other courses. This Web environment is called Creator, and is a course management and authoring system that is designed to combine the flexibility to satisfy the academic needs of different disciplines with a University-wide interface consistency for staff and student users alike. It provides a unique generic authoring tool and integrated platform for the communication of education over a network, either internet or intranet.

It has become trite to say, but is still true, that the role of the educator is undergoing a transition from that of the 'sage on the stage to the guide on the side'. Being a repository of expert knowledge is no longer enough to be accepted into the hallowed halls of pedagogues. The online world of the Internet can provide a wealth of information; the important skill now is to manage and synthesise it all. Many are struggling with the transition from an industrial to an information society. On the other hand, many are embracing the opportunities provided by new technological innovation [Reeves & Reeves 1997].

With the convergence between database and internet technologies we are seeing the rise of education as a consumer item in a general sense. Something to be packaged neatly into modules ready to be taken away, unwrapped and 'consumed' at leisure. Coupled with this is the changing nature of educational delivery via the Internet, a delivery mechanism by virtue of bandwidth limitations, demanding that information be provided in snapshots or manageable chunks to enable acceptable delivery times online.

These forces combine to ensure that any semester course created or converted to online delivery will consist of many individual elements. Management of large sets of data has typically been handled by databases. They are purpose-built to store large amounts of data. The Internet is an excellent mechanism for serving up information via browsers. In the past twelve months there have been rapid developments in the convergence between database and internet technologies to the point now where new middle layers of functionality are being developed to potentially revolutionise the delivery and management of online educational material.

Once the question of getting course material on the Internet has been addressed, and the decision has been made to follow a digital direction, the issue then becomes one of how much time and resources are available to ensure delivery. This is where integrated authoring environments come into play. For small-scale teaching with only a few students and limited resources, the creation of ordinary HTML (HyperText Markup Language) files is quite appropriate [Hart 1996]. As a site grows with the accumulation of text, graphics and videos along with the incorporation of CGI scripts or Java applets to ensure some degree of interactivity, the site begins to require more and more basic management to ensure that the ever-growing number of individual files are organised in a coherent way.

An integrated environment based on active server page technology, such as Creator, allows for resources to be stored in a database and then served-up 'on the fly', as they are needed. In this way, the same resources can be shared among many users. Of more importance to the authoring academic is the ability to collaborate with other academics via the Internet to assemble resources into learning activities.

The potential for online authoring in a virtual university environment is immense, particularly where the issue of Intellectual Property is addressed by allowing individually created learning objects, such as text, graphics, quizzes, Shockwave objects and so on, to be 'stamped' as created by a particular individual. Creator allows for these 'learning objects' to be authored into a sequence of case studies, tutorials or lectures for delivery to students.

A summary of Creator's features are:

- Text, images, animations, video, audio and other media objects are stored in a database for fast retrieval on the fly and efficient management.
- Teachers can create different reference works from the same data, or can provide different views of the same work to individual students.
- Objects cut and pasted into the resource palette can be re-used in other work.
- Easy-to-use authoring tools are provided for teachers to create learning objects containing interactive multimedia components.
- Collaboration between teachers is managed through a set of editorial tools.
- Outputs from quiz and other assessment objects are stored in the database for reporting purposes.
- News groups on particular subjects supporting synchronous and asynchronous group discussion can be easily created.
- Threaded discussions to simplify tracking of multiple email messages are included.
- Chat sessions, video/audioconferencing are enabled using MicroSoft NetMeeting.
- The results from simple or complex searches can be added to individual Resource Palettes for later inclusion in Library and Learning objects.
- Intelligent agents provide a variety of unique, powerful search features.
- Includes a dictionary helper for inserting lengthy names into the search field.
- Tracking of student performance at a subject and course level is provided, including the time a student spends on each activity.
- A wide variety of graphical and text-based reports of assessment results, student activity, etc. are available to teachers and administrators.

Development of the VetSource Materials

An international consortium of veterinary bacteriology and mycology teachers using problem-based learning and interactive multimedia was formed in January 1996. The educational mission of the consortium is to improve the quality of veterinary bacteriology and mycology teaching by facilitating adoption of problem-based learning systems that incorporate innovative use of interactive multimedia. This is to be achieved through an integrated system that electronically links the learning (problem-based) process with multimedia information sources. In other words, it uses the educational concepts that have been practised over the past five years for teaching veterinary bacteriology and mycology at The University of Melbourne. However, there will be two important differences. The first is that the teaching materials are being delivered via the World Wide Web using the Creator platform being developed by Melbourne IT. The second major difference is that the combined specialist talents of the teachers involved will be available to the consortium as a group. The most tangible immediate benefit of this will be the production of an international, multimedia textbook on the subject that is accessible to consortium members and their students via the Web. An editorial board has been formed to oversee the content and educational quality of the electronic text. In addition, it is expected that consortium members will share case studies and other materials. However, it should be emphasised that other than for the text content, the ways in which the materials are used will be up to the discretion of individual teachers. Flexibility of learning modes has been built into the system. As a pilot, two chapters and accompanying case studies were produced to allow members of the consortium to comment on issues such as content and style. At this initial stage the information content is the focus; a focus on communications will follow.

The first two chapters of theVeterinary Bacteriology and Mycology book in the Library were:

- Campylobacter, Helicobacter, and other curved Gram negative rods
- Mycoplasma—Class Mollicutes

There is also a Dictionary of Veterinary Bacteriology.

The first two case studies are:

- Puppy diarrhea case (John Prescott), and
- Air sac disease (Kevin Whithear)

'Air sac disease' is an original VBM case study which has been translated to the Web environment. While the 'story line' of the linear unfolding of a case study is still apparent, students can access any place in the case study. It is hoped that the 'authenticity' of the original case study about problems in a 28 day old broiler flock still remains with additional flexibility and functionality. The material appears as a menu:

1. Quiz about some important biological properties of the organism involved
2. Quiz about culture of fastidious pathogens.
3. Identifying a bacterial species belonging to a genus with unusual properties
4. Quiz about some biological consequences of unusual properties of the causal organism
5. Quiz on possible role of parent to progeny transmission in this case
6. Identifying an important secondary pathogen
7. Pathogenesis of the disease
8. Controlling the infection
9. Feedback

'Puppy diarrhea case' is a new case study designed for the Web environment. It was designed with the intent of getting veterinary students to understand some of the complexities of the problems that they will be faced with in their work, including highly charged contexts in which high value placed on an entity (here an unborn child) can significantly distort perceptions of risk. The case was designed to help students identify possible issues involved in a problem, then to use the search function of VetSource to identify an agent(s) of possible significance. As the Library element of VetSource is developed then other agents will be added to the list. As the case progresses, the students continue to search the relevant part of the text to increase their understanding of the sources of this infection, and of the relative risks of different sources. The underlying aim is to get the student to understand the sources of this infection, the type of disease that it causes, as well as how to analyse a problem which they might not see initially as within the field of veterinary medicine. They are led to engage with the material by their need to know and by the intriguing nature of the problem, rather than because some professor tells them this is important. It is also part of the concept behind VetSource that they need to find out about how to find and use information, and therefore need familiarity with a text that they can learn to know and trust. Like 'Air sac disease', the case study appears as a listed menu.

1. Quiz about case
2. Search on words: pregnant, diarrhea, young dog
3. Choose what to do next.
4. Choosing the correct laboratory sample
5. Choosing an antibiotic
6. Choosing a photograph
7. Quiz about sources
8. Put a list in order of importance
9. Feedback

Student Response to these Initial VetSource Materials

The first author interviewed five students in September 1997. In most cases she watched them open VetSource for the first time and then came back a few times to see how they were progressing.

- All found it easy to get going. This is very encouraging, especially as there were glitches with using Netscape 2 instead of Netscape 3.
- Indeed, students were unfazed by the prototype 'bugs' and navigation issues that would have greatly concerned students a few years ago. Here are a few examples of these initial problems. They are mentioned because students' ability to deal with them and record them for our benefit represents a stage where formative evaluation has reached a much more sophisticated level than in previous years. For example:
    - We had problems with the 'back' Netscape button.
    - It was not clear that the vertical buttons 'Learning', 'Library', 'Discuss' and 'Search' are ABOUT buttons and that access is by the menu bar at the top. It doesn't take long to figure out but it is not elegant.
    - The buttons on the menu bar always take you to the beginning of the 'Learning', 'Library', etc. section. This means that if you are in the middle of a Learning module and decide to go to the Library, you then get sent back to the start of the Learning section again.
- All of the students liked the speed of access.
- The layout of the Library material was considered great. In particular the expandable thumbnail images were appreciated. Three students commented favourably on the number of images and the juxtapositioning of the images and text.
- All of the students like having only short sections of text. One called it a 'leaner and meaner' approach. One suggested the possibility of 'more info' as a possible button. This point does raise questions for Web designers to consider. How much is this a real change in student learning styles? Is this a visual age? How much are we concerned because of our own text-based education? How can we decide on a useful balance point?
- All commented that they liked the brief introduction to the case studies. Of course, this evaluation was done near the end of the academic year where, as one student commented, the students are tired of extended stories. It is planned to try one case study with a longer introduction and one with a brief introduction with some students in 1998.
- All liked being able to move around the Learning modules easily. They acknowledged the need for better graphic design, rather than a list of numbers, but didn't think it a big deal. One student actually began to discuss the design for a map of a case study which could be implemented with mapping software currently available.
- All liked the idea of explanations to both right and wrong answers.

- The level of discussion with students was high. For example, the idea of different types of question formats was discussed with two students; they were very receptive to the idea of variety and made suggestions about possible formats. As stated above, many students are now sophisticated computer and Web users and we may be under-using these students as potential ideas sources in educational design.
- Staff wanted more of an immersion feel for each Learning module—the sense that students were in a clinical laboratory was much less pronounced than in the original VBM. Staff are concerned by this. The students didn't seem to feel this; they were too interested in the advantages described above. However, the 'feel' (flatness?) of a Web environment is an item we think we should keep this on the agenda.

Student response to the initial VetSource materials is very encouraging. There is clearly a great deal of developmental work still to do but the results appear to be worth the effort.

Emerging Veterinary Projects

Several other staff in the Faculty of Veterinary Science at The University of Melbourne have decided to use Creator as a vehicle for development and we have a sense of growing momentum towards a veterinary online curriculum—not yet an avalanche but a really significant change. These projects are:

- Redeveloping an existing Basic program for a PC called 'Sick Moo' which aims at assisting students to develop a clear procedure to use in examining cows. The focus is on facilitating clinical examinations and diagnosis. While the current software is well-designed from an educational point of view, in that students enter their ideas about clinical procedures as free text and so are not influenced by choosing from a list, a separate set of audiovisual equipment is needed for its use. A Web version will be more elegant, will allow for more data to be accessed and will facilitate future extensions to the project.
- Regional anatomy of the dog. This is a new project aimed at enhancing students' attitudes to veterinary anatomy and maybe how this might affects their approaches to learning.
- Clinical pathology. This will focus on providing another experience for students in viewing pathological slides so that their ability to use slides diagnostically is enhanced.
- Mammary gland and respiratory tract streams. The focus here is on vertical and horizontal integration of material. This will be designed as a series of problem-based activities linked to information sources which students can use across several years of their studies.
- Continuing education for practising vets on mastitis. The potential for developing short modules aimed at exploring topical material in an interactive way brings another dimension to veterinary education.

Evaluation plans are being developed for these new projects as well as further work with the microbiology materials. We believe we are entering a new phase of the use of CIT in T&L. We can use all what we have learnt about designing for stand-alone multimedia environments in these new integrated online learning environments. It is a new phase but not a new slate.

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The Impact of Information Technology on Practices and Policy in Higher Education

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Abstract: Are computers just another tool for teaching? Nice images, lots of memory, but nothing fundamentally new? Or have we entered a 'new age' in our ability to explore and represent knowledge, to present knowledge to our students, and to design systems of education for delivery of this knowledge to large numbers of students? These are not simple questions to answer. This paper will explore some of the characteristics of information technology. In particular, nformation technology raises epistemological questions which are explored. Some implications of the characteristics of information technology for university policy and planning will be discussed.

Characteristics of Information Technology

> By appreciating the metaphorical power of the computer as well as its technical capabilities, ... the computer is more than merely a sum of its component parts. It has become an 'object-to-think-with'—stimulating thought and providing a new medium of expression.
>
> [McQuillan 1994], p. 650, using [Turkle 1984]

There is no doubt that computers have transformed the working and living conditions of many people. Four of these transforming characteristics are:

- access and retrieval of large amounts of information,
- representation of information in a wide variety of ways,
- information access geographically widespread, and
- rapid communication.

However, much of the current debate centres around the logistics and economics of technological advances—the what?, when? and how? type questions. There are also fundamental epistemological questions which need to be explored—why? and towards what future? What is needed is an overview of how changes in the nature and structure of higher education are interdependent with changes in technology. Some of these interrelationships are shown in [Fig. 1]. Higher education is a highly dynamic and rapidly changing situation, and staff development and training needs become of paramount importance in university policy and planning. [Fig. 1] portrays many areas which need exploration and debate. This paper will focus on exploring some of the epistemological questions raised by information technology and discuss some implications for university policy and planning.

Epistemological Implications

As we represent data in new ways, do we ask new types of questions? There are some indications that this is occurring. As we share our ideas in new ways and in new time frames, do our thinking patterns change? We need to consider what epistemological shifts that may be facilitated by current technologies. Some of these are:

- from object-focussed to process-oriented views of knowledge,
- from individual ownership of knowledge to a community ownership of knowledge,
- from a transmissive to a transformative view of student learning,
- to an increasing legitimation of collaborative processes,
- towards a public process of peer refereeing,

- towards a greater focus on associational thinking over linear thinking, and
- towards the use of visualisations as both research and teaching strategies.

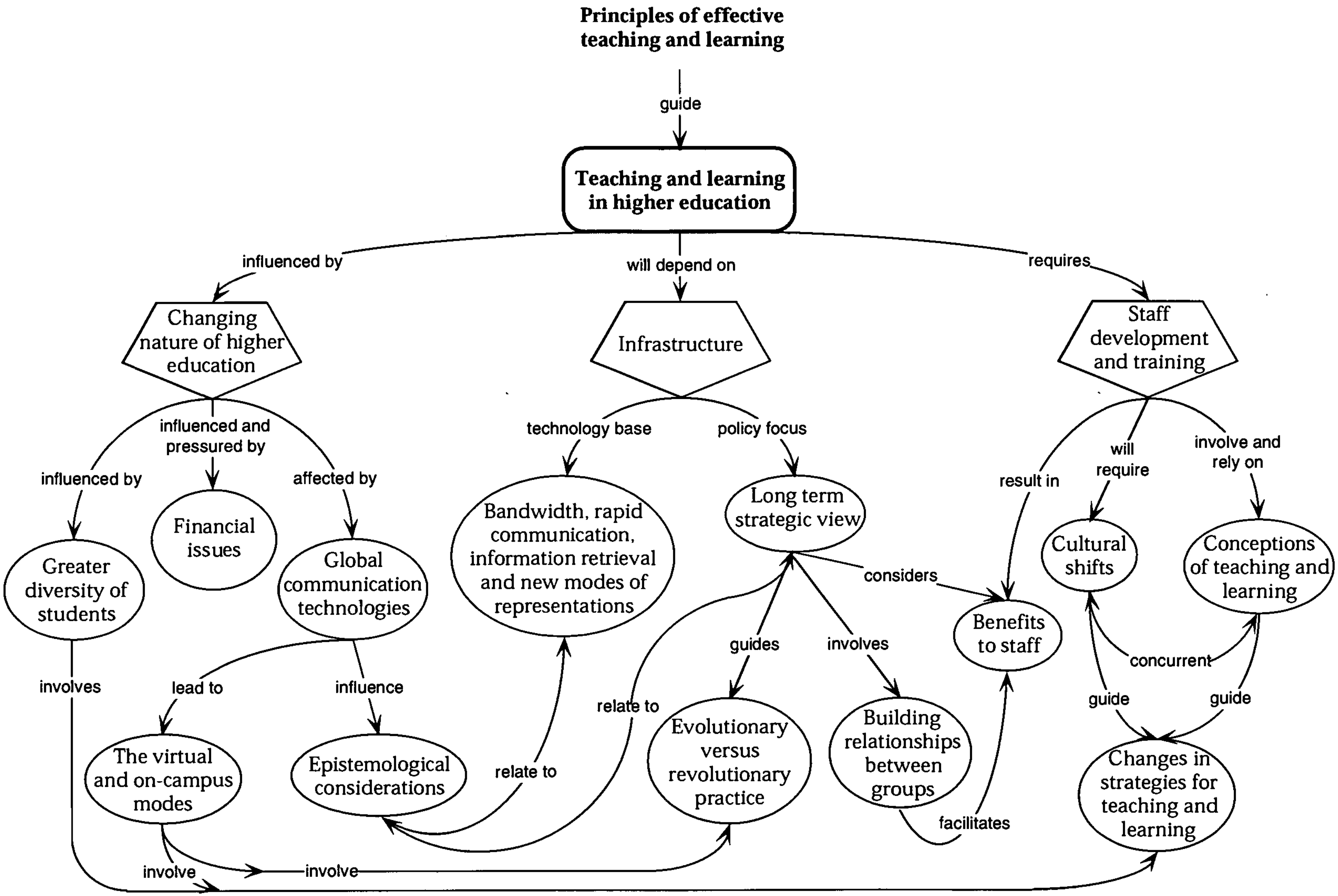

Figure 1: Interdependent relationships between the nature and structure of higher education and new technologies

Traditional view	New tendency	Comments
1. Knowledge as an object (printed, storable) (closure is possible)	Knowledge as conversation (consensus, process) (closure is difficult)	This is not to say that knowledge was only viewed in an objective framework before the advent of computers, but rather that the fluidity of knowledge exchange using computer technology is beginning to challenge an objective paradigm in new ways. I have only recently begun citing email discussion groups and Web sites. The shift in my own thinking and academic practices has been marked. The 'authority' of the words on the screen has added another resource to my literature searching. Note that this is an enrichment of my knowledge base, not a replacement of one resource by another, and brings new criteria into my assessment of the value of ideas and strategies I read about onscreen. I have a sense of being more critical, less reliant on the authority of other reviewers. This places new responsibilities on academics—both in their own scholarly work and in relation to the academic training they provide for their students.
2. Knowledge identified with individual 'experts' (e.g. theories are labelled as Freudian, Darwinian, etc.)	Knowledge identified with community (e.g. public email discussions)	This table was originally posted on the AAHESGIT (American Association for Higher Education Special Group on Information Technology) listserv and opened to public debate. Many of the comments I am including have been stimulated by that open, quite rapid, international debate.
3. Teaching as conveying knowledge	Teaching as getting students engaged in the knowledge-development process	Interactive multimedia has enabled the construction of resources for students to use in constructing their own understandings. Computers offer more dynamic opportunities for using visual media to represent both concrete and highly abstract entities and relate these representations. A good example is use of multiple representations by [Thomason, Cumming & Zangari 1994] in their statistics multimedia package where students can manipulate and construct their own distributions and visually solve statistics problems in several distribution playgrounds. The emphasis is on personally held constructs and not on formula-driven solutions.
4. Professional collaboration still difficult in some fields	Collaboration seen as how knowledge is developed and therefore legitimate	Collaboration is now much easier at both national and international levels. Sharing of large data files on a global basis is now relatively easy, making genuinely collaborative work across continents and cultures a reality. In Australia collaborative grants between universities which are thousands of kilometres apart are actively encouraged by several funding agencies and the use of email and computer conferencing are normal professional practices.
5. Publications are refereed before distribution	Publications may be refereed ex-post facto	Some Web sites now clearly distinguish more finished papers from works in progress. An example is the Australian Committee for the Advancement of University Teaching (CAUT) Humanities and Social Sciences site called [ultiBASE] where active debate is encouraged on posted papers.

Traditional view	New tendency	Comments
6. Linear favoured over associational thinking	Associational thinking gains credence	The advent of hypertext media, both in instructional interactive multimedia and in hypertext essays on the Web illustrates this well. [Beaumont & Brusilovsky 1995] and [Ecklund 1995] discuss the relationship between cognitive structures, instructional design and learning outcomes; they argue that people learn by constructing several links between concepts, personal records of events and formal theories. Hypertext media are therefore likely to facilitate learning. [Kozma 1991] describes the critical capability of the computer to proceduralise and relate the relationships between symbols in mental models. One powerful tool that has evolved is concept mapping software that is used in variety of ways, e.g. [Gaines & Shaw]. Many Web sites are still very linear in design and therefore underutilise the potential of the medium; a good example of a hypertext essay on the Web is on the Open Learning Technology Corporation [OLTC] site.
7. Classroom and the real world seem separate	Classroom connected to off-campus world	Open learning now applies to both on- and off-campus courses. Email and electronic conferencing (both desk-top and room-based) technologies have reduced 'the tyranny of distance' considerably [Ring & Watson 1994]; [Goddard 1995]. Many large IMM projects are being converted to Web delivery. The technology for this exists; large resources (video, animations) can be on a local CD-ROM but the interactive elements can be Web-based. Substantial projects, e.g. ChemCAL, 70 hours of introductory chemistry [McTigue et al. 1995] are currently being reworked in this way.
8. Visualisation a 'frill' in some fields	Visualisation as a knowledge path	The supremacy of text is changing. There is an increasing awareness that students are becoming more visually literate and that the ways in which they learn from visual material may be changing, e.g. [McNaught, McTigue & Tregloan 1996]. Computers afford opportunities for dynamic use of visual material. For example, visual search engines on the Web are being produced, e.g. [Apple Computers] Hotsauce project which should allow more flexibility in our explorations of the loosely structured world of the Web; one can literally look around for information, rather than searching with pre-determined key words. This is done using the mouse to move into a specific domain of knowledge and then down through layers to reach specific Web sites.
9. Experimental methods limited to certain fields	Simulation used as a means to explore knowledge in many fields	Data mining using genetic algorithms or neural networks is now being used to rapidly sift enormous amounts of data relatively rapidly, looking for new patterns and relationships. These techniques are used in a wide range of disciplines from business to astronomy [Kiernan 1994]; [Matthews 1996].

Table 1: Epistemological shifts that are facilitated by current technologies (after [Batson 1995])

[Batson 1995] lists nine dichotomies in an attempt to map the epistemological shifts that are facilitated by current technologies. As with all attempts to dichotomise issues, Batson's framework should not be taken as implying that all approaches on the left no longer have value and should be replaced by the approaches shown on the right. It does, however, provide a framework where new approaches can be seen as presenting fresh opportunities in higher education. The discussion is contained in [Tab. 1].

Some Implications for University Policy and Planning

My own interest is in the use of information technology in teaching and learning, though the distinction between research and educational uses of computers is not at all clearcut. One of the benefits that competition between universities for student markets is that the educational design of new courses is getting more serious attention and real effort is going into the conceptualisation of interactions between teacher and students. [Laurillard 1993] describes a teaching and learning model containing the four aspects of discussion, interaction, adaptation and reflection. She argues that the use of multimedia can enhance the teaching-learning process effectively by facilitating 'conversations' between students, teachers and instructional material. Many innovative curriculum projects in higher education involve stand-alone interactive multimedia modules. Others involve open learning modules using network delivery. There are also other curriculum strategies which can enhance student learning such as email discussion groups, online help processes, students producing their own multimedia presentations, and computer databases used for cooperative learning projects. Certainly the quality of some of these innovations is not high but there are enough examples now of projects [Wills & McNaught 1996] where improved student learning has been demonstrated for us to feel that the investment may indeed pay off! These pedagogical questions are not just for individual teachers to consider; there are larger policy questions for universities to consider.

[Laurillard 1996] examined the balance of student study activities in a UK university. She mapped the distribution of student learning activities by type of activity and nature of the process, using four categories—attending (21 hours), practising (10 hours), discussing (1 hour) and articulating (8 hours). This data was taken from an engineering department in a campus-based university where the main activities were lectures, use of audiovisual materials, tutorials, problem practice sessions, private reading and completing assignments. There were several differences found in other departments and in another university but the general pattern was usually the same, with attending being by far the commonest activity:

Laurillard then describes how the use of information technology could be used to redistribute student learning time in a different way, so as to achieve a more effective balance between active and passive modes of learning. She describes this as follows:

> 'To the standard methods of university teaching we could add computer-assisted learning (CAL, to represent any form of computer-based teaching program), audio-graphics (to represent synchronous conferencing), computer-mediated conferencing (CMC, as the asynchronous form of conferencing), and interactive computer-marked assignments (ICMA) to cover those aspects of assessment that can be handled adequately by a program. The same total student study time can then be redistributed over a wider range of teaching methods, resulting in a more balanced distribution across the key types of learning activity, as shown again in the final totals for each line.'

The final totals could then be attending (14 hours), practising (13 hours), discussing (4 hour) and articulating (9 hours). The technology infrastructure in a university can be organised to maximise the potential for more active student learning.

This piece of research can be embedded into a theoretical framework where we can view university policy making as an evolutionary scenario or a revolutionary scenario [Alley 1996]. Evolutionary changes are essentially 'more of the same', an adaptation of new technologies and conditions into existing frameworks; revolutionary changes work towards the development of new models of communication and accountability. The differences between evolutionary OR revolutionary scenarios can be considered for a range of policy issues, including:

- hardware choices—fixed networks OR dial-up phone lines
- media support—video OR Web, email, chat
- instructional design support—distributing traditional teaching OR inventing new learning
- funding arrangements—State/Institution special funds (not base funds) OR Institution base funds

- location for student activity—user comes fixed, prescheduled classes OR site is with user in flexible mode
- curriculum assessment—retains classroom groups idea OR based on individual needs and career pathways
- institutional quality assurance—productivity for provider OR quality for clients (staff and students)

There are congruences or patterns which exist between epistemological and policy perspectives. The consequence of these patterns for the design of on-campus and open learning systems of education is that there are now a much greater number of options which are available for course design and delivery. It is hoped that the university of the future will use this flexibility to create a variety of pathways for students to follow. This may relate to the ways in which students mix on-campus and distance courses, to flexibility in the design of individual courses, to changes in assessment options and to altered relationships between the work place and university education. A time of intense exploration lies ahead. Let us not set our universities in electronic concrete that locks us into modes of delivery that are too specialised and inflexible. Rather let us keep to a vision of global sharing of knowledge and systems in a manner that allows the needs of individuals learners and communities to be met.

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Metrics applied to Hypermedia Authoring for Education

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Abstract: This paper reports the results of applying metrics to hypermedia authoring under the SHAPE research project. The aim of SHAPE is to help authors develop high quality large hypermedia applications for education. The quality characteristics considered are the reusability of information, the maintainability of applications and the authoring effort.

Although a number of metrics for hypertext systems have been proposed, we believe that many of the measures proposed in the past lack the necessary mathematical and/or empirical justification.

The metrics proposed in this paper have been developed using the Goal-Question-Metric approach, and adhere to the representational theory of measurement.
We describe the development of the metrics and the results of a quantitative empirical study which compares two different hypermedia authoring systems.

1 Introduction

Even with a very clearly stated theory, there have been plenty of examples of software development projects whose budgets and schedules overrun. Software engineers have tried to address such problems by continually looking for new techniques and tools to improve process and product, but without corresponding empirical evaluation [Fenton & Pfleeger, 96].

Measurement can be used to [Basili et al., 94]:

i) Support project planning.
ii) Determine the strengths and weaknesses of the current processes and products.
iii) Provide a rationale for adopting/refining techniques.
iv) Evaluate the quality of specific processes and products.
v) Assess the progress of a project during its course.
vi) Take corrective action based on this assessment.
vii) Evaluate the impact of such action.

The representational theory of measurement seeks to formalise our intuitions about the way measurement works. That is, data obtained as measures should represent attributes of the entities observed, and manipulation of the data should preserve relationships observed among the entities [Fenton & Pfleeger, 96].

In the hypertext field we can identify similarities with software engineering: for a long time there has been little interest in any sort of evaluation to prove the usefulness of a method or tool. Thus, the community can be accused of 'advocacy research' [Fenton et al., 94], [Glass, 94].

There have been proposals for hypertext metrics, developed in an ad-hoc fashion, expressing measures in an ambiguous manner and therefore limiting their use. Many measures proposed in the literature therefore lack the necessary mathematical or empirical justification.

At the University of Southampton we have developed metrics for hypermedia authoring under the SHAPE research project [Mendes & Hall, 97a], [Mendes & Hall, 97b]. The aim of SHAPE is to aid authors in the development of high quality large hypermedia applications for education.

In applying scientific method to the definition of metrics, we base the principles of our work on a framework for software measurement proposed by Fenton et al. [Fenton & Pfleeger, 96], and on the guidelines from the DESMET project [Kitchenham, 96], [Kitchenham, 93].

In Section 2, we present a survey of hypertext metrics already proposed and in Section 3 we compare those proposals and offer further discussion. In Section 4 we present the research project SHAPE and describe how we have developed metrics applied to hypermedia authoring. Finally, in Section 5 we give conclusions and comments on future work.

2 Hypertext Metrics

The application of metrics to hypermedia has stimulated considerable interest [Botafogo et al., 92], [Rivlin et al., 94], [Garzotto et al., 94], [Garzotto et al., 95], [Hatzimanikatis et al., 95], [Yamada et al., 95] but their utility is still questionable since there has been little corresponding empirical validation.

Botafogo et al. [Botafogo et al., 1992] proposed the *stratum* and *compactness* metrics, both calculated by considering only the structure of the hyperdocument. The *compactness* metric indicates the connectedness of the hypertext and the *stratum* metric indicates to what degree the hypertext is organised so that some nodes must be read before the others.

The work from Garzotto et al. [Garzotto et al., 1994] provides a framework for design-oriented hypermedia evaluation, using both a set of design objects, based on HDM [Garzotto et al., 91], [Garzotto et al., 93], and a set of fine-grained attributes of these objects that can impact on hypermedia usability. No internal attributes were proposed as measures since they assumed that finer grained attributes could be obtained by combining the three categories (consistency, self-evidence and predictability) with the three classes of design constituents (structure, behaviour, and presentation) and with the two levels of design (in-the-large and in-the-small), producing eighteen finer-grained attributes in total.

Yamada et al. [Yamada et al., 95] propose three metrics: i) an interface shallowness metric (ISM), ii) a downward compactness metric (DCM), and iii) a downward navigability metric (DNM). The ISM represents the heaviness of the cognitive load on users. The DCM measures the compactness of links from the root and the DNM metric measures hypermedia navigability. This assumes that an easily navigable hypermedia system (1) has a shallow interface layer from the root to the nodes (light cognitive load) and (2) is compact from the root (that is, it is structurally simple to reach the nodes from the root).

Hatzimanikatis et al. [Hatzimanikatis et al., 95] define a hyperdocument quality model using the Factor-Criteria-Metric model [McCall et al., 77]. The factors considered are readability and maintainability, which they decompose into: size, path complexity, tree impurity, modularity, node complexity, coherence, complexity of node contents and simplicity. They define metrics for path complexity, tree impurity, modularity and individual node complexity. Their definitions are, respectively: the number of different paths or cycles that can be found in a hypertext graph; the extent to which a graph deviates from being a tree; whether modules are self-contained and independent; the complexity that a single node imposes on the overall hypertext structure.

[Tab. 1] compares the four proposed hypertext metrics considering the four questions that should be asked when validating a measure [Briand et al., 97]:

1) Is the measure adequately capturing the attribute it purports to measure (i.e., construct validity)?
2) Is the attribute itself well-defined based on an explicit empirical model (i.e., empirical relational system) ?
3) Is there any empirical evidence supporting the underlying hypotheses of the empirical model?
4) Is the measure useful from a practical perspective?

'X' means that the characteristic has been fulfilled by the proposal.

	Metrics Proposals			
Questions	Botafogo et al.	Garzotto et al.	Yamada et al.	Hatzimanikatis et al.
(1)	X		X	
(2)			X	
(3)			X	
(4)	X	X	X	X

Table 1 - Comparison of the proposals

The metrics proposed by Botafogo et al. have been used in some experiments [Adams & Jr, 97], [Calvi & DeBra, 97], but they were neither based on an empirical relation nor proved to be useful by empirical evaluation. According to Calvi & DeBra "while these methods are able to find link structures which are likely to be unusable, they cannot guarantee that link structures having all suggested values for different metrics will actually belong to highly usablehyperdocuments". Hatzimanikatis et al. did not define any empirical relationships for their metrics. They were unable to present precise limits or ranges for acceptable values of the metrics proposed because they believe that acceptable values can vary according to the application, the authoring tools used and the production environment. Empirical evidence would help to provide baselines for these metrics.

3 Metrics applied to SHAPE

3.1 The SHAPE project

Southampton Hypermedia Authoring Paradigm for Education (SHAPE) [Mendes & Hall, 97a] is a research project being carried out at the University of Southampton. The aim of SHAPE is to help authors in the development of high quality large hypermedia applications for education. The quality characteristics we consider are reusability of information, maintainability of applications and authoring effort.

Instead of defining improvements to be applied to an authoring tool and later verifying if they are adequate, we decided to use a more consistent and systematic approach: to apply metrics in order to identify how adequate an authoring tool is for the maintainability of applications, information reuse in applications and the level of authoring effort required.

We have chosen to compare Microcosm [Davis et al., 92] to the Web [Berners-Lee et al., 94] because the two systems propose different and opposite ways of representing and managing links, and this seems to have a big influence on authoring [Hill et al., 95]. Microcosm is an open environment, characterised by the separation of link structures from the information being linked [Hill et al., 95]. The WWW, on the other hand, provides a simple point-to-point linking model based upon embedded links.

The principles of the metrics we have developed [Mendes, 97] are based on the goal-based framework for software measurement proposed by Fenton et al. [Fenton & Pfleeger, 96], and on the guidelines from the DESMET project [Kitchenham, 96], [Kitchenham, 93]. Both have been extensively used in experiments in the software engineering field [Harrison et al., 95], [Daly, 96], [Briand et al., 96], [Briand et al., 97], [Basili & Rombach, 88], [Basili et al., 94], [MacDonell, 91].

We have planned two evaluations within SHAPE. The first was a quantitative evaluation and the second is quantitative and qualitative evaluation. In Section 3.2, we describe and present the results of the first evaluation.

3.2 Design of the First Evaluation

For the first evaluation the stated hypothesis was:

H1 - Microcosm applications are more maintainable and their information more reusable than applications built using a standard WWW environment.

3.2.1 The Method

The survey involved the use of questionnaires that were completed by either Microcosm or Web developers.

A survey offers the following advantages [Kitchenham, 96]: i) reaches a lot of users; ii) makes use of existing experience; iii) makes use of standard statistical analysis techniques; and iv) confirms that an effect generalises to many projects/organisations.

Both questionnaires had three sections: reusability, maintainability and experience. The reusability section was defined using knowledge from three distinct domains: software metrics, hypermedia and software reusability. The maintainability section was also defined using the knowledge from three domains: software metrics, hypermedia and software maintainability. The experience section was defined using knowledge from software engineering and hypermedia domains. More information about the questionnaires and the evaluations within SHAPE can be found in [Mendes, 97]. In order to prepare the maintainability and the reusability sections we had to consider common tasks accomplished by authors in the development of hypermedia applications for education.

Before sending the questionnaires to both Microcosm and Web authors we carried out a pilot study [Preece et al., 94] where the questionnaires were answered by a group of five people with previous experience in the development of hypermedia applications for education, using either Microcosm or the Web. They gave us feedback concerning: i) Ambiguous questions; ii) Unusual tasks; iii) Definitions in the appendix; and iv) Number of questions.

3.2.2 The Results

The survey results were analysed using standard statistical techniques. To determine whether the two sets of questionnaires (from Microcosm and Web authors) were from different populations we used the Kruskal-Wallis one-way analysis of variance, with a level of significance of 5% and 10%. To identify the correlation between the independent and dependent variables we used Gamma as a measure of correlation, with a level of significance of 10%.

The applications developed by both the Web authors and the Microcosm authors shared similar compactness, stratum, size, connectivity and structure of the applications. This was also confirmed using statistical tests. No statistically significant differences were found. Both groups shared similar experiences and levels of involvement in the development of the applications. This was confirmed statistically.

We measured time and level of difficulty using a questionnaire with 15 tasks. For each of these tasks, authors were asked: i) the level of difficulty to accomplish the task, on a scale from 1 (very easy) to 5 (very difficult) and ii) the time it would take, in minutes, using 10 different intervals given. Thirteen tasks were based on usual activities concerning maintenance and reuse. As we did not want to bias the evaluation, only two questions were developed where the tasks involved might be more effectively accomplished using generic or local links. These were questions 12 and 13 respectively . The tasks are described below:

1) Finding dangling links within a document that has five links to other documents.
2) Deleting a document, that has five links to other documents, without leaving dangling links.
3) Adding a new paragraph to the beginning of a text document, that has five links to other documents, keeping the links intact.
4) Modifying the source anchor of a link.
5) Modifying the destination of a link.
6) Deleting a link.
7) Checking for dangling links caused by the deletion of a document that had two links.
8) Link ten terms to descriptions defined in a glossary.
9) Copy five documents (each with two links to other documents) to another application, keeping all the links already defined.
10) Finding if a document is part of an island.
11) Moving five documents (each with five links) from one directory to another, keeping their links valid.
12) Moving five documents (each with five links) from machine A to machine B, keeping their links valid, where both machines have the same operating system.
13) Checking for islands caused by the deletion of five links.
14) Linking a word that occurs in five documents (once in each) to a destination document.
15) Copying a document that has two links within your application, keeping all the links already defined.

When comparing tasks involving *point-to-point* links in both Microcosm and the Web we found that in 33% of the answers the medians for the level of difficulty were lower for Microcosm than for the Web and in 46% of the answers the time was shorter. In 46% of the answers the time spent in both Microcosm and the Web was the same. But Web authors needed to use an auxiliary set of tools in order to accomplish the tasks in a reasonable time and with a low level of difficulty. This was not necessary using Microcosm.

Even with 7 answers where the level of difficulty was higher for Microcosm than for the Web there was no corresponding increase in the time spent to accomplish the tasks. As Microcosm is an *open hypermedia system*, the author has to edit the linkbase many times in order to maintain links. This task can be considered more difficult than changing links on the Web, but, as shown by the data, there was no overhead on the time spent.

When comparing tasks involving point-to-point links in both Microcosm and the Web we also found 8 answers with a statistically significant difference. Four showed advantages for The Web and four showed advantages for Microcosm. The medians for tasks involving Microcosm point-to-point links, Web point-to-point links and the corresponding level of significance are presented in [Tab. 2]:

Question	Attribute	Median point-to-point Microcosm	Median point-to-point Web	Level Significance
02	Time	1	2.5	0.04*
05	Difficulty	2	1	0.00*

06	Difficulty	2	1	0.03*
08	Time	1	3	0.03*
12	Difficulty	1	2	0.04*
13	Difficulty	1	2	0.00*
14	Difficulty	3	1.5	0.03*
15	Difficulty	2	1	0.00*
*denotes that the result is statistically significant at the 5% level				

Table 2 - Medians for tasks involving point-to-point links in Microcosm and The Web, with corresponding level of significance.

Questions 5, 6, 14 and 15 represent simple tasks, but for Microcosm authors involve the editing of the linkbase in order to update the information about the links. We understand that this was the reason for a higher level of difficulty using Microcosm. But, even with a higher level of difficulty, no statistically significant differences were found when comparing the time involved in the same tasks. Questions 2 and 8 showed a statistically significant difference in the time spent in accomplishing the tasks. The time was higher using The Web. Questions 12 and 13 also showed a statistically significant difference in the level of difficulty spent in accomplishing the tasks. Again the level of difficulty was higher using the Web. Questions 12 and 13 would be easily accomplished (in Microcosm) using generic links for the former question and local links for the latter question. Here we can see that when the applications require the definition of links to be valid within the whole application or within a particular document, the use of point-to-point links on the Web increases either the time involved or the level of difficulty in accomplishing the task.

For the independent variables number of documents, compactness, stratum and experience we found significant Z values for questions 9,14 and 15. The results are presented in [Tab. 3]:

Questions		Application size	Compactness	Stratum	Experience
09	Time	1.85*			
	Difficulty	2.04*			
14	Difficulty		1.67*	2.06*	2.31*
15	Difficulty				1.98*
* A Z critical of 1.64, denoting that the result is statistically significant at the 10% level					

Table 3 - Significant association between independent and dependent variables

We found values of Gamma higher than 0.50 not only for the four independent variables presented in table 7, but also for the number of links and the structure of the application. Values for Gamma equal or higher than 0.50 show that there exists an association between the variables compared, but without corresponding statistically significant Z values we cannot generalise the results.

We are carrying out further evaluation, using large hypermedia applications, in order to determine whether or not the metrics proposed can be applied to measure the maintainability and reusability of hypermedia applications.

4 Conclusions

Hypertext metrics have been developed in an ad-hoc way, expressing measures in an ambiguous manner and limiting their application. For example, there are many different decisions that have to be made when defining a usability measure or maintainability measure. These decisions have to be made with respect to the goal of the measure and by defining an empirical model based on hypotheses. Unfortunately, many measures proposed in the literature do not have the motivation behind these decisions documented, making it difficult to understand the underlying assumptions of the measure.

The principles of the metrics we have developed are based on the framework for software measurement proposed by Fenton et al. [Fenton & Pfleeger, 96], and on the guidelines from the DESMET project [Kitchenham, 96], [Kitchenham, 93].

We carried out quantitative evaluations aimed at comparing both Microcosm and the Web concerning the reusability of information and the maintainability of the applications. The data collected showed strong evidence that the link representation, link type, highlighting of anchors, structure of the application and the author's experience can strongly influence the maintainability of the application and the reusability of information. We also found some evidence that the number of documents, compactness and stratum can also influence the maintainability of the application and the reusability of information.

The next evaluation will be both quantitative and qualitative and its aim will be to measure the authoring effort involved in the development of a hypermedia application using both Microcosm and the Web.

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Are We Really Doing Students a Favour? - A Study of the Use of an Electronic Study Guide in Distance Education.

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Abstract: The climate of increasing demand for higher education places, serious discussion of global strategies for the delivery of courses and an extensive body of relevant literature are notable for the dearth of discussion about the effect of the use of electronic materials from a student perspective. Research which was focused on the definition of a set of features that might make electronic books a more desirable alternative to printed ones for distance education students, collected and interpreted data about the way that distance education students used various features of an electronic study guide. Analysis of the results indicated that there are serious misconceptions in the literature about how acceptable such products really are. The major issues are not simply ones of how sophisticated the electronic book might be but ones of minimising the inconvenience to the learner. Many more learning features need to be provided than is generally thought necessary, to compensate for the restrictions that an electronic medium places on the learner.

The higher education system in Australia and indeed many other parts of the world, is changing. The demand for more higher education places is growing as a result of community expectations and the effect of such things as the need for retraining [Zastrocky 1996]. Offering education in the distance mode is one of the key expansion areas for higher education. International competition and the marketing of education courses globally are already established trends [Ayad 1996]. For organisations that have a successful history in 'Distance Education' (DE) as well as those who are only just embarking on such ventures, the choice of most appropriate delivery medium is one of the critical factors in their success. Many already anticipate using electronic means such as the World Wide Web (WWW), CDROM etc. as a distribution mechanism. Pressures for change have been building for some time as successive governments cut budgets while Australian society expects progressively more and more of its school leavers to aspire to post secondary education.

Teaching is a labour intensive task. No university can afford the luxury of Socratic dialogue for any but the most rare of students. Providing guidance, assessment and feedback for the vast majority is a goal that is difficult to achieve in a climate of increasing student:staff ratios and decreasing per capita grants. Administrators and policy makers sometimes use economic rationalist terms such as 'economies of scale' or 'cost effective' practices. There are many such as the vice-chancellor of the Open University in the United Kingdom, Sir John Daniel, [Daniel 1996] who believe that the future of higher education is inexorably tied to the implementation of strategies based on the use of new and emerging information technologies.

DE or 'Open Learning' as it is sometimes referred to, is one of the methods by which the high cost of face to face teaching may be reduced. There are serious doubts about the intrinsic value of some of the traditional face to face methods such as the lecture, that most universities have used for quite some time [Laurillard 1993], [Ramsden et al. 1995]. Prior to 1993, the provision of distance education courses in Australia was controlled by government regulation but the subsequent removal of these restrictions has seen some of the larger universities enter the marketplace in search of DE students. The issues of cost effectiveness, quality of service and quality of distance education materials form a formidable set of criteria by which the success of DE providers will be judged.

The appropriate use of technology is a significant component in such ventures. Computer technology has been used in education for many years but what is surprising, is the relatively superficial effect that it has had. From almost the very beginning, computers were seen as an important tool to be used in the educational process. Society was promised [Suppes 1968] the ultimate in individualised instruction, an infinitely patient tutor, a system which would revolutionise both the educational processes at schools and in the home. [Bork 1980] claimed that: *"By the year 2000 the major way of learning at all levels, and in almost all subject areas will be through the interactive use of computers."* (p53)

The Australian National Teaching Development Projects since 1994 bear witness to the same sort of confidence that Bork expressed nearly two decades ago but also highlight the difficulty of extremely high production costs. Such high costs are unacceptable in the current funding climate unless they can be spread over a large student load or produce significantly higher learning outcomes. The widespread adoption of the Internet and the WWW by academic as well as business and private interests around the world has led to suggestions that this is the means by which cost effectiveness may be achieved. While the concept of the 'virtual university' is most definitely an item on the higher education agenda, questions about the mission of such a university [Gilbert 1996] and the impact of working in one [Taylor 1996] are only just beginning to be raised. However, little appears to be written from the perspective of the learner.

Charles Sturt University (CSU) is one of the major providers of DE in Australia with over 24,000 students, three quarters of whom, study in the DE mode. The Technology Strategy Report [Rebbechi & Barnard 1994] mapped out a comprehensive set of alternatives for the development of technology used in the teaching and administration of CSU students. One of its key recommendations involved the conversion of as many as 1200 subjects from print into electronic form by the year 2000. This was seen as an ambitious and probably unrealistic target but it did indicate a support for the use of electronic teaching at the strategic planning level within CSU. There was general agreement that some method of automatic conversion would need to be used for a large percentage of these subjects and that this would not provide the opportunity for substantial enhancements.

Fundamental to this decision to move to electronic format for teaching materials was the belief that in doing so, students would not be disadvantaged and indeed the provision of 'added value' features would actually make this method of delivery more attractive to students. The adding of value is the attribute about which, least quantitative data is available. The notion of just what the value is, that is being added, is different from the student's, academic's and organisation's point of view. Quite clearly, the organisation might see value in the reduction of the cost of printing or the perception of 'With-it-ness' [Taylor 1996]. Academics might see value in the reduction of lead times from existing levels associated with a production model dominated by the publishing process. Students however, would not necessarily be aware of this type of added value or even see this as having much to do with the quality of their learning experiences in a course.

For students there may be added value in just having the learning materials in electronic format. Such a scheme could be achieved with minimal extra effort requiring just a simple translation of existing DE materials that are already largely in electronic format as word processor files, into a suitable format for user viewing. This type of translation is already commonplace in the publishing industry with the use of Standardised General Markup Language (SGML) or commercial programs like Adobe Acrobat.

This would facilitate access to the content in a way which allows them to manipulate, extract, reorganise and customise the learning materials to suit their own needs and preferences. Catering for individual differences and learning styles has been a long standing goal of education. Being able to make margin notes which do not limit one to the width of the margin, using copy and paste to export some sections to another electronic document or import sections from another source are examples of value that is added by virtue of having the materials in an accessible electronic form.

Electronic copies of learning materials are usually much more compact than bulky printed ones, are less bulky to carry around and easily duplicated. This would allow students to have multiple copies of their materials at different locations such as at home and work. Taking study materials on a plane would add very little to the weight of the baggage and in that respect encourage portability.

Whether these are sufficient to have students perceive an increase in quality is open to question but this represents only the minimal set of possible advantages that may accrue from a move to electronic format. Since cost of printing determines such things as page limits for learning materials, the number of colours used in the typography, diagrams and other graphics, these could be easily enhanced with very little increase in cost, both in terms of money and time. The use of colour to enhance presentation and information content is well documented [Macaulay 1995]. This would be an obvious example of added value from the student's perspective.

The provision of more valued added items would require additional effort which would reduce the cost effectiveness from the organisation's perspective but if it enhances the learning process and results in higher success rates, better client satisfaction and ultimately an increase in prestige for the course, the academics or the university, then such increases may be justified. Among the value added features that could fall into this category are ones such as the better integration of resources. Providing structural features such as hotlinks, multiple views, expansion boxes, content maps, free text searching etc. to give the student more sophisticated tools with which to use the basic materials would require a significant effort on the part of the producers of these materials. Allowing students to make their own links is in the opinion of [Jonassen 1993], a vital step in constuctivist use of such learning materials. Links to WWW resources are an obvious extension to this type of value adding.

[Laurillard 1985], argues that the full benefit of computer based materials does not come with just the student's control over the sequence of content and learning strategy. It requires the provision of highly interactive simulations which are designed to help the student acquire the requisite knowledge by means of a goal oriented manipulation of the information in the domain. Such features are extremely expensive to provide and serve as the upper limit of what could conceivably be achieved in the process of adding value to existing materials.

Determination of the amount of advantage or disadvantage that results from the provision of electronic learning materials is difficult. Even considering only the student's perspective there are many variations which affect the ability to make accurate judgements. Objective measures such as differences in the amount of time required to deal with same amount of content need to be analysed in the light of various factors in the students' background that could affect this. Allowances also need to be made for additional 'overhead time' such as how long it takes between the arrival of the materials and when they are actually installed and functional. Simple cost benefit analyses need to take account of the real cost to the student of such practices including hardware, software, consumables (paper, ink and possibly telecommunications costs) not just the obvious ones of production time and cost of distribution. Even so, there will be many subjective factors such as the amount of inconvenience that it may cause or the amount of enthusiasm that it engenders, that will be impossible to accurately quantify.

Computer programming is a subject that requires a significant amount of integration of relatively easy to produce resources (program code as text, problems, flowchart diagrams, pseudocode) with the basic explanations of the concepts. Since most of these resources already existed in electronic form by virtue of their nature, the conversion of an introductory programming subject's learning materials into electronic format using a minimalist approach outlined above was a good choice to establish a benchmark for levels of acceptance of this style of delivery of DE materials. Programming was also an ideal choice because the nature of the subject required students to undertake significant amounts of interactive exercises with computers, eliminating one of the potential variables, the need to use a computer and also minimising the effect of some others such as computer anxiety. Programming students are more likely to be adopters of the technology than other students.

A substantial body of literature is available that deals with a range of theoretical issues surrounding the design and implementation of hypermedia based learning materials. Most of it however, discusses these from the perspective of the designer rather than the end user and makes assumptions about student reactions. Empirical studies of users' behaviour are usually focused on specific features that are often investigated over a short period of time and in controlled laboratory situations. This study [Messing 1997] was carried out for the duration of a full semester for five consecutive semesters.

The goals of the study were to collect and interpret data about the way that students used various features of an electronic study guide in the context of a distance education setting and to uncover any relationships that affected the desirability of this as a means of delivering educational materials. Data were collected using computer logging procedures within the study materials which recorded every action along with time based data. Surveys were used before the start of the subject to determine the level of experience with computers and computer based learning materials. Surveys and interviews after the teaching period were used to gather data about student reactions.

The analysis of the survey data using the 3G approach proposed by [Collis 1991] proved to be an appropriate technique for evaluating electronic books. The '3G factors' may be loosely translated as:

Gewin - a meaningful gain in relation to the goals of the project i.e. some level of performance or achievement

Gemak - a payoff in making the life of the participant somewhat easier

Genot - a measure of the pleasure or satisfaction derived from the project

Two variations of the standard 3G approach were used. Positive and negative aspects were quantified separately and plotted and the whole group was divided into four categories based on their disposition to using the technology as well as inclination to make strong or weak comments.

The 3G vector diagram agreed very well with the theoretical prediction for the use of electronic books in a school setting without a teacher support focus as suggested by Collis. One could argue that such a setting is not dissimilar to a distance education environment. The results in [Fig. 1] graphically illustrated the dichotomy that was evident in other aspects of the analysis. The positive aspects indicated a measure of achievement and satisfaction that students derived from using the electronic study guide while the negative components reflected the fact that there were some significant costs associated with using it.

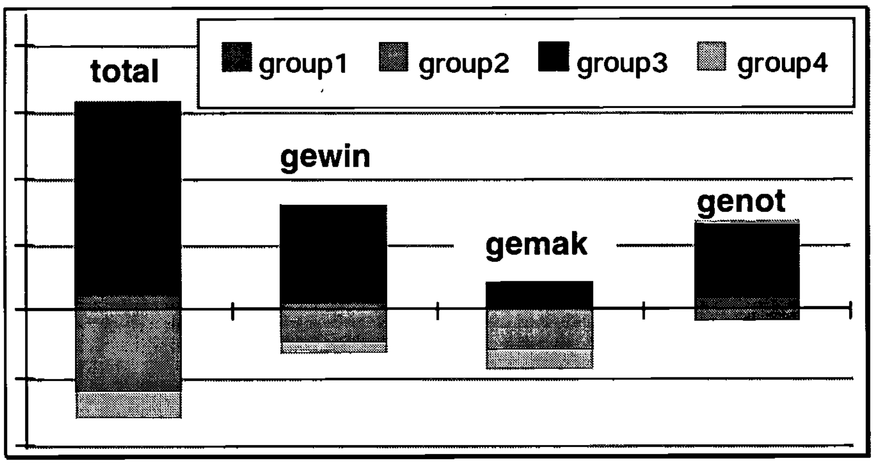

Figure 1: Modified 3G graph of student evaluations

The gemak (payoff) vector appeared to represent the factor which needs to be addressed most urgently. The negative components were a measure of the obstacles that students had to overcome in using an electronic format which still largely restricted portability. Rather than making life easier, the use of the electronic study guide actually caused significant inconvenience. The results for the pleasure vector indicated that in general, the students in this study were, as suggested, adopters of the technology. As [Bates 1997] observed of other distance education students, they were prepared to overcome significant hurdles and still retain a commitment to technology-based education.

The analysis of the usage data revealed that even though a number of significant features were added to the electronic book to make it a supposedly attractive alternative to the printed version, these were not sufficient to prevent most students from preferring the printed one. Electronic format places many restrictions on distance education students due largely to its lack of portability. It forces changes in the way that students study which are not really taken into account in the cost/benefit analysis that the providers of this material undertake. For example, one student semi-jokingly replied that *"I used to read in bed at night but the 14 inch monitor got too heavy for my arms!"*.

Such restrictions are even more pronounced when this is coupled with tighter requirements such as having to connect via a telephone line. Not only does this cause disruption to family organisation and routine but it can cause considerable acrimony on the part of the student who may feel that the additional social pressure is not really being balanced by exceptionally good learning material. It may seem like a good move from the academic and organisational perspective to supply students with their learning materials over the Internet, but unless these materials justify the expense and inconvenience to the student, they will not be well received. The indications from this study are that the perceived benefits need to be much higher than the typical level currently available.

In listing the supposed benefits, one must be careful not to confuse perceived benefits from the designer's projection of the learning process with the reality. The way that features of electronic learning materials affect student learning may not be what was originally expected. For example, being able to easily execute program code in the examples was considered a highly positive aspect of providing an electronic study guide for this group of students. Data revealed that there were a number of unanticipated factors that partly explain why the usage was actually quite low. Some students who initially made moderate or extensive use abandoned the technique for a very sound educational reason. While the process made it relatively quick to demonstrate program code in action, it by-passed the act of typing code into the compiler. During such an act, there would normally be a great deal of incidental learning of the structure and syntax of Pascal programs as well as how to operate their compiler. These students reported feeling that they derived better learning experiences by actually typing the code themselves.

The majority of students in the study could be characterised as having both highly positive opinions on the use of electronic format as well as highly negative ones. They could see the educational value of many of the features that were provided but the practical restrictions of having to use a computer for most of the time were dominant. They, in common with most DE students [Roberts 1984], use their learning materials in a diverse collection of situations, on the train to work, at work during lunch breaks, in planes, at airports, waiting in the car for a child at football training, in bed at night and many more. Not all of these situations are conducive for interactions with a computer.

Electronic learning materials may well meet the various objectives that their academic creators have for themselves or their organisation but in the end, the test is whether the learners share these positive views. The implication from this study is that the break even point where learners prefer to use the electronic materials because of added value features and despite the greater restrictions, is much higher than one would expect. The following student comment provided an accurate summation of the general attitude:

"It exposed us to the way all distance education is likely to be delivered in the not too distant future and it showed us what learning from course notes provided only in electronic form is really like - which wasn't as easy as I thought it would be - there is something about learning and reading from paper which is so much easier than doing it from a screen. I had originally thought that I would really enjoy studying from a computer screen - but I really didn't, although it was an effective way of providing a lot of interconnected information. "

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An Hypermedia Multilevel Interactive Language Learning Tool

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Abstract: Due to the increasing need of educational tools for the Portuguese language learning by foreign people and also by the great community of lusophone countries spread around the world, emerges the Simmpatico Project which tries to fulfil that gap using the possibilities created by the new Information Technologies. This paper describes technical and educational issues related with the development of this project.

1. Introduction

The decision to construct a multimedia tool for the teaching of Portuguese as a foreign language is linked to the importance which this language has assumed in the world today, both in terms of numbers of speakers, and of its distribution over all the continents. Having been worked on for more than a thousand years, permanently enriched by the contributions of the multiple variants of Europe, America, Africa and Asia, the Portuguese language, spoken by more than 150 million people, as a mother tongue, second language or official language, is part of the universal heritage.

"Portuguese is a living element in political, economic, cultural and scientific exchange between the peoples of Africa, Asia, America and Oceania. It is therefore a matter of placing the Portuguese language in the position it deserves to occupy in international affairs, in a world where its contribution – on account of the wealth and diversity of cultures which it vehiculates – can reinforce international Cupertino between nations." [OSPINA 1985]

The structure of the course, conceived primarily for the teaching of Portuguese as a foreign language, permits, however, with some alterations, its use in support of the teaching of Portuguese in the lusophone African countries (countries where Portuguese is the official language) and even in the teaching of Portuguese as a mother tongue (being able to facilitate and stimulate teaching through appropriate, interactive use of the techniques of hypertext).

2. Package Organisation

2.1 Linguistic Approach

The target population for this course is young people and adults who have acquired several types of competence through the learning of their mother tongue and probably through the learning of one or more foreign languages (or a second language) – linguistic competence, metalinguistic competence, narrative/discursive/textual competence, pragmatic competence (communicative / metacommunicative).

There exist, however, significant individual differences in relation to linguistic knowledge, which are linked to a great number of interdependent factors: aptitude, motivation, memory, attitude towards target language, time given to learning, quantity and type of input in the target language, socio-economic, educational, and affective factors, knowledge of the mother tongue and other languages.

These differences will cause significant variation in the speed and effectiveness with which the learners are capable of creating and putting to work a control mechanism, i.e. the way in which they will retrieve the appropriate knowledge from several separate knowledge's (modular structure), causing the posterior integration of these several knowledge's. The objective of this course is to facilitate the installation and development of these retrieval procedures, in such a way as to make them progressively more automated [McLaughlin & Rossman & McLeod 1983].

The non-reflective acquisition of knowledge is not, however, incompatible with the process of becoming aware of the way in which the learner solves his/her learning difficulties. This course therefore presents (relatively brief) descriptions of the levels of language functioning – phonological/phonetic, morphological and morphosyntactic – which we consider indispensable for the construction of representations of the linguistic structure of Portuguese.

In this way, we appeal to the metalinguistic capacity of the user (conscious representation of the properties of the various utterances) and to the capacity/possibility of transferring prior linguistic knowledge (especially lexical knowledge, which is normally neglected in favour of syntactic orthodoxy) to the resolution of problems (especially in comprehension tasks) [E.Kellerman 1977] [E.Kellerman 1978a] [E.Kellerman 1978b] [Kellerman & Sharwood 1986] [Ringborn 1987] [Miranda 1996]. The grammar is presented explicitly in order to help the learner to explicit (gain awareness of) the way in which he/she understood and interiorized the workings of utterances – through multiple choice exercises using paraphrases, rules, judgements of acceptability/grammaticality.

2.1.1. Methodological Organisation

The course consists in a set of teaching modules divided into three levels: Level 1 (real beginners); Level 2 (post-elementary); Level 3 (pragmatic/cultural). With Level 1, the learner should be able to recognise and produce isolated words and simple sentences (at a relatively slow speed of oral discourse), being able to communicate with native speakers on matters of daily routine, obtaining essential information, understanding and producing simple (and essentially written) instructions. With Level 2, the learner should be able to participate in verbal interaction with native speakers, understanding and expressing opinions on topics (which go beyond themselves and their personal sphere), at a speed of oral discourse which is progressively closer to intercommunication between native speakers. With Level 3, the learner should have acquired sufficient autonomy in Portuguese, to be able to understand authentic documents (written – literary texts and non-literary texts covering sociocultural and oral aspects – songs and media documents, talk-shows, news, interviews).

The course is conceived as a "journey", a path through the several "scenes of daily life", and attempts to cover a wide range of interests: tourism/travel, business/shopping, food, sport, etc. Each one of these levels is made up of a particular number (not necessarily the same number) of thematic units approached in specific situational contexts [Casteleiro et al. 1988].

The situations of communication are organised in successively smaller units (exchanges and speech acts), made explicit through utterances whose difficulty depends on the level in which they are situated. The themes and situations of communication are repeated in the first two levels, helping the learner to transfer and reuse the various "knowledge's" and motivating him/her to construct (or make more complex) some situations. This can either be done by introducing variations in the extra-linguistic parameters and reconstructing the web of discourse accordingly, or by modifying the semantic-pragmatic structure of the to fit new communicative intentions.

Example:

Level 1 – *Topic:* Tourism/Travel *Situation:* In the hotel/reception. A couple are looking for accommodation; they ask for information - Dialogue on video, possibility of visualising the text by means of subtitles corresponding to each utterance, or even the whole text of the dialogue. Slow discursive speed (non-native)

Level 2 – Same *topic*, same *situation*.

- The text of the interaction which took place at level 1 is repeated, but the dialogue becomes more and more complex, the verbal exchanges are in greater number and the discursive speed is closer to the "native mode".
- From this situation, two new situations are created which do not exist at level 1, one for oral production (telephone conversation) and one for written production (the female character writes a postcard, in the hotel bedroom).

Some of the elements of this situation can be transferred (re-used) to another situation (in the same thematic unit or in different thematic units).

The course comprises:

- Various exercise types, according to the capacities which are being developed in each step: exercises which are more focused on the structure of the language, paraphrase/lexical expansion exercises (reduction and integration), confrontation exercises and text/discourse production, the written transcription of oral register, the reconstruction of texts/according to a framework of discourse types.
- Explanatory and systematic tables of grammatical elements and their functioning (using a grammatical metalanguage which can be easily understood by the majority of users).
- Assessment exercises, with the respective answer keys or suggestions (appropriacy).
- A Portuguese/French/English dictionary, based on Basic Portuguese [Port. Fund. 1984].

2.2. Hypermedia Structure

Our program structure tries to cope with a correct integration of day to day communication dialogues with, up-to-date hypermedia concepts into an intuitive, and interactive, human-machine interface. The multiple communication dialogues originated various digital video records in a coherent sequence, organised in 3 learning levels. Text labelling is synchronised with each video and translates ongoing dialogues. Both video hot-spots and text labelling have hypermedia connections to other information structures as depicted in [Fig. 1]. These different hypermedia elements contents have a relation with culture, nature, local/national tourism, geography, etc, producing an integrated environment to understand the local/national socio-cultural signature as a whole.

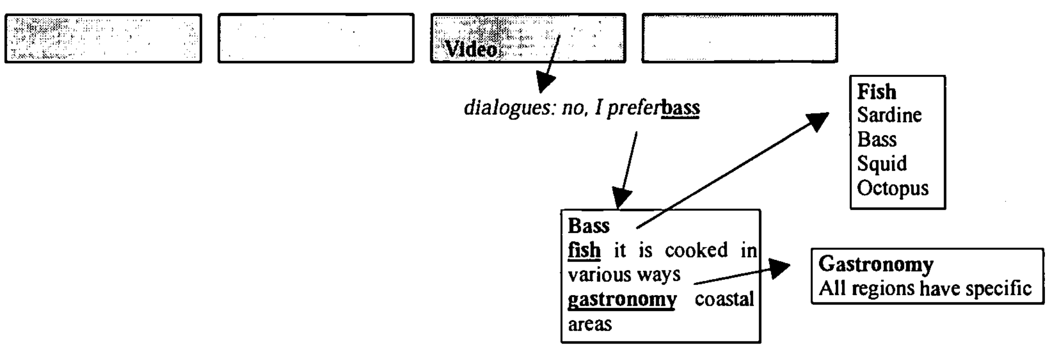

Figure 1: Hypermedia relations.

2.2.1 Interface/Icon study

The interface project took into account the program's usability, interactiveness and its various options. The interface icons try to translate common day to day situations using intuitive symbols within a creative perspective. The next figures, [Fig. 2] and [Fig. 3] represent some of our interface proposals.

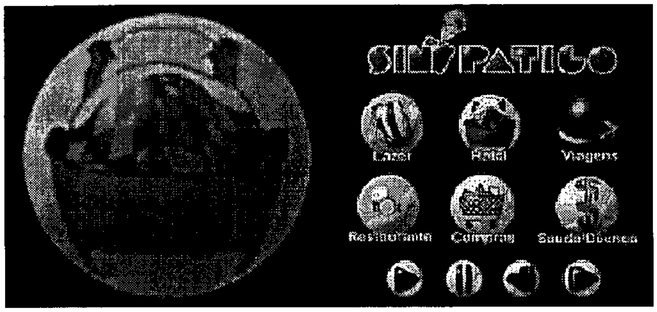

Figure 2: From left to right and top to bottom, background image, logo, dialogue situation icons and video control buttons.

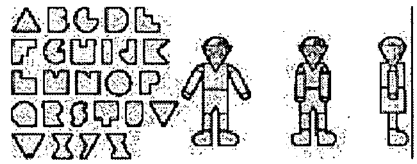

Figure 3: Simmpatico's font and main character.

3. Technical Aspects

As in any multimedia application it was defined a target machine with a set of minimum requirements to play the SIMMPATICO multimedia piece: IBM-PC or compatible; MS Windows 95 or above; 16 MB of RAM; 4X CD-ROM drive; 16 bits sound card; Graphic Card with a minimum of 256 colours at a resolution of 800x600; MPEG-1 enabled hardware or software decoding capacity.

These requirements are the result of a constant optimisation process during the development phase, with the purpose, that even a common and simple multimedia machine can run the application . As a consequence of this, a wider range of potential users is reached by our project.

The development of the application is being done on a well known multimedia authoring tool - Authorware. This program has long been the leading tool for computer-based training and interactive learning.

With the developing of a multimedia application, there are various types of media to produce, process and finally integrate in a main program. Each type of media as is own characteristics, and production cycles.

Sound - Every sound was originally recorded in studio, and afterwards digitised with the aid of a professional sound card at a 22,050 kHz, 16 Bits and Mono quality. By doing this, a quality sound is obtained and the associated files are in a very acceptable size (Data flow of 43KB/s). After that, every sound file was processed with the use of the Animator SoundLab, namely the tools for noise removal and sound equalisation. In the end, the sounds obtained were of excellent quality and with a reduced file dimension.

Image - The multimedia application makes use of original artwork and also of photos, icons and vectorial drawings contained in popular clipart CD-ROM's. The original artwork was digitised in a Umax PowerLook 2000. All this material was then processed and manipulated using the Photoshop and some of its plugin filters from Kai's Power Tools. The final images were limited to the maximum resolution of 800x600 with a colour depth of 256 colours and were saved in DIB graphic format. This type of graphic format is one of many with direct integration in Authorware. In the end all images were reduced to a common 256 colour palette with the purpose of avoiding strange colour shifts in systems with only 256 colours.

Computer-Generated Animation and Images - Certain concepts and ideas that could not be easily explained, with real videos or images, were created in virtual animations or graphics. All this was made possible, thanks to the use of modern 3D Graphic Packages like 3D MAX, which can create still or animated images. All the animations were produced in the FLIC format which is directly integrated in Authorware. The still images were first generated in the popular BMP format and later converted to the already referred DIB format. With all animations and images great efforts were made in the creation of a global palette, to avoid the

Video - This was the most challenging and difficult media to produce, process and integrate, because of the huge quantity of data involved. Initially the decision of delivering the final videos in the so popular AVI format

terms of storing it in a single CD-ROM. So a different approach was followed, the compression of the videos in the MPEG-1 format. The use of this compression method gave a significantly reduction in the video file sizes,

Pentium 120MHz and 48MB of RAM. The video production chain was the following:

1. Recording the scenes and scripts on studio or on location, using U-MATIC SP equipment. The actors were recruited among the members of the University Theatre Company with a special care for the actor's

the sound recorded during the video shoots, because any noise could interfere with the comprehension of the dialogues.

Analog Editing with the purpose of cleaning the raw video footage's from the major part of unwanted
to reduce the amount of data to be processed in the next steps.

digitalisation process was made with the parameters referred in [Tab. 1]. Special care was taken with the video sound tracks, to ensure a maximum purity of sound in the dialogues.

Digital Editing on Premiere. The original captured files were here edited and assembled in AVI video

user. The most significant parameters of the AVI's files are in the [Tab. 1].

5. Video Sound Tracks Processing on Animator SoundLab. Due to the high sound gain in the Miro card and some noises generated during the precedent steps, every video file had to be processed in respect to its sound
of 50% on the sound volume level and afterwards a digital filtration with a band-pass filter to remove unwanted noise.

Codification in MPEG-1 format on a MPEG Encoder. As a mean to reduce the large amount of video
a MPEG-1 compression of the AVI's was made. The size of the video files was reduced has the [Tab. 1] indicates, while maintaining a good image and sound quality level.
of video and audio quality.

	Digitalisation Miro DC30	*Premiere*	*Codification*
Codec	M-JPEG Codec V4.0		MPEG-1
Compression		None	Quad-speed CD-ROM
	384x288	320x240	
Number of Colours	16M (24 Bits)		16M (24Bits)
Fps	15	15	15
Audio	PCM 22KHz 16Bits Mono	PCM 22KHz 16Bits Mono	PCM 22KHz 16Bits Mono
Compression Time	-	-	4 min.
File Size	10,624MB	3,890MB	1,521MB

Table 1: Video Production Chain

4. Conclusion and Future Work

The dialogues corresponding to the various situations of communication (Levels 1 and 2) have already been recorded, and the descriptive/explanatory tables of the several grammatical topics and the dictionary are nearing completion. The next tasks will be the completion of the exercise banks and the selection and digitalisation of the documents to be used at Level 3.

Given that this is a research project, we believe that tracing mechanisms should be included to enable the system to be perfected, while at the same time permitting self-assessment to take place. These mechanisms will further permit the elicitation of feedback which will be important for the evaluation of our strategy of "back to lexico-grammar" or of "lexico-grammar refresh".

The first prototype will be tested with foreign students who frequent Portuguese university courses (Erasmus/Socrates programme), and the International Summer Course (July 1998).

One of the important goals in the SIMMPATICO project is to develop an "on-line" version of the final application. For this purpose we used the Shockwave technology, with which anyone can easily convert and transform a regular desktop multimedia application to a *web-based* multimedia application. This technology picks a desktop multimedia piece and creates a compressed runtime version of it, that will play across Intranets or over the Internet using the networking services of a simple HTTP client.

The major drawback in this technology is the fact that Shockwave doesn't support streaming audio and video over a network. So as a consequence we have to limit in great extent the audio and video contents of the "on-line" application in comparison to the desktop version. If this problem isn't serious over a fast Intranet, it becomes a great burden to the overall performance and joy of use when the application is delivered over the slower Internet. The potential user has to wait until the video and audio parts are downloaded before he can start using the application, so if there is a great amount of video and audio information on the piece, the starting delay time could be very frustrating, leading him even, to not explore the application at all.

In conclusion great cares have to be taken, to create a low-bandwidth demanding application with less or smaller video and audio files. Also in the graphical interface some changes have to be made to make a *lighter* piece as possible, that is, a application that will play nicely and smoothly even over the Internet.

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The Notion of Functionality in the Faculty Use of E-mail for Instruction

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Abstract: The notion of functionality is described as the way in which users perceive the usefulness of a computer. This paper demonstrates that the faculty use of E-mail for the purposes of instruction are related to the way in which they perceive its functionality with the faculty with a positive pre-disposition profile tending to use it more.

1. Introduction

Much of the existing research on e-mail and education makes an implicit assumption that teachers, students and other members of educational institutions *indeed use* e-mail for their teaching, learning and administrative activities. It is also assumed that since Computer Based Communication Technologies (CBCT) are becoming increasingly available to members of educational institutions, there is little reason to doubt the *universality* of e-mail use. However, I argue that this assumption of *universal use* needs to be verified on a case by case basis, particularly because the widespread computerization of universities is providing the e-mail option to a heterogeneous group of faculty and students. This larger group could include people with minimal computer skills or a specific predisposition toward computers, and they could represent groups who have not volunteered to be included in courses where the use of computers plays a significant pedagogic role. Here the distinction between use and acceptance becomes especially critical. While it might have been *accepted* that e-mail is part of the emerging pedagogic system, the actual *use* of e-mail is perhaps lagging behind. This paper first attempts to discover the extent of faculty use of e-mail for communicating with students within the environment of a small Southeastern private liberal arts institution where the barriers to CBCT usage have been largely removed through a collaboration with a major information technology provider.

One set of attitudes that can impact the use of technology is the notion of "expectation," and ways in which a desire to use or not use a technological tool is related to expectations associated with that tool. Jackson summarizes this by saying:

> The social elements are the expectations of what the artifact will or can do. They act to conscribe or enlist the artifact in the accomplishments of some particular purpose or task...Expectations buffer our perceptions of the material elements (Jackson, 1997, p. 256).

These expectations fall into the category of social elements of the use of technology that can influence the material elements of technology use.

The author makes these claims on the basis of an extensive review of the existing research on CBCT, and then develops a framework to categorize the research into broad areas of emphasis based both on the social and material elements of CBCT. My purpose is to elaborate on the notion of expectations by hypothesizing that people with different expectations for technology would have different levels of technology use. However, the notion of expectation itself is differentiated into several components to reflect the social elements that can implicate the use of technology.

Following from Jackson, I argue that the first component of expectation is related to what can be called the functionality of technology. Functionality refers to the "ability of an artifact to be used to accomplish a social task (Jackson, 1997, p.255)." It is likely that low- and high-level users could exhibit differences in expectations about the ability of technology to improve the current pedagogical process. If indeed a technology is considered functional it is then necessary to assess whether the faculty perceive themselves using the technology. In other words, the faculty may *accept* the functionality of technology, but might not anticipate their personal *use* of it.

Based on the concept of functionality, it is now possible to present a preliminary research question that address the relationship between functionality and use:

Is there a difference in the levels of faculty e-mail use for teaching based on differences in expectations about the *functionality of technology in instruction*?

2. Method

The data used in this study comes from the first year of a five-year longitudinal study that began when the university implemented the computerization initiative that provided new students and all faculty with a standardized laptop computer. The overall goal of the study is to assess the effects of the implementation on different university constituencies. The study includes annual surveys of all enrolled students, incoming first-year students, alumni, and faculty. The faculty survey was distributed by campus mail to all full- and part-time faculty of the university. Two mailings of the questionnaire were conducted, separated by a period of three weeks.

The questionnaire was sent to all faculty members. A response rate of 50% produced a total of 154 responses from the faculty. The respondents consisted of 71% men and 29% women, with 49% of the faculty claiming, "anthropology, business and accounting, communication, economics, education, history, politics, psychology and sociology" as their major academic discipline. Of the remaining 51%, nearly half belonged to the arts (e.g., art, classical languages, religion, romance languages and theater) and the rest claimed the sciences (e.g., biology, chemistry, mathematics, computer science, and physics) as their major discipline. In terms of length of employment, 17% claimed that they had taught for less than three years at the university, 9% claimed to have been teaching at the university for four to six years, 23% for 6 to 10 years, and 51% for more than 10 years. Nearly 86% of the respondents were either tenured or on a tenure track while 14% were assistant professors; 31% were associate professors and 43% were full professors.

The research question was answered by dividing the respondents into two groups based on high (responses 3 or 4) and low (responses 1 or 2) scores on the functionality scale and then computing the differences in mean usage of e-mail with students. Statistical tests of significance were conducted with the use of independent sample t-tests assuming equality of variance of the two groups.

3. Results

First, the extent of e-mail use by faculty to communicate with students for teaching-related activities was estimated. The mean response to this item was 2.0 (SD = 1.2) on a four-point scale where "1" represented no use and "4" represented frequent use, with 56.3% of the faculty respondents indicating that they have never used e-mail to communicate with students about teaching-related activities, 9.3% indicating that they use e-mail with students infrequently, 15.2% indicating frequent use of e-mail with students, and 19.2% indicating that they very frequently use e-mail with students. These findings support the assumption that not all faculty members use e-mail with students even though both the faculty members and the students have easy access to e-mail. As shown in Table 1, this trend is also reflected in the frequency of e-mail use with on- and off-campus colleagues.

Table 1: Extent of use of e-mail for teaching: Frequency of use and Mean use

E-mail with:	Very Frequently (4)	Frequently (3)	Infrequently (2)	Never (1)	Mean (SD)
On-Campus Colleagues	31.6%	6.6%	1.3%	60.5%	2.1 (1.4)
Off-Campus Colleagues	23.5%	10.1%	1.3%	65.1%	1.9 (1.3)
Students	19.2%	15.2%	9.3%	56.3%	2.0 (1.2)

These results lead to the research question, which focused on the differences in use of e-mail to communicate with students between faculty members who had high and low expectations about the functionality of technology in instruction. There were significant differences in the use of e-mail with students, with faculty with a positive expectation reporting a mean use of 2.1 (SD = 1.0) and faculty with a negative expectation reporting a mean use of 1.6 (SD = 1.3). These means were significantly different at the 0.05 level (p,149=0.023).

4. Discussion

4.1 Expectations

The preliminary results suggest that the use of e-mail is not necessarily universal, particularly when considered within the context of campus-wide implementation of CBCTs.

Indeed, it is the perceived expectations about the functionality of technology that is related to the use of technology. In this case, the expectations about the functionality of technology with respect to instruction are moderately related to the extent of use of e-mail technology for the specific purpose of communicating with students. The faculty members who perceive that technology will positively impact the general process of instruction tend to be more frequent users of e-mail for communicating with students.

Faculty who perceive that technology plays a positive functional role in improving the instructional process are also the ones who feel that e-mail can function as an effective and appropriate communication tool for interacting with students. As the results indicate, such perceived positive attributes and expectations are related to the extent of e-mail usage. Faculty members who have a more positive opinion about the "promise" of technology tend to use it more. From this perspective, the use of e-mail is related to the way in which the technology is perceived, and not on its availability or material efficiencies of speed, ease of use, etc. These results illustrate that use is related to a very fundamental perception about what technology's promises, and how the faculty perceives the ability of technology to deliver on its promise. Needless to say, the expectations about technology's promise are also related to the specific aspects of academic life that technology is most expected to enhance.

In summary, those who are not hopeful about how they perceive "the promise of technology," tend to use it less. Technology as a material artifact is expected to serve a series of functions in its particular application. As discovered in the focus group discussions with faculty and students, both groups anticipated that the computerization at the university would have certain specific effects. To be sure, some sections of the population were far more skeptical about the expectations, and it is precisely the nature of such expectations that appear to be related to the extent of use of the technology. As demonstrated in the results of this study, these expectations reflect a variety of components of technology and the expectations are, in turn, related to each other.

4.2 Usage

The results also suggest that heavier users of technology tend to use the computer for a variety of applications. Like the earlier studies, this study also demonstrated that faculty who would use the computer for e-mail with colleagues would use e-mail with students as well. Similarly, non-users tend not to use e-mail with either colleagues or students. There is certainly an element of customary work pattern that is related to computer use, where the usage level is related to the existing "habit" of computer use. If faculty members use computers for exchanging e-mail with colleagues there is a likelihood that they would also use computers for interacting with students.

The significance of this finding lies in being able to promote the use of computers to communicate with students. This encouragement can take several shapes. Earlier it was suggested that forced compliance would be a way to encourage use (see, e.g., Kerr and Hiltz, 1982). However, other studies seem to reject that assumption, as Komsky (1991) suggests that requiring people to participate in an established electronic mail system "will not be the most important determinant of usage." It is perhaps easier to demonstrate the value of e-mail in communicating with peers, and if that can be encouraged and facilitated for the faculty, there is a likelihood that the users would also apply the technology to communicating with students. No doubt, usage is related to attitudes and expectations, but if e-mail is perceived as the accepted and customary form of communication it is likely that faculty will use the technology to communicate with students.

4.3 User and Non-User Profiles

Finally, these results suggest that there are a set of attitudinal and behavioral criteria that are related to usage trends, particularly with respect to faculty use of e-mail to communicate with students. Use of computers is certainly not guaranteed, and institutions adopting wide-scale computerization can expect to have non-users of the CMC technology. This begs the question: who are potential users of electronic mail CMC technology? This question can be approached by developing tentative profiles of faculty users and non-users of e-mail for communicating with students. The descriptors of the user and non-user groups are composed of a series of attitudes and demographic attributes. The attitudes include the general attitude toward the use of computers, the specific feelings about the computerization initiative at the university, and the attitudes toward the application of computers in teaching. The demographic attributes include age, gender, and position in the university, as well as computer-related attributes such as self-reported computer skill level and experience with computers. The profiles are thus based on a set of attitudinal items and some demographic and technographic characteristics.

The data suggests that there are two preliminary profiles of the users and non-users of electronic mail with students. The younger faculty who have been exposed to computers early in their academic career tend to be users of electronic mail for communicating with students. The older faculty, with less exposure to computers, have lower confidence with computers and are less likely to use electronic mail with students. Similarly, faculty members who have a positive predisposition toward the introduction of computers in education would be more willing to communicate with students using electronic mail as compared to faculty who are less hopeful about the promise of technology. Finally, faculty members who are in the habit of using computers for other tasks are also more likely to use electronic mail to communicate with students (see Table 2).

Table 2: Profiles of Users and Non-Users

Attribute	Non-User	User
Self-ranking of computer skill on a scale of 1 (Low) to 7	3.7 (SD=1.5, n=82)	4.6 (SD=1.5, n= 65)
First used computers in (1 "Elementary School" 2 "Middle School" 3 "High School" 4 "Junior College" 5 "Four Year College" 6 "Graduate School" 7 "In Academic Employment)	6.3 (SD=1.2, n=83)	5.3 (SD=1.6, n=65)
Years of teaching at the university (1 "0-3" 2 "4-6" 3 "6-10" 4 "More than 10 years")	3.3 (SD=1.0, n=78)	2.8 (SD=1.3, n=64)
Current Rank (1 "Instructor/Lecturer" 2 "Assistant Professor" 3 "Associate Professor" 4 "Professor)"	3.3 (SD=1.1, n=79)	3.1 (SD=1.0, n=63)
Computers are effective for communicating with faculty colleagues	3.3 (SD=1.2, n=83)	3.8 (SD=1.0, n=66)
The use of computers enhances the academic climate at the university	3.3 (SD=2.1, n=83)	3.8 (SD=1, n=66)
The university needs to provide time and material for CAI	3.3 (SD=1.0, n=83)	3.7 (SD=1.1, n=66)
Today's scholars in my field must be computer literate	3.2 (SD=1.1, n=83)	3.6 (SD=0.9, n=65)
The computer has increased my effectiveness	3.2 (SD=1.8, n=82)	3.8 (SD=1.7, n=66)
Adequate computing capacity is essential in recruiting new students	3.2 (SD=1.6, n=82)	3.9 (SD=1.9, n=66)
I feel comfortable using computers	3.1 (SD=1.0, n=84)	3.5 (SD=0.8, n=65)
I have a certain apprehension about computer use	2.2 (SD=1.1, n=81)	1.8 (SD=1.2, n=65)

5. Conclusion

The results from this study illustrate that the availability of technology does not necessarily suggest its use. The potential user must see a clear advantage to the use of the technology to use it. In the case of communication technologies, these results suggest that these advantages are related to the communication functionality of the technology. This finding adds another dimension to the possible reasons for use or non-use of technology. The results supplement findings that, for instance, confirm the importance of determining factors such as communication apprehension, computer anxiety, or writing apprehension. While varying levels of communication apprehension, writing apprehension and computer anxiety can have an impact on the desire to use CMC, these results suggest that attitudes toward the functionality of technology can also play an important role.

The results also indicate that faculty use of e-mail with students is also related to the use of other technologies and certain components of the demographic attributes of the population. Given the significance of the differences between usage patterns and demographic attributes, it is thus possible to develop preliminary profiles of the user and the non-user. Such profiles can have great utility in assessing the potential user and non-user. Particularly when higher education is challenged with the need to incorporate CBCTs within its pedagogic style, it is certainly useful to consider such profiles. This would allow managers of higher education to anticipate the locus of support from the users of technology. Moreover, by examining the profiles, particularly with respect to usage patterns and attitudes, it could be possible to develop plans of action that can encourage the non-users to become more active users of CBCTs.

Finally, this study is methodologically different from most of the other research because of the survey design adopted in the study. Instead of creating an "artificial" experimental condition to assess the impact of a particular technology, this study used an approach where it was possible to assess the conditions of a particular academic environment within which significant improvements in computer availability were about to happen. This provided a more "natural" environment where the spectrum of use could be observed without having to assume that all the participants of the study are users. Indeed, the fact that a significant portion of the faculty claim not to use e-mail challenges the emerging assumptions of the technology-education partnership where availability is considered an incentive for use. It is implicitly assumed that since the technology is being made available it will be used, as suggested by Oblinger and Rush in saying:

> The advent of the learning revolution is facilitated by the availability of a reliable and ubiquitous network infrastructure as well as access to computers, at any place and any time (Oblinger and Rush, 1997, p. 16).

However, the results from this study suggest that while availability of technology might make it easier for the existing users to continue using the technology, it might not be enough to convert traditional non-users to users. That change could call for more far-reaching alterations in the attitudes toward the functionality of computers.

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A Knowledge-Based Teaching System for SQL

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Abstract: The paper presents SQL-Tutor, an intelligent teaching system for SQL programming. SQL-Tutor is designed as a guided discovery learning environment and supports problem solving, conceptual and meta-learning. The system uses Constraint-Based Modelling to form models of its students. We present design issues by focusing on the system's architecture. Student modelling and the generation of pedagogical actions are discussed in the light of tailoring instructions towards a particular student.

1 Introduction

Structured Query Language (SQL) is the dominant database language today, containing data and view definition statements, as well as data manipulation statements. Although SQL is a simple and highly structured language, students have many difficulties learning it. This paper presents SQL-Tutor, an Intelligent Teaching System (ITS) that helps students in overcoming these difficulties. SQL-Tutor is designed as a practice environment; it supposes that students have previously been exposed to the concepts of database management in lectures. Therefore, the system is not a substitute for the conventional style of education, but a complement to it. The system currently covers only the SELECT statement of SQL, but the same approach could be used with other SQL statements. This focus on the SELECT statement does not reduce the importance of the system, because queries cause most misconceptions for students. Moreover, many of the concepts covered by SELECT are directly relevant to other SQL statements and other relational database languages in general.

The paper examines the problems of learning SQL firstly, and then presents the architecture of the system in [Overview of SQL-Tutor] and examines the system's components in the following three sections. The directions for future research and conclusions are reached in the last section.

2 Difficulties with Learning SQL

Students experience many problems when learning SQL. Some errors come from the burden of having to memorize database schemas; incorrect solutions may contain incorrect table or attribute names. Other errors come from misconceptions in the student's understanding of the elements of SQL and the relational data model in general. Some of the concepts students find particularly difficult to grasp are grouping and restricting grouping. Join conditions and the difference between aggregate and scalar functions are another two common sources of confusion. Other researchers report the same student misconceptions [Kearns et al. 1997].

SQL is usually taught in classrooms, by solving problems on the blackboard, complemented by lab exercises. However, students find that it is not easy to learn SQL directly by working with a RDBMS, because error messages are limited to the syntax only. [Fig. 1] illustrates a situation in which a student is required to specify a SELECT statement with five clauses, as shown in the correct solution. When the student enters an incorrect solution, typically the error message generated by a RDBMS (Ingres in this case) will not be of much help. The RDBMS can only complain about the syntactic error. The same figure illustrates the kind of messages [1] the

[1] Note that the student would usually be offered only one message at a time, as governed by the pedagogical rules. Here we show all possible messages for illustration.

student may obtain from the system. SQL-Tutor can generate messages about semantic errors as well; in this case, the student specified two tables in the FROM clause, when only one of them (MOVIE) is really needed.

Example 1: For each director, list the director's number and the total number of awards won by comedies he/she directed if that number is greater than 1.

Correct solution:	**Student's solution:**
SELECT DIRECTOR,SUM(AAWON) FROM MOVIE WHERE TYPE='comedy' GROUP BY DIRECTOR HAVING SUM(AAWON)>1	SELECT DIRECTOR,SUM(AAWON) FROM DIRECTOR JOIN MOVIE ON DIRECTOR=DIRECTOR.NUMBER WHERE TYPE='comedy'

INGRES: E_USOB63 line 1, The columns in the SELECT clause must be contained in the GROUP BY clause.

SQL-Tutor:

- You do not need all the tables you specified in FROM!
- You need to specify the GROUP BY clause! The problem requires summary information.
- Specify the HAVING clause as well! Not all groups produced by the GROUP BY clause are relevant in this problem.
- If there are aggregate functions in the SELECT clause, and the GROUP BY clause is empty, then SELECT must consists of aggregate functions only.

Figure 1: Inadequacy of Feedback from a RDBMS

3 Overview of SQL-Tutor

SQL-Tutor is a knowledge-based system that supports students in learning SQL. As in the case with other ITSs, SQL-Tutor tailors instructional sessions to the needs, knowledge, learning abilities and general characteristics of its students. SQL-Tutor is based on guided discovery, one of the teaching styles commonly found in ITSs. Guided discovery is based on the idea that students should be given opportunities to discover things themselves, rather than being told about them. There are psychological studies [Anderson 1993] which show that students learn better from discovery than from direct instruction and that such knowledge is retained for longer than when learning by being told. Of course, unrestricted exploration is not advisable, especially for novices, as students may waste too much time wandering. The solution is found in providing guidance, in form of solicited or unsolicited hints from the system.

The system is designed as a problem-solving environment and as such is not intended to replace classroom instruction, but to complement it. We assume that students are already familiar with the database theory and fundamentals of SQL. Students work on their own as much as possible and the system intervenes when the student is stuck or asks for help. In such a way, students maintain a feeling of control.

SQL-Tutor is implemented in Allegro Common Lisp [Allegro 1996] on SUN workstations and PC compatibles (see [Mitrovic 1997] for more details). The components of the system (illustrated in [Fig. 2]) are the interface, a pedagogical module that determines the timing and content of pedagogical actions, and a student modeller (CBM), that analyzes student answers. There is no domain module, as usual in ITSs that can solve problems given to students. There are two reasons for not having a domain module. Firstly, database queries are given in a natural language; however, the current state-of-the-art in Natural Language Processing (NLP) is still far from being able of handling various problems present in such queries, such as references and synonyms. There is a possibility to avoid NLP: the text of the problem may be represented not in its natural-language form, but in a form that could be the product of NLP, as done in [Anderson et al. 1995]. However, it is hard not to build parts of the solution into such a representation. Furthermore, even if we overlook the NLP problem, the knowledge required to write SQL queries is very fuzzy and it would be very difficult to develop a problem solver in this area.

Nevertheless, an ITS must be able to evaluate student answers. SQL-Tutor does that by comparing student solutions to the correct ones. That is the reason for SQL-Tutor to require ideal solutions to problems. In order to be able to check the correctness of the student's solution, SQL-Tutor uses domain knowledge represented in the form of constraints, described in more detail in [Student Modeller].

The system contains definitions of several databases, implemented on the RDBMS used in the lab. New databases can easily be added to SQL-Tutor, by supplying the same SQL files used to create the database in the RDBMS. SQL-Tutor also contains a set of problems for specified databases and the ideal solutions to them.

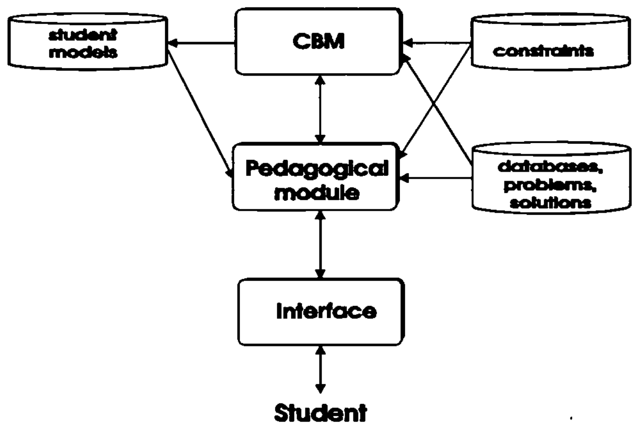

Figure 2: Architecture of SQL-Tutor

At the beginning of a session, SQL-Tutor selects a problem for the student to work on. When the student enters a solution, the pedagogical module (PM) sends it to the student modeller, which analyzes the solution, identifies mistakes (if there are any) and updates the student model appropriately. On the basis of the student model, PM generates an appropriate pedagogical action (i.e. feedback). When the current problem is solved, or the student requires a new problem to work on, PM selects an appropriate problem on the basis of the student model. The following subsections discuss the individual components in more detail.

4 Interface

The interface of SQL-Tutor, illustrated in [Fig. 3], has been designed with several pedagogical guidelines in mind. Generally, interfaces for ITSs should be robust, flexible, easy to use and understand. An interface is a mediating device; hence it must provide information about the system itself. At the same time, ITS interfaces are problem-solving environments and therefore should be similar to real environments, support the reification of goal structure and reduce the working-memory load of students

The interface of SQL-Tutor reduces the memory load by displaying the database schema and the text of a problem, by providing the basic structure of the query and also by providing explanations of the elements of SQL. The main window of SQL-Tutor is divided into three areas, which are always visible to the student. The upper part of the window displays the text of the problem being solved and the student can always remind him/herself easily of the elements requested in the query. The middle part contains the clauses of the SQL SELECT statement, thus visualizing the goal structure. Students need not remember the exact keywords used and the relative order of clauses. The lowest part displays the schema of the currently chosen database. The visualization of a schema is very important; all database users are painfully aware of the constant need to remember table and attribute names and the corresponding semantics as well. SQL-Tutor users can get the descriptions of databases, tables or attributes, as well as the descriptions of SQL constructs. The motivation here is to remove from the student some of the cognitive load required for checking the low-level syntax and to enable the student to focus on higher-level, query definition problems. SQL-Tutor supports the reification of the

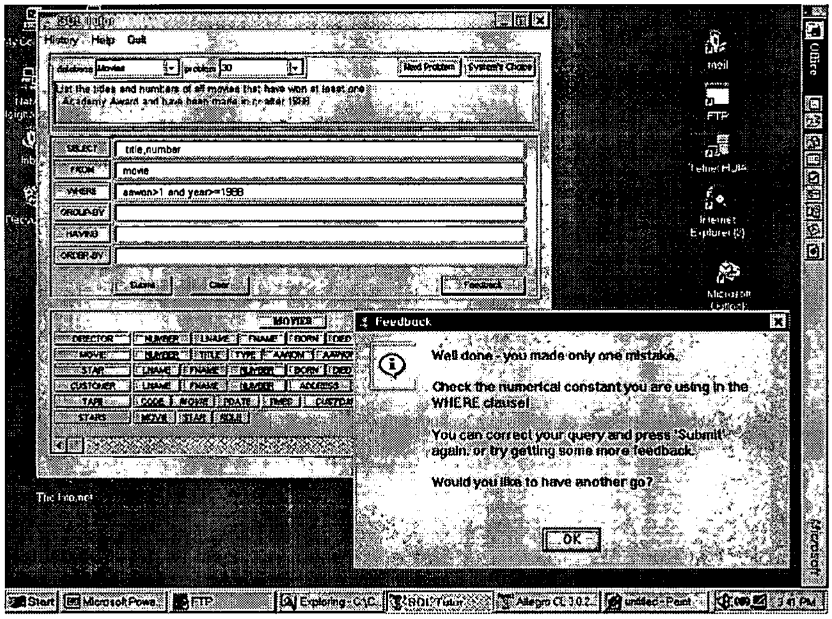

Figure 3: The interface of SQL-Tutor

goal structure by visualizing the elements (clauses) of an SQL query. The student can obtain short descriptions of the roles of various clauses by selecting the appropriate clause or by asking for help from the main menu.

5 Student Modeller

A student modeller develops an understanding of the student's state of mind that can be used to generate instructional actions tailored to the particular student. The task of building a student model is extremely difficult and laborious, due to huge search spaces involved and the small amount of information to start from. Several researchers have pointed to the inherent intractability of the task [Holt et al. 1994, Ohlsson 1994, Self 1990]. If the goal is to model student's knowledge completely and precisely, student modelling is bound to be intractable. However, a student model can be useful although it is not complete and accurate [Ohlsson 1994, Self 1994, Stern et al. 1996]. Even simple and constrained modelling is sufficient for instruction purposes, and this claim is supported by findings that human teachers also use very loose models of their learners, and yet are highly effective in what they do [Holt et al. 1994, Self 1994]. SQL-Tutor uses Constraint-Based Modelling (CBM) [Ohlsson 1994] to form models of its students.

CBM reduces the complexity of student modelling by focusing on faults only. Domain knowledge is represented in the form of state constraints, where a constraint defines a set of equivalent problem states. An equivalence class triggers the same instructional action; hence the states in an equivalence class are pedagogically equivalent. The assumption here is that there can be no correct solution of a problem that traverses a problem state, which violates the fundamental ideas, or concepts of the domain. A violated constraint signals the error, which comes from incomplete and incorrect knowledge.

A state constraint is an ordered pair (*Cr*, *Cs*), where *Cr* is the relevance condition and *Cs* is the satisfaction condition. *Cr* is used to identify problem states, in which *Cr* is relevant, while *Cs* identifies the class of relevant states in which *Cs* is satisfied. Each constraint specifies the property of the domain, which is shared by all correct paths. In other words, if *Cr* is satisfied in a problem state, in order for that problem state to be a correct one, it must also satisfy *Cs*. Conditions may be any logical formulas, hence may consist of various tests on the problem state.

There are several advantages of CBM over other approaches. It does not require a runnable domain module and is computationally very simple, because student modelling is reduced to pattern matching. Conditions are combinations of patterns, and can therefore be represented in compiled forms, such as RETE networks [Forgy 1982]. Student modelling is very fast then: in the first step all relevance patterns are matched against the problem state. In the second step, the satisfaction components of constraints whose relevance conditions match the problem state are matched. If a satisfaction pattern matches the state, the constraint is satisfied, and the ITS is not to take any action; in the opposite case, the constraint is violated. The student model thus consists of all violated constraints. Furthermore, CBM does not require extensive studies of student's bugs, and is not sensitive to the radical strategy variability phenomenon. [Ohlsson 1994]. The approach is also neutral with respect to the pedagogy, since different pedagogical actions (immediate or delayed ones) may be generated on the basis of the model.

SQL-Tutor models students by looking at the student's solution and by comparing the student's solution to the ideal one. The constraint base of SQL-Tutor currently consists of 352 constraints, which are acquired by analyzing the domain knowledge [Elmasri & Navathe 1994, Pratt 1990] and from a comparative analysis of correct and incorrect student solutions. Each constraint has a unique number, and contains the relevance and satisfaction patterns. Additionally, there is a constraint description, and the name of the clause of the SELECT statement the constraint refers to. Relevance and satisfaction patterns can be any logical formulas, consisting of any number of conditions. Some conditions match parts of the student's solution to prespecified patterns or the ideal solution; other conditions are LISP functions.

It is well known that knowledge acquisition is a very slow, time-consuming and labour-intensive process. Anderson [1995] reports 10 or more hours necessary for induction of a production rule. When interviewing domain experts in order to acquire knowledge for expert systems, usually 2 to 5 production rules equivalents are identified per day. The time spent on identification, implementation and testing of SQL-Tutor's constraints averages at 1.3 hours per production, which is significantly shorter than times above. This may be the consequence of the same person serving as the domain expert and knowledge engineer (and the system developer, at that matter), but may also illustrate the appropriateness of the chosen formalism.

A student model in SQL-Tutor contains general information about the student, history of previously solved problems and information about the usage of constraints, as demonstrated in the solutions produced by the student. For each constraint, SQL-Tutor stores information about how many times it was found relevant for ideal solutions, how many times it was actually used by the student and how many times it was used correctly. This information is stored in terms of three indicators (*relevant*, *used* and *correct*), used by PM for selecting new problems as explained in [Pedagogical Module], and updated by the student modeller.

6 Pedagogical Module

Pedagogical module is the heart of the system; it selects problems to be given to students and generates appropriate instructional actions according to the student model. In SQL-Tutor, instruction can be individualized by generating feedback dynamically and selecting problems.

The level of feedback determines how much information is provided to the student. Currently, there are five levels of feedback in SQL-Tutor: positive/negative feedback, error flag, hint, partial solution and complete solution. At the lowest level (positive/negative feedback), the message simply informs the student whether the solution is correct or not and, in the later case, how many errors there are. An error flag message informs the student about the clause[2] in which the error occurred [Fig. 3]. A hint-type message gives more information about the type of error. Here, the student is given a general description of the error. This description is directly taken from the definition of constraint. Partial solution feedback displays the correct content of the clause in question, while the complete solution simply displays the correct solution of the current problem.

It was stated earlier that a student's solution may violate several constraints at the same time (as in [Fig. 1], where 5 constraints were violated simultaneously). In such cases, SQL-Tutor examines the violated constraints and selects one, which is likely to be a genuine misconception. That is, SQL-Tutor selects the constraint with the maximum difference between the *used* and *correct* indicators. The rationale here is the student has made the same error several times, and therefore instruction must start with that constraint. Currently, the student is told the total number of violated constraint, but the error messages only deal with one constraint at the time. This decision is based on our intuition that it would be much easier for the student to deal with errors one at a time.

Problems are also selected on the basis of a student model. SQL-Tutor examines the student model and selects a problem for constraints that the student is not sure about (i.e., the one with maximal *used-correct*). Another

[2] In case that there are several massages in various clauses, the pedagogical module will select one of them to start with .

possibility for the problem to be posed to the student is a problem that requires the use of a constraint that has not been used by the student so far.

SQL-Tutor also allows the student to select the problem on his/her own. Such an approach introduces randomness in the coverage of constraints, which can mean that the student in practising the use of some known constraint or even introducing new ones. Admittedly, such problem selection strategies are very simple and we are currently developing more sophisticated strategies.

7 Conclusions

SQL-Tutor is an intelligent teaching system, based on learning-by-doing. It supports three kinds of learning: conceptual, problem solving and meta-learning. The student can learn about concepts and elements of SQL. SQL-Tutor is a problem-solving environment which supports acquisition of domain knowledge in a declarative form (i.e. constraints) and strengthening of this knowledge in practice. The system provides assistance in problem solving and arguments against incorrect actions. Finally, SQL-Tutor encourages meta-learning by supporting self-explanation on the basis of error messages and correct solutions given to the student.

The system has been shown to a number of database teachers, and all were very supportive and expressed great enthusiasm for using it in their own courses. The first evaluation study is scheduled for early April 1998. We expect that a hands-on approach will encourage most students to experiment more fully and acquire a more in-depth understanding of SQL.

There are many possibilities for extending this research. The evaluation study will provide the data for completing the constraint base, and tuning the interface. A more sophisticated way of selecting new problems is the current focus of our research, as well as the development of a set of pedagogical rules that would govern the selection of appropriate amount of help for each student. We also plan to connect the system to a RDBMS, in order to allow students to view the results of their queries, once they are completed successfully. Porting the system to Web is another of planned tasks. There are many related areas in the database world, such as relational algebra and calculus, data modelling or normalization, which could serve as domains for other small instructional tools and be connected with SQL-Tutor into a "database exploration world".

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A Tutoring Wizard Guiding Tutorial Work in the Virtual University

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Abstract: The Virtual University is a netbased learning environment developed at the University of Hagen. Complex teaching activities based on totally new concepts integrating netbased communication and cooperation facilities take place in the Virtual University. Our experiences show that there is a threshould especially for tutors of non computer science fields to use the new technologies for tutoring activities. The problem is: they have to arrange completeley new organizational processes and they have to manage the new technology. In order to ease the tutor's work we are developing a netbased tutoring concept that supports tutors considering both aspects: organzational and technical support. We demonstrate our concept of a netbased tutoring wizard as a model for the management of virtual seminars.

1. Introduction

As life-long learning is getting more and more essential in professional life, distance teaching is getting more attention and has started to play an increasingly important role in all modern societies. It's core features are that it offers timely and locally independent studies, and that it supports on-demand learning as required today. Obviously, time to be spent at the university campus has to be kept at a minimum. A project team at the University of Hagen has developed a concept for a virtual university, implemented a prototype and tested it with students:

The Virtual University [Buhrmann et al. 1996] of the FernUniversität Hagen is a virtual university system that integrates all functions of a university into a complete, homogeneous, extensible and cost-effective system with an easy to use and intuitive user-interface. The main menu of the Virtual University [Fig. 1] offers the functions: *education* - for participation in courses, seminars, practical trainings and exercises, *news* - a campus wide blackboard containing all sorts of up-to-date information relevant to the users of the Virtual University, *office* - the component including administrative functions, *research* - offering access to all research-related activities in the university, *cafeteria* - a forum for social contacts between students, *library* - offering access to both traditional and digital libraries, *information* - a menu containing general information about the university, and *shop* - offering all material that can be purchased from the university.

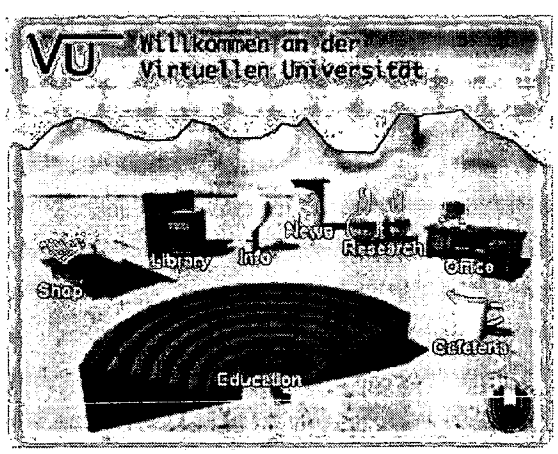

Figure 1: Home page of the Virtual University, http://vu.fernuni-hagen.de

The Virtual University supports totally new forms of learning like distributed working groups, seminars and practical trainings etc. Unfortunately, too many approaches focus on electronic delivery of learning material ("online-university") - indeed, this is only a very small part of the overall concept of the Virtual University in Hagen. The major breakthrough comes from the integration of various media and communication and cooperation support via networks. In this environment the users learn an important element of today's industrial world: to cooperate in distributed processes and to manage and organize this kind of cooperation.

Of course, the impact of the Virtual University is not only restricted to students, but to all university users and user groups respectively tutors, authors, secretaries etc. Each user must learn to work and manage his job within the Virtual University system. Therefore user-interfaces fitting the individual user-groups' requirements must be developed.

Due to the fact that totally new forms of learning are executable in the Virtual University, particularly the tutors' work - organizing and managing teaching activities - changes. At the same time the integration of tutors is an important fact for the acceptance of our system: the more (teaching) activities we offer in the Virtual University, the more students will accept the system. As a reason, one important aspect of our future work is the development of tutoring interfaces.

In the following chapters we compare the tutors' work in traditional distance teaching environments with his tasks in netbased environments. The virtual seminar serves as an example for the comparison of tutoring tasks. Then we present our ideas for netbased tutoring support, again the seminar serves as an example. Of course, the tutoring concept is universal, extendable to other learning forms like practicals, exercises, courses etc.

2. Traditional and Netbased Tutoring - Concepts and Problems

All tutoring activities in a traditional distance teaching university must be well thought out, they have to be initiated a long time in advance; spontaneous reaction is nearly impossible. Most information is printed and sent to the students via mail. Personal communication is restricted to the phases of presence at the university; furthermore, communication between students and tutors is realized by mail or telephone, communication between students takes place rarely.

To give a practical impression of the tutors' activities in traditional learning environments, let us briefly describe the organization of a typical conventional seminar at the University of Hagen [Berkel et al. 1997]:
At first the tutors announce the seminar in the 'info', a booklet published every four weeks and sent to all 55.000 students of the University of Hagen. The students enroll by sending a postcard to the tutors. The tutors decide which student is allowed to participate and send a confirmation or cancellation to the students. Each confirmed student gets a specific topic he has to elaborate as his seminar contribution via mail. A written list of literature is added to help the student with searching for relevant literature. After two months, the student sends the written structure of his contribution to the tutors. They review the structure and send their comments and hints back to him. The student eleborates a written version of his contribution and a set of slides. During the elaboration phase, the student may contact the tutors via mail or telephone. Two weeks before final presentation, the students send the final version of their written contributions to the tutors. The presentation of all contributions takes place within two days at the university in Hagen. After the students' presentation, the actual topic is discussed between all students and the tutors. The students get the corrected and commented written version of their contribution back from the tutors. A booklet containing the corrected contributions is published for all participants of the seminar.

To summarize the problems of traditional tutoring:
- tutors publish mostly written announcements and information to very early dates (detailed seminar information must be fixed seven months in advance),
- tutors have rare contact to students (mostly in written form, but it is very tedious and normally restricted to only two discussion partners),
- there is nearly no possibility to react on students' remarks during the current semester (e.g. correct a mistake in the course material),
- tutors have to clearly define the problems for the students (e.g no participation of the students in the selection of topics),
- hardly cooperation / arrangement between students to deal with overlaps concerning their topics.

Netbased tutoring can reduce most of the above mentioned problems in distance tutoring, but some other difficulties - especially for the tutors - arise. We examined them on the basis of the virtual seminar, an example for distance tutoring via networks [Berkel et al. 1997]. The seminar was carried out in the winter of 1996/97 with students from the faculty computer science. All (traditional) seminar activities described above were carried out over the internet. Therefore, various internet services - asynchronous components like email, news, ftp and www and synchronous components like chat, audio- and videoconferencing - were mixed in different combinations for specific seminar activities. The used internet services were integrated into the Virtual University user interface, based on the www. Students could initiate all activities by mouseclick (search for adequate communication partners, participate in a seminar videoconference or read the seminar newsgroup) from the seminar web pages.

We noticed that most negative aspects of traditional distance tutoring could be reduced in the netbased learning environment as described for the virtual seminar: spontaneous reaction on students' remarks was possible, various communication offers between students and tutors and students themselves were available, tutors could leave problems to the students to decide or they could help amongst themselves via network based communication. The tutors merely played the role of moderators who coordinated various messages, comments, remarks and hints of the students and organized and published them to the other participants. Therefore, in contrast to traditional seminars the tutors needed to have advanced technological knowledge about the internet and the usage of internet tools in order to generate the seminar web pages and to support the students with technical hints and tips, establish communication offers and integrate them in an easy-to-use way for the students.

To summarize the results: there are two elementary new tasks for tutors (apart from the effort for achieving a rudimentary knowledge and experience in the use of internet tools):

- the organization, technical arrangement and presentation of information produced during the far more dynamic process of netbased teaching activities and
- the moderation and management of students' collaboration.

Both aspects must be regarded in further developments of the Virtual University. In this paper, we focus on the first aspect. Therefore, we develop a concept of netbased tutoring - a tutoring wizard - supporting tutors in arranging the technical frame for their work. Our approach will be presented in detail in the following chapter.

3. Concept of a Netbased Tutoring Wizard

Netbased tutoring as described in the previous paragraph includes various - sometimes quite technical - activities. In contrast to traditional tutoring activities, most of the netbased tasks can be supported electronically. Our idea is to develop a tutoring wizard, that simplifies the process of creating and managing webbased tutoring activities:

The tutoring wizard is an application that offers an easy-to-use interface to the tutor. It supports standardized organizational frames for the tutor's work and helps him to collect, organize and presentate the neccessary information without having much knowledge of the underlying technologies. The wizard automatically creates and manages webbased information and reminds the tutor of forthcoming dates and tasks and delivers information automatically to responsible persons.

A scenario clarifies our idea: The tutors Berkel and Lenzen shall organize a seminar. The first task they have to deal with is the seminar announcement. They start the tutoring wizard, authentify themselves and select 'seminar' as the tutoring activitiy to support. Now they have to fill in the course number, the title of the seminar and the names of the responsible tutors. Furthermore they specify the kind of communication offers they would like to integrate into their presentation. The wizard now initiates all server based activities like creating a seminar directory on the web server, installation of communicational offers (e.g. sending a mail to the web administrator) etc. Now the announcement text must be filled in. Therefore, the tutors fill in all relevant information in the textfields of the step-by-step presented dialog boxes. With the inserted text the wizard generates on the basis of a seminar template a web based seminar presentation including all necessary web pages (e.g content and navigation pages). The tutors chose the 'Publish'-command in order to publish the information on the web server. For the moment, they leave the program. If any reaction of the tutors is required (e.g. the tutors specified a discussion which is announced for the next days) the wizard mails a message to the tutors reminding them of publishing further infos.

The scenario shows some characteristic functionalities that are expected of a tutoring wizard:

Templates for webbased tutoring: The wizard includes various templates for the diverse tutoring activities. The templates generate frames for complex web pages based on elementary components: e.g. header and footer pages, navigation functionality, frame construction etc. Changing the elementary component header page means that the header page changes in all web pages of the current tutoring web.

Automatic generation of web pages on the basis of the tutors' information filled in dialog boxes: The users need not to know anything about the techniques to process material in suitable formats: the wizard automatically generates the information the tutor fills in the textfields of the wizards' dialog boxes into suitable formats, e.g. directly as HTML web pages or as database input which is generated later to appropriate formats. The advantage is: The user needs not to know HTML or any other web presentation language. Furthermore, information can be integrated in various web pages - e.g. the title of the seminar is the header of each seminar web page - the tutor must fill it in only once, the wizard automatically copies it to various locations.

Support of publishing and changing information on the web server: A publishing assistent helps the tutor to publish the seminar presentation on the Virtual University web server. The assistant can be activated by clicking a simple 'Publish to Web'-button. It includes the address and the parameters for publishing, the tutors do not need to start a completely new (ftp) program.

Task management: The wizard gathers all further to do's in a task list, that shows what kind of action is requested and at which time it is requested. The tasks might be weightened (showing the priority of the task) either by the system on the basis of definitely required information or by the tutor's subjective estimation.

Notification mechanism: Time fixed tasks can be related to a notification mechanism that reminds the responsible tutor of the task. Notification might be implemented via mailing mechanisms.

Support of tutor groups: Suggesting tutors often work in small groups, the wizard should support group oriented tutoring. Therefore specific functionalities like the management of tasks depending on the tutor's identity, gradual access restrictions etc. must be considered.

Integration of workflow aspects: For tasks depending on subtasks, a task workflow can be described. It automatically generates the following to do's and reminds the responsible tutors of the next steps to do.

Some further requirements derive from the Virtual University platform. They comprise aspects like: an easy-to-use interface, multi-platform compatibility, compatibility to existing software and the ability to expand the system with further software packages, services and protocols.

4. Implementation of a Tutoring Wizard Prototype

A first rudimentary prototype is implemented on the basis of Microsoft FrontPage. FrontPage is a web publishing and administration tool, that supports templates and wizards. It does not fullfil the requirement of multi-platform compatibility, but to begin with the work we can suggest that tutoring activities are done on PC's. Furthermore, the tutors can work on their web presentations individually by using the FrontPage tool. In any cases, the FrontPage interface [Microsoft 1997] enables us to rapidly develop a specialised tutoring wizard showing our ideas described above.

The templates implemented in FrontPage build up the basic structure of web based seminar presentations: a frame structure subdeviding the screen into navigation and content pages, and a number of pages containing the diverse seminar information (announcement / introduction, content / themes, organization, lectures, communication / discussion). Furthermore, additional pages like glossaries, guest books, literature tips and blank pages can be included. A description and a preview of the templates is shown to the tutor in the preview window [Fig. 2].

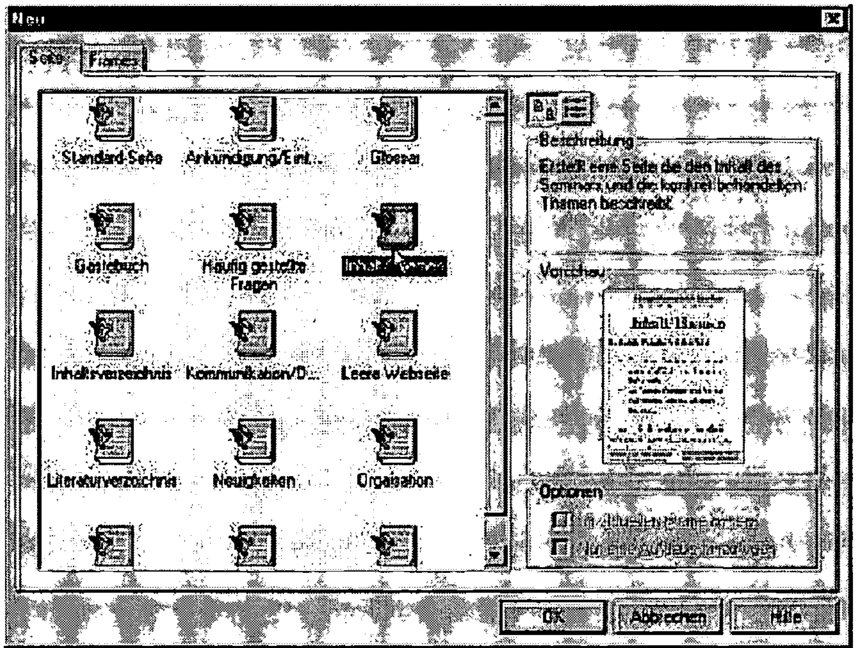

Figure 2: Seminar specific templates integrated in FrontPage

Dialog boxes are implemented to support the user in collecting the tutoring information. On the basis of earlier chosen templates the given information is integrated into the seminar presentation. This functionality is realized by self-implemented FrontPage wizards, independent executable programs written in Microsoft Visual Basic that collect input from the user in a series of dialog boxes, then place OLE automation calls to drive FrontPage by 'remote control' to create new web pages.

The seminar wizard asks the tutor step-by-step about the structure and the design of the seminar information and about the information itself; e.g. in the fiest step the tutor has to decide on the frame structure (navigation menu left side or at the bottom), afterwards he selects the required pages for his presentation [Fig. 3], then he fills in the seminar title and a short description and so on.

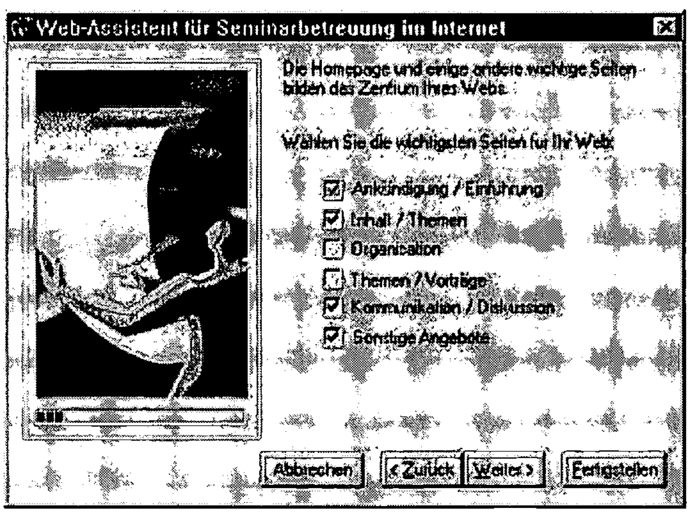

Figure 3: The wizard supports the user with dialog boxes

After filling in the information a 'seminar presentation' (in FrontPage called FrontPage Web) is created by remote control. The user can see the result and work on it with the FrontPage program [Fig. 4]. At the same time, a task list will be generated. The FrontPage web publishing functionality supports the publication of the created web on the basis of the WebPost API, an API for publishing information to web servers.

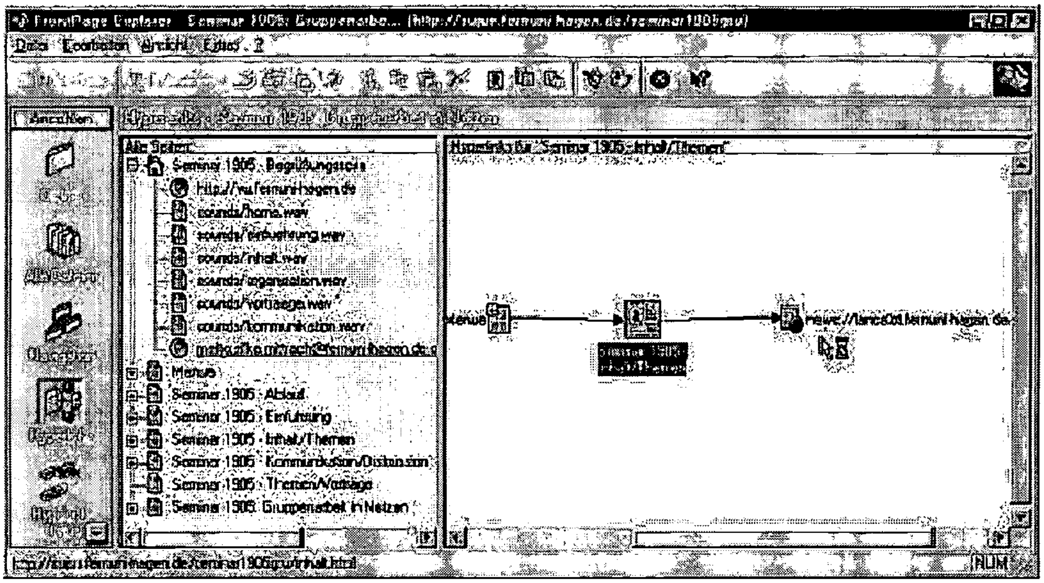

Figure 4: The web presentation is created automatically and presented in the FrontPage Explorer

5. Summary and Prospects

In this paper we present the tutors role in a distance teaching environment. Tutors in virtual environments have to manage technical processes, therefore they need a basic technical knowledge. The tutors' work is changing with regard to organizational (completely new courses) and tutorial aspects (tutor as a moderator). The paper shows our concept of a tutoring environment supporting tutors with regards to organizational aspects of their work.

A first prototype is implemented on the basis of FrontPage, a web administration and creation tool that supports some of the basically required functions. Primarily, further implementations shall demonstrate our ideas, e.g. the FrontPage task list will be extended with mailing functionalities, and experiences with users must show the suitablility of our approach. Aspects like group support and workflow integration must be concepted in detail.
Later on, aspects like the dynamic generation of information will lead us to (re)implement the system in combination with the VU databases: information will not be any longer managed in static HTML pages, but generated dynamically just-in-time and on-demand. Therefore, the seminar information will be saved in VU databases.

6. References

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The Interactive Course Map

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Abstract: We describe the Interactive Course Map, and discuss some of the rationale behind its design. This multimedia map provides a meat-learning environment, designed for use in distance education., and is intended to provide undergraduate students of a maths and computing course at the Open University with both an overview of the course structure, and also an introduction to the mixed media resources employed in its presentation. Formative user testing is described and its findings reported. We suggest that a meta-learning environment, such as this map, helps students take control of their learning experience by clarifying relationships between resources and learning goals, and by helping the student stay oriented and pace their study as the course proceeds.

Introduction

When forecasting the learning situation of the future, we envision students working with a wide array of on-line tools – ranging from standard productivity tools and communication software, to specialised learning environments tailored to particular curricular needs. In this scenario, learners are not only trying to master the subject or domain content, they must also cope with: (1) mastering a potentially complex assortment of software tools, and (2) developing new study habits to make effective use of these tools. A challenge for learners in such a situation is effectively 'managing the media mix' to achieve their educational objectives [Laurillard 1995]. Recent empirical studies indicate that many learners, particularly those who are inexperienced with computer technologies, feel overwhelmed when faced with this new way of learning [Sumner and Taylor 1998].

We are investigating how interactive course maps and study guides can help students successfully manage potentially complex mixes of new technologies to enhance their learning process. In effect, we are trying to create meta-learning environments; i.e., environments to help beginning scholars 'learn how to learn' with new media. Here, we describe the Interactive Course Map we have created for a new first-level course on object-oriented computing, and discuss some of the rationale behind its design.

Setting: A First-year Computing Course

Since the late 1960's, The Open University (OU) has been providing mixed media, distance education courses combining printed texts, television, video, audio, and home-laboratory kits. Materials are centrally produced to an academically high standard, and presented in an open learning style that is accessible to people with no previous academic qualifications. The specific setting for this work was the design and development of a new first-year undergraduate introductory computing course called "Computing: An Object-oriented Approach" being developed in the Maths and Computing Faculty here at the OU. Such introductory courses at the OU often have 3000 to 5000 students enrolled during a given presentation. Table 1 shows the resources that were created for this course, a more detailed discussion can be found in [Woodman and Holland 1996]. What is striking about this table is the multitude and diversity of learning environments used to support a rich, year-long course.

The Interactive Course Map

As shown in Table 1, the M206 course involves a fairly complex mix of media. The challenge which the multimedia Interactive Course Map aims to address is to give the student an overview of the whole course structure, and to introduce the mixed media resources required while studying. It also introduces the computer tools the student will be using. The map needs to present a complex situation as simple and manageable. It should help the student to feel that they are in charge of the situation, and that they need not feel overwhelmed by the pile of course materials arriving through the post.

Course Resources
Printed Texts
Smalltalk LearningBooks Programming Environment
Set Book: Parsons & Oja (Parsons and Oja Second Edition, 1996)
Eleven Television Programmes
Two Multimedia Titles – 'The Object Shop' and 'Grumble's Grommets'
Electronic Glossary
World Wide Web Site
Computer Conferencing
Email
Personal Productivity Tools

Table 1 Course resources.

We began by analysing the proposed course structure and resources. We identified three key strands of information: study time in weeks, a guide to block structure, and study resources. It was particularly valuable to look at the relationships between the three strands of information to be presented in the map, and from this build a visual representation [Figure 1].

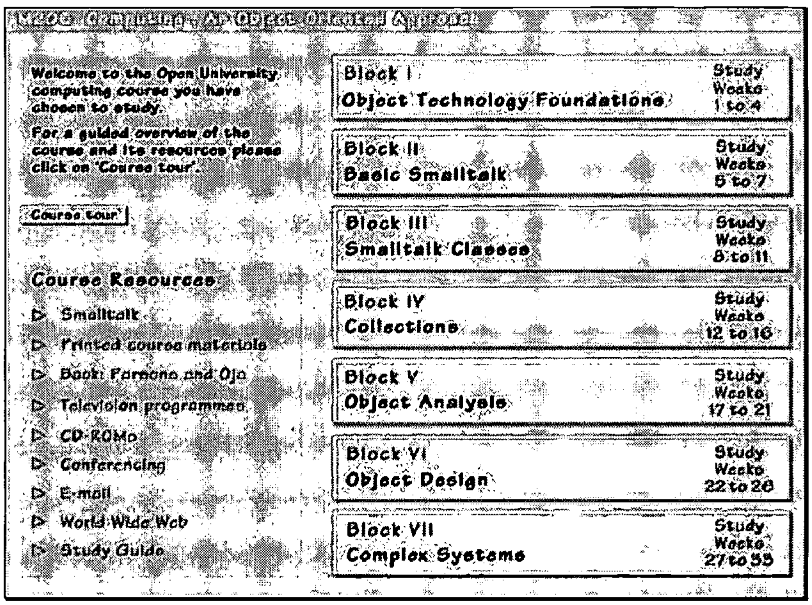

Figure 1 The Course Map. The course content area (right half of picture) reflects the course's block structure and provides information about what students need to do each study week. The course resources area (bottom left) provides a high-level overview of how each resource is used in the course. The tour area (top left) is used to provide students with advice about how to study and how to use the Map.

The map is composed of three main areas reflecting these strands: the course content area, the course resources area, and the tour area. The course content area consists of seven large buttons, corresponding to the block structure of the course. The course resources area lists all the resources used in the course. As the mouse cursor moves over items in the resources list or the big block buttons, these items are highlighted, giving visual feedback to indicate that they are pressable. The box in the tour area is used to display a narrator's head with headlines supporting the audio narrative. Each of the three areas will be described in more detail below.

The Course Content Area

This area has been designed to give the student an overview of the teaching blocks and to help the student in the organisation and pacing of their own work. The time line through the course study drives the main pathway through the information. This time is also reflected in the print materials which are presented in a large reference binder, with dividers for each week of study. The week dividers each carry the colour of the block to which they belong, thus linking study weeks to blocks of study. Consistency of colour coding is carried across to the use of colours for the Block Buttons in the multimedia map.

Pressing the Block 1 button at the top level brings up the two panes shown in Figure 2. Each block area is structured into two panes – the block overview pane (on right) and the weekly resource pane (lower left). The block overview pane shows how each study week is composed of one or more chapters. Clicking on any chapter title will bring up a third level pane containing a brief chapter description.

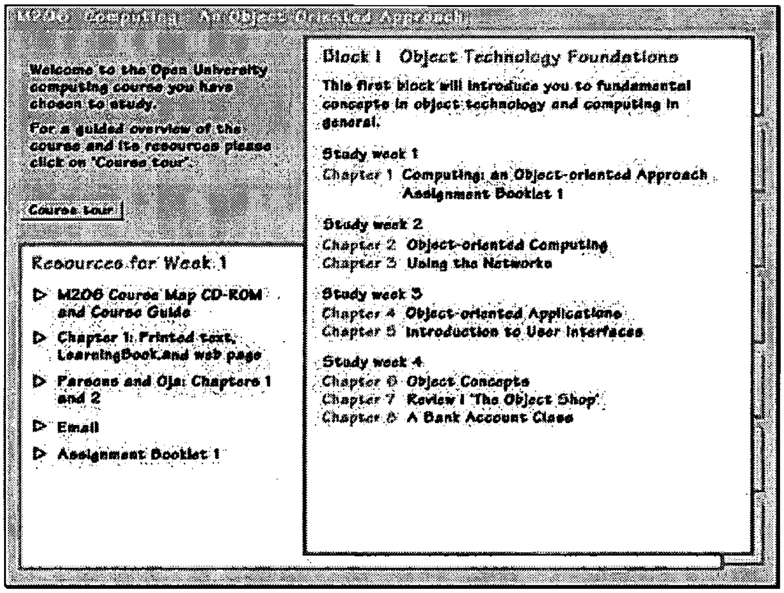

Figure 2 The Contents of Block 1. Each block area is structured into two panes – the block overview pane (on right) and the weekly resource pane (lower left). The block overview pane shows how each study week is composed of one or more chapters. The left side of the weekly resource pane shows what learning resources are used in any given study week. The right side (not shown, under the block pane) discusses how the resources will be used to meet specific learning objectives.

The weekly resource pane shows what learning resources are used in any given study week and what resources comprise each chapter. As shown in Figure 2, Chapter 1 consists of a printed text, a Smalltalk LearningBook, and a chapter web page. Clicking on a study week heading brings up that week's weekly resource pane. This mechanism enables students to get a quick overview of the amount and the type of work they'll need to do for any given week.

Our second objective was to provide bridging support to help students make connections between learning goals and more detailed activities. This objective is supported by the interplay between the block pane and the weekly resources pane. These two panes are layered, clicking on one brings it to the front and overlays part of the other pane. The chapter descriptions available from the block pane focus on learning goals. The left side of the resources pane shows what tools and resources are used to achieve the learning goals.. Clicking on the resource pane brings it to the front and makes the right side visible, which describes how the resources will be used to meet specific learning objectives. If the resource being discussed is a television programme or an interactive multimedia title, then previews or demonstrations are available on the right hand side of the week resource pane

The colours and fonts used in the Map match those used in the printed text and the course web site. Thus, where possible, resources used in the course have a familiar and consistent 'M206 look', regardless of the media. By using a familiar look and following a simple and straightforward layout, we hoped to make the Map seem friendly, fun, and relatively intuitive to use. The colours used for the pane borders match the colours used to identify the different blocks (e.g., the light blue is always used for Block 1 and the deep red for Block 7). The colours are not only pleasant, they also reinforce a sense of orientation. These design decisions reflect Shneiderman's [Shneiderman 1992] findings about the use of colour:

- Recognise the power of colour as a coding technique.
- Be consistent in colour coding.
- Design a display in monochromatic form, using spacing and arrangement for organisation, and then judiciously add colour where it will help the operator.

The basic structure of the map, with these two overlapping panes, is very simple yet powerful. We believe that simplification where possible is entirely appropriate in designing educational multimedia such as this. In 'The Psychology of Everyday Things', Donald Norman describes his "...fundamental principle of designing for people: (1) provide a good conceptual model and (2) make things visible" (page 13, [Norman 1988]). Though Tufte's [Tufte 1990] starting point is specifically graphic presentation of complex statistical data, his conclusions can be applied more generally to visual presentation of information, i.e., "The operating moral premise of information design should be that our readers are alert and caring; they may be busy, eager to get on with it, but they are not stupid. Clarity and simplicity are completely opposite simple-mindedness. Disrespect for the audience will leak through, damaging communication."

The Course Resources Area

The aims of this area are twofold. One aim is to provide an overview of how a particular resource will be used in the course. Another aim is to provide students with global advice about how to study with the resource for this particular course. For instance, the course team has developed a special version of the LearningWorks™ environment for the Smalltalk language. This environment organises work into computer-based modules called LearningBooks that contain exercises, learning worlds, and programming tools. Figure 3 shows the course resource area for the Smalltalk LearningBooks.: this pane is obtained by clicking on Smalltalk in the resource list at the top level. Notice how the area does not describe Smalltalk in general, this is what the course is about! Instead, it focuses on describing the LearningBook structure and how one might study using this structure.

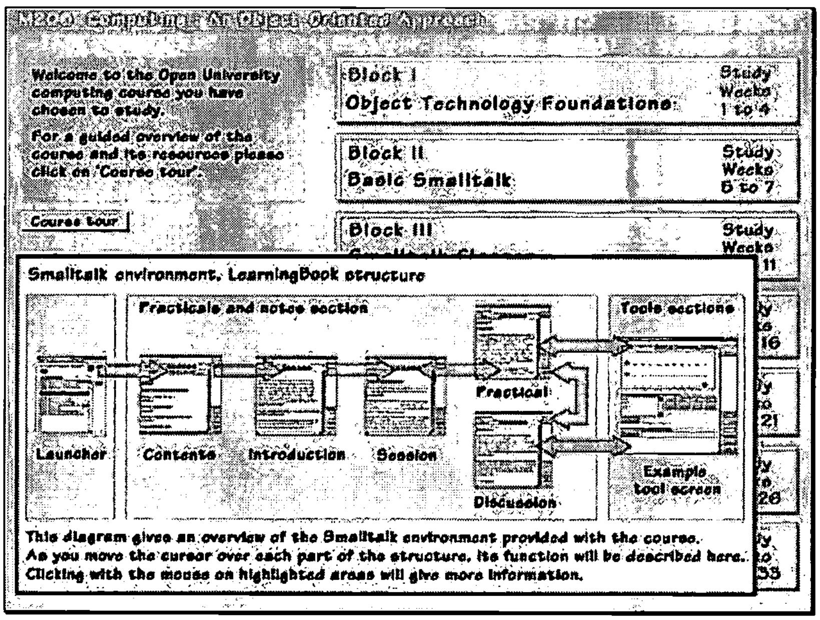

Figure 3 The Smalltalk pane in the Course Resources Area. This pane shows the structure of the Smalltalk LearningBooks. As the mouse cursor rolls over each of the miniature screens, it is highlighted, and an overview of its purpose appears at the bottom of the pane. The arrows illustrate one idealised work flow using the LearningBooks.

The Tour Area

We have outlined the structure of the map and the ways in which it can be navigated. Now we return to the goal of bridging between resources and course content. We wanted not only to facilitate the linking of different media with different learning experiences, but to also provide a guided experience which would take learners through the map, and show how to use it through a process of self disclosure (DiGiano and Eisenberg 1995). We combined this notion of self-disclosure with Plowman's notion of *narrative guidance* and the use of an 'explicador' [Plowman 1996].

She describes Bunuel's account at the turn of the century of people called explicadors who used to stand in front of the cinema screen interpreting for the audience the revolutionary new form of the moving picture. This was necessary because audiences had not yet built up a grammar of interpretation to allow them to understand filmic devices indicating passage of time, change of location, intensity of focus and so on. Plowman adapts this role to multimedia, arguing that users have similar difficulties in acquiring an appropriate grammar, or literacy, in the new media, so explicadors are needed to help in the process.

In the map, the explicador(s) take learners on tours of the map. There is a general Course Tour and a Block 1 Tour. Students can obtain print-outs of the audio scripts if they wish (this is important for supporting hearing impaired students). The Course Tour introduces the overall structure of the course, but most importantly, students are shown each of the various media and given advice about how to use that medium to maximum benefit. The Block 1 Tour steps through the different activities in each of the first four study weeks, discussing how the computer-based learning tools will be used in the different activities. The Block 1 Tour also emphasises the need to get organised and get the software installed.

The explicador in the Map is not a full-motion video head. Such a representation be a drain on the computational resources available, thereby slowing the tour down We also felt it was unnecessary. The particular form of the explicador is adapted from KMi Stadium [Eisenstadt and Scott 1998] and is a low-band width format which conveys a small amount of information when attention is focused on the explicador, but otherwise stays very much in the background. We used members of the course team as explicadors (as opposed to famous celebrities or cartoons) since, from our experiences with television, we know that students enjoy seeing programmes which feature course team members because they like putting faces to names.

Next Steps: Improving the Map

The Map obviously needs testing to ascertain whether or not it actually meets its design goals. We use two types of testing: formative testing, which feeds into the current round of development and is conducted intensively with small numbers of people; and summative evaluation which is based upon students' experiences with the map during the first year of the course's life.

We have completed the first round of formative testing [Sumner, Taylor et al. 1997]. Six volunteers, all drawn from a pool of people who would typically register for such a course, were asked to do two tasks. Each task consisted of taking a tour first and then use the map to answer three questions. Each participant was then asked questions about the tours, the map layout and structure. Each session took approximately 1.5 - 2.0 hours.

All participants were very enthusiastic and positive about the overall look and feel of the map, and had few problems navigating, seeming easily to find the things we set them to look for. We were most anxious about the tours, because there was a strong chance that people might find them irritating, and of no use whatsoever. However, all participants described the tours as 'helpful' in the following specific ways: for taking them through the structure of the course phase by phase, for introducing the media and for showing them how to use the map itself. All participants said they would probably listen to all, or parts, of the tours several times. The drawbacks, however, were that the tours, as written, tended to cover too much, too fast. Most people were comfortable with the general content and level of description offered, but wanted more time to assimilate what they had just heard. To address these shortcomings, we have re-written and simplified the scripts to eliminate detail, and we have synchronised the audio track and the text more clearly to help prevent cognitive overload.

As a result of using the Map (with tours), 5 out of 6 participants were able to clearly articulate the structure of the course and the rather complex structure that 'chapters' might have (e.g. printed text, electronic learning books, web pages and television programmes). Additionally, everyone was able to articulate the general role of major resources in the course; i.e., that conferencing was for communicating with other students and tutors, whilst the web was a resource area for getting updates to course materials. We regard this as a measure of success.

As a final part of the testing, we asked people to select descriptors (e.g., boring, technical, approachable, interesting, hard, fun, etc.) from a stack of cards that best described the course as they perceived it after using the Map. Most participants claimed that the organisation of the Map and the tours made the course look well-organised, interesting, and approachable, yet challenging due to the subject matter. Several participants who stated that the course looked approachable noted that they would normally not have the confidence to take such a technically challenging courses. A few felt it even looked fun! In our view, the map clearly made a large contribution to people's overall positive perceptions of the course.

Obviously, testing involving such small numbers can only tell us a certain amount. As a next step, we will engage in summative testing to track the Map's usage during the course's presentation. The key point for us is not so much to ascertain whether students CAN use the map (which is the main focus of formative evaluation), but DO they use it? We may find that we still do not have quite the right level of description to provide the bridging function between media and content in actual practice. Students may respond that the map was a good idea, but it just didn't quite work.

Conclusions

In summary, many students can feel overwhelmed when facing a new way of working and learning. We hypothesised that meta-learning environments could alleviate this problem by helping students take control of their learning process, making clear the relationships between resources and learning goals, and helping students stay oriented as the course proceeds. We have built an initial version of such an environment: The M206 Interactive Course Map and our experiences with the map so far are very promising.

So what next? Do meta-learning environments only fulfil a short-term need? With increased exposure to tools, environments and media, will students develop the kinds of skills and literacies that eliminate the need for meta-learning environments? We don't think so. In both the short and long-term, the need for meta-learning environments will not disappear. We accept, as a fundamental principle, that learners need support from their teachers, no matter how sophisticated their materials are, or how elaborate the learning environment is. This support may be provided in a variety of ways, and need not always be from the human teacher to the learner on a one-to-one, face-to-face basis. But we can – and do – confidently assert that students will always need help!

Acknowledgements

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An Object-Oriented Architecture for a Web-based CAI System

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Abstract: This paper describes an object-oriented design and implementation of a Web-based CAI system. The goal of this design is to provide a flexible CAI/ITS framework with full extendibility and reusability as well as to exploit WWW-based software technologies such as JAVA, ASP, or various plug-ins for customizing the behavior and appearance of the material. Courseware objects are defined to implement ITS courseware consisting of tree-structured material objects and the learning target objects associated to the material objects. Each material object has the method to invoke the tutoring strategy thus the strategy is easily customized or replaced by the class inheritance. The page object, the leaf level object of the material tree, is associated with the URL pointing to either the normal multimedia data or the exercise script consisting of server-side script like ASP. The page object communicates with the exercise script to dynamically generate the interactive exercise. An example of courseware consisting of an interactive simulation is implemented by making use of the exercise script. The proposed object-oriented design has the potential to be extended for constructing the framework of distributed courseware object.

1. Introduction

As the World-Wide Web becomes more and more important, there have been a lot of researches or projects on the WWW-based CAI/ITS systems[6, 5, 1, 11]. We have been working on a ITS on the Web called CALAT[8, 9, 10].

CALAT, as well as the other WWW-based CAI/ITS systems, is based on the conventional CAI system or ITS shell on the standalone computer. The system consists of CAI logic on the WWW server and GUI on the WWW client. It uses http for the multimedia data communication between the server and the client. In this sense the WWW framework is used just as a multimedia communication platform. Although CALAT allows multimedia data on the other WWW server to be incorporated as the static courseware pages, the characteristics of the WWW as a distributed media platform it is not fully exploited. In addition, the current WWW-based system based on the conventional CAI system inherits the problem of the conventional system that it is often very difficult to modify, improve or extend the functionality or behavior of the system. As pointed out in [3], this is due to the design in which the module structure directly reflects the basic ITS functional components, namely tutoring engine, student model, courseware scenario, courseware pages and GUI. This structure makes it very hard to make even a slight function improvement, since the modification can not localized in one module but it causes every module to be affected. This means that it is difficult to modify tutoring strategy as well as to implement smart courseware pages/GUI by making use of new WWW-based software technologies like JAVA, ASP, or various interactive plug-in programs.

To overcome these problem, an object-oriented architecture is employed to design new version of CALAT. Courseware objects are defined to implement ITS courseware consisting of tree-structured material objects and the learning target objects associated to the material objects. Each material object has the method to invoke the tutoring strategy thus the strategy is easily customized or replaced by the class inheritance. The page object, the leaf level object of the material tree, is associated with the URL pointing to either the normal multimedia data or the exercise script consisting of server-side script like ASP. The page object communicates with the exercise script to dynamically generate the interactive exercise with variety of multimedia and GUI plug-in components. An example of courseware consisting of an interactive simulation is implemented by making use of the exercise script.

This direction leads to the distributed ITS or distributed courseware on the WWW recently discussed[2,

7], as well as the initial study motivation of the CALAT system[8].
This paper is organized as follows. The next section discusses the requirements and issues to be considered in the new design. Then the current object-oriented design is described in the third section. Application of the design to a particular courseware is presented in the following section. The concluding section discusses the potential of the proposed design to be extended for constructing the framework of distributed courseware object.

2. Design Issues

The current WWW-based ITS, including CALAT, are usually implemented based on the conventional ITS shell as their kernel. Common ITS shell consists of the modules directly reflects the basic ITS functional components, namely tutoring engine, student model, courseware scenario, courseware pages and GUI. This module structure is quite intuitive and naive but even careful implementation based on this structure tends to lack the flexibility for additional improvement and customization[3].
This is because there are very complex dependencies and references between each modules. For example, to add a new parameter in the student model requires the new method in the tutoring engine to calculate and interpret the parameter, the new behavior description in the courseware scenario to utilize the parameter, and so on. From the software engineering point of view, numerous dependencies between modules means the poor module design.
With this module structure, it is very difficult to incorporate the new WWW-based technology like JAVA, ASP, or various interactive plug-in programs for courseware pages or GUI customization because the existing pages or GUI module has the strong dependencies to the other modules. The concept of distributed tutoring systems aiming at high reusability of the intelligent tutoring resources[8, 2, 7] is also incompatible with this module structure in which the highly dependent modules form the closed courseware world.

3. Implementation

The new object-oriented ITS platform is designed to overcome the design issues discussed in the previous section. The design is intended to provide a increased flexibility for modification or improvement in the tutoring strategy as well as to provide a generic interface to utilize the new WWW-based technology for implementing easy-to-customize courseware pages. Extension to the distributed tutoring environment is also in the scope of the new design.

3.1 Courseware objects

As mentioned in the previous section, it is very important to minimize the dependencies and references between the system modules to achieve a high flexibility. Concept of the courseware object is introduced for this purpose. Main classes of the courseware object are shown in Figure 1:

- Tree-structured material objects. Objects of this class forms the usual tree structure of the text such as chapter, section, subsection, ..., and text page. These objects have their own method invoking the tutoring strategy, and the pointers to their upper and lower level objects. The page object, the leaf level object of the tree, in addition has the pointer to the corresponding physical courseware page represented as the URL, the method returning the available ITS command, the methods corresponding to these commands, and the method controlling the GUI.
- Learning target objects. This class is introduced to implement the learning target based ITS. Target objects are associated to the material objects. State of the target object reflects the learner's state concerning the learning target, which is referred and updated by the associated material objects.

Tree structure is employed with several reasons:

1. Each subtree of the courseware can have its own tutoring strategy. This means that courseware

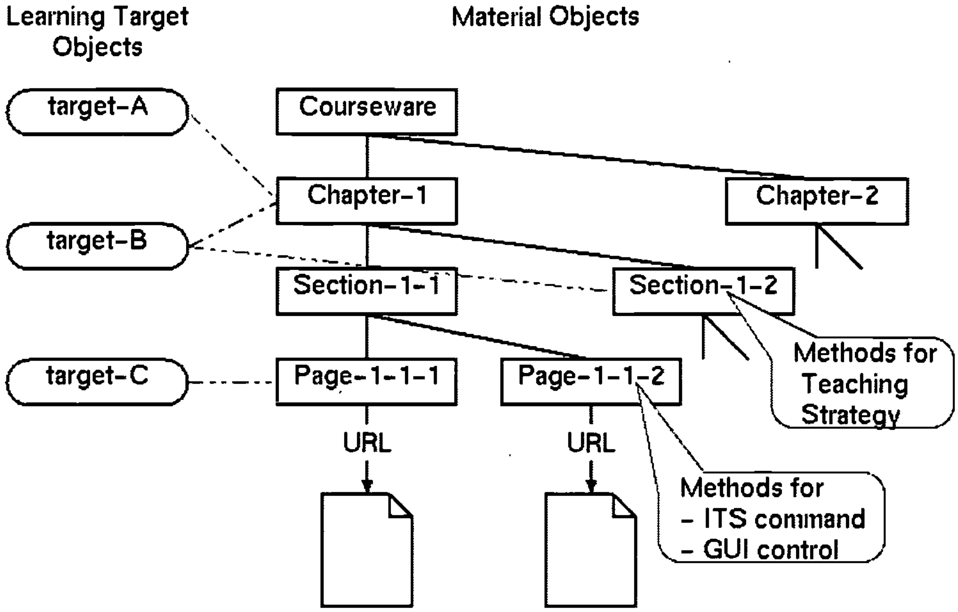

Figure1: Courseware Objects

chapters or sections with various tutoring strategies can be combined to compose a courseware. For example, it is possible to built the courseware such as: the first chapter has no ITS strategy, the second chapter has the overlay strategy,and one section in the second chapter has the exercise based on buggy model. It is rather easy to improve or specialize a tutoring strategy to be suitable for a certain chapter without affecting the strategies of the other chapters in a courseware.

2. It is natural to build a large tree-structured courseware from the chunks of courseware subtrees each associated with its own leaning targets. This is well-suited for the reuse of the tutoring resource.

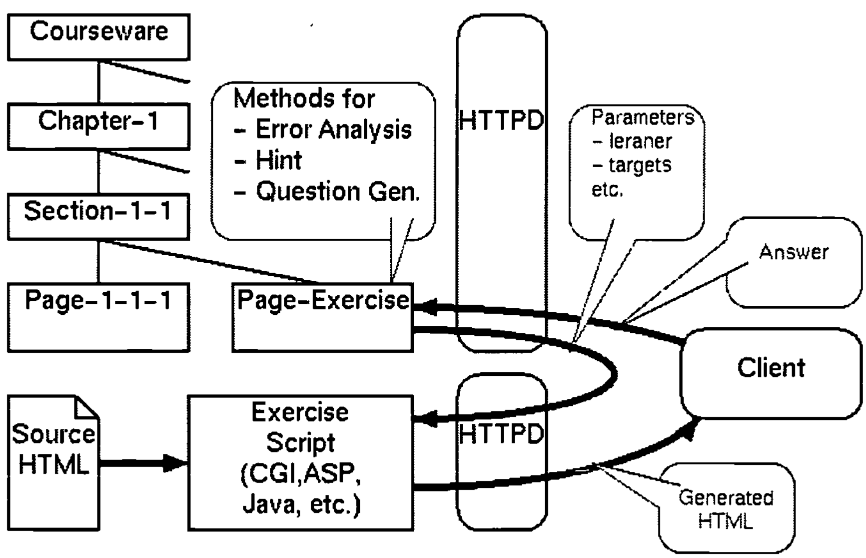

Figure 2: Exercise object and exercise script

3. From the practical point of view, tree-structured courseware material is valuable even without ITS functionality. There already exist a lot of tree structured courseware material which can be a starting point of ITS courseware.

3.2 Exercise object and exercise script

Among the tree-structured material objects, exercise object has several special characteristics because of its interactive function between learner. In addition to the method and data of the usual page object, it has the method for question initialization, error analysis, hint generation, and so on. There is also a method to judge if the learner mastered the learning target associated to the exercise. The behavior of the exercise page can be thus customized by modifying these methods. Similar to the usual page object, the exercise object has the URL entry pointing to the physical WWW page. This URL can not only point to a usual multimedia page but invoke a server-side script such as CGI, ASP, or Java Servlet which can dynamically generate the physical exercise page. This server-side script is called "exercise script" (Figure 2). The exercise object passes the exercise script parameters such as learner name, courseware name, learning targets, etc. The physical exercise page generated by the exercise script send to the exercise object the information reflecting the learners response for the presented questions. The exercise object analyzes the learners response and determines if the exercise script should be invoked again or the control should be returned to the upper level material objects. This structure has significant advantage compared with the usual dynamic HTML page generation/modification employed in the other WWW-based CAI systems. The other system has a HTML page with special syntax extension[6, 11] or the HTML template with special keyword embedded[10]. These syntax or keywords are interpreted by the system to generate the actual exercise page sent to the client. This schema has several drawbacks:

- Lack of reusability. The HTML page with these special syntax or keyword has no interoperability with other system.
- Lack of extendibility. It is very hard to enhance the capability of dynamic page generation without introducing very powerful language processing module into the CAI system.

In contrast to these drawbacks, the proposed exercise script scheme does not need special HTML syntax but utilizes commonly used server-side scripting system. It means that the script itself can be reused from any tutoring system as long as the invoking URL is identical. Moreover, these server-side script is based on the complete programming language like Java Script, Visual Basic, or Java, making it

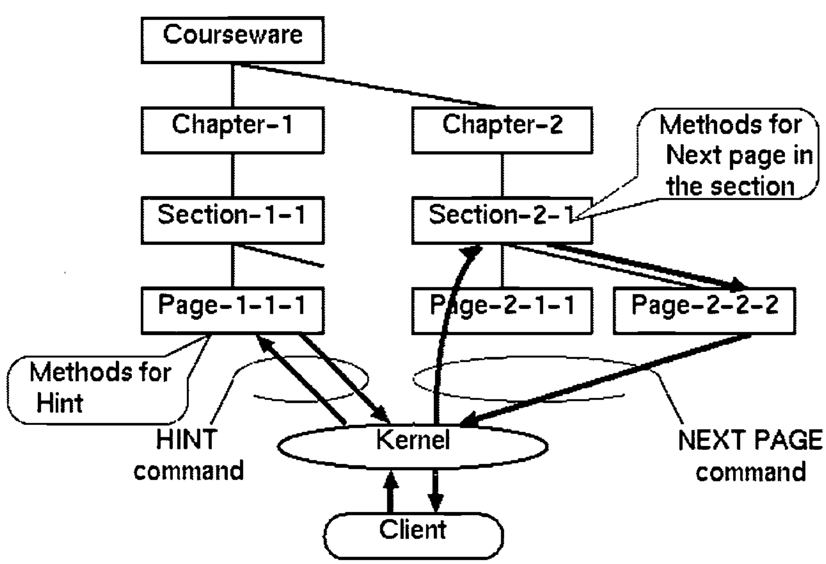

Figure 3: Message passing between objects

possible to perform virtually any type of processing for exercise page generation. It is also possible to generate HTML page including client-side script, Java applet, or interactive multimedia plug-ins. Of course the courseware authors can choose favorable script language for them.

3.3 Event driven kernel and message passing between objects

Runtime control of the tree-structured material objects are taken care of by the small event-driven kernel(Figure 3). This kernel receives the event from the learner such as "press NEXT button" and send it as the command to the "current page" object which corresponds to the physical page presented to the learner at that time.

The current page object receiving the learner's command tries to process it. For example, when "HINT" command is sent to the exercise object, the object presents the appropriate hint by itself since it "knows" the hints related to its questions.

On the other hand, when "NEXT PAGE" command is received, the current page object passes it to the upper level material object such as section object since the page object does not know how to deal with the command. This is because it is the responsibility of the section object to invoke the tutoring strategy which selects most suitable next page object among the section pages by taking into account of the student model. The selected page object will be the next "current page" object. If the section object has no page to be selected, it again passes the "NEXT PAGE" command to its upper level section object, and so on.

This bottom-up control scheme, in which the object of each level processes the command it can deal with or otherwise it passes the command to the upper level, simplifies the dependencies between material objects maximizing the modularity of the design.

4. Courseware Example

Simple courseware example[4] has been developed exploiting the features of the proposed architecture. The courseware deals with the fax equipment which also functions as normal telephone and photo copy machine. The courseware consists of a section object, explanation page objects and exercise objects under the section object, and learning target objects corresponding to the operational steps for the fax,

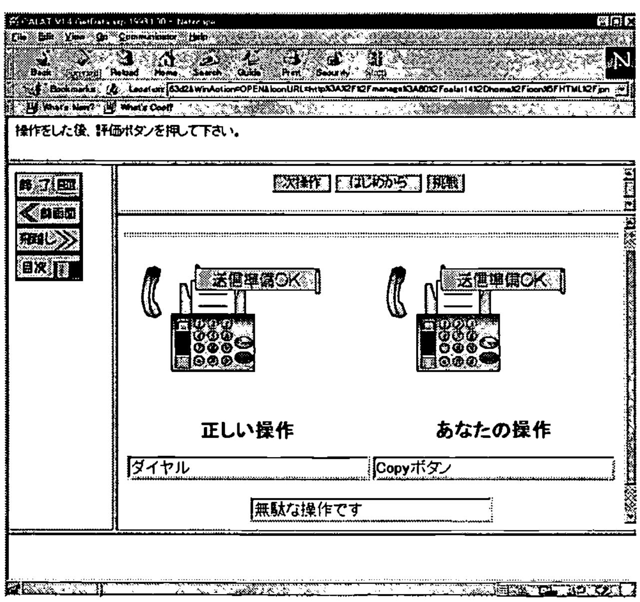

Figure 4: Courseware Example

telephone and photo copy mode(Figure 4). The exercise page objects are associated with the exercise script which invokes the interactive simulation of the fax equipment. The simulation program itself is implemented with Java script and Macromedia Flush running on the client. The target function mode to be learned is selected by the parameter passed from the exercise page object to the simulation program via the exercise script. The simulation program stores the learners operation steps, compares the steps with the correct operation, and returns the result to the exercise object. The exercise object judges if the learner masters the learning target corresponding to each operation step, and pass control to its upper level section object. Then the section object invokes the tutoring strategy to determine the next page presented to the learner taking into account of the status of the learning target.

This courseware example demonstrates the flexibility of the exercise object and exercise script which makes it possible to take advantage of the server-side script and the multimedia plug-in. The example also indicates that the tree-structured material objects increases the modularity so that each object having active method can be modified independently to some extent.

5. Conclusion

An object-oriented design and implementation of a Web-based CAI system has been described. Tree-structured material objects have been introduced to allow teaching strategy customization whose affect is localized to the relevant module. The exercise script is proposed to to exploit WWW-based software technologies such as JAVA, ASP, or various plug-ins. Sample courseware has been implemented to demonstrates the effectiveness of the proposed architecture. The sample courseware in this demonstration is too small to completely justify the proposed design. Further trial is required to develop more larger courseware consisting of various tutoring strategy to evaluate the effectiveness and limitation of the proposed architecture.

It seems that the proposed architecture could be naturally extended to the distributed courseware object framework. Exercise script could be regarded as a primitive distributed tutoring resource which is possible to be reused from several coursewares. The bottom-up control scheme, minimizing the interaction between the objects, could be adopted in the distributed environment. Further investigation towards this direction could lead the distributed tutoring resource environment.

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Compressed Video Classrooms: A Survey Of Student Attitudes And Instructor Concerns

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Abstract: This study evaluated student attitudes on Compressed Video Instruction (CVI). Of particular interest were questions related to instructor concerns, student attitudes, and course improvement. One hundred and nine students responded to the survey and indicated that CVI does not necessarily improve instruction, but that convenience in travel time is a strong factor in their positive evaluation of CVI. Recommendations include the use of cooperative groups, a mix of lecture and discussion, and the use of "portfolio assessment" as part of the course grade. Implications of this study include (1) survey results on several items, (2) a review of student and faculty attitudes and concerns in establishing a CVI facility, (3) data for schools making decisions to use CVI, and (4) a contribution to a growing body of research on the use of emerging technology in classrooms.

1. Introduction

The purpose of this study was to examine the reactions and adaptability of faculty and students to a new teaching format, Compressed Video Instruction (CVI). CVI transmits in real-time, lectures and interactive discussions to several locations simultaneously where students can respond to questions by pressing buttons which activate video cameras that enable all sites to see and hear the response on site-located TV screens.

2. Equipment

Jacksonville State University (JSU) first implemented CVI in its Distance Learning program for the 1997 Spring semester by offering four graduate courses on a Compressed Video Network that served four different locations, Guntersville, Gadsden, and Oxford, as well as the Jacksonville State University (JSU) campus site.

The CVI equipment is as follows: ITU-T standards supported: H.221, H.230, H.242, H.261, H.281, H.320, G.711, G.722, G.728, and HDLC - based proprietary. The *characteristics of the system* includes VTEL, Teleconferencing System (January, 1997), PC based, document stand, three monitors, three cameras, wireless, lavaliere and push-to-talk microphones, Internet access, thirty frames-per-second, node on LAN/WAN, University supported T1 connections to all remote sites (BellSouth provider), and multipoint control unit (4 - 20 ports), to operate sites at 512 Kbps.

The *system capabilities* include audio and video conferencing, data sharing, slide sharing, document sharing, multimedia at all sites, CD-ROM, VCR, Laserdisk player, real, opaque, and transparent materials (Elmo), and computer generated or stored images (PowerPoint). The Compressed Video options included: BRI ISDN BRI = 64 kb per channel, two 64 kb channels = 128 kb, three BRI's = 384 kb, PRI ISDN 23 (64 kb) channels + data channel (64 kb) = 1.544 Mb which may be used to provide 128 Kb to 1.544 Mb T1, 1.544 Mb, unused bandwidth which can be utilized for the Internet.

In sum, each off-campus site has two large video/TV units: one to see the instructor (or overheads, PowerPoint presentations, videos, campus site students (etc.) –controlled by the instructor), and the other to see other sites. The on-campus site has three large video/TV units, two in front for the students to see the instructor and other sites, and one in back for the instructor to see the other sites so all students would view the instructor facing forward.

3. Method

3.1 Participants

Of the 119 graduate students enrolled in the Spring courses, 109 responded to the questionnaire. Gender representation was 34% male and 66% female. Ethnic representation was 14% Afro-American, 2% American Indian, 82% Caucasian, 2% "other." Most participants were at distant sites (89%).

3.2 Measures and Procedures

To evaluate the attitudes and effectiveness of CVI, a 42 item questionnaire was developed (see Table 1). A wide variety of questions were used to explore several aspects of CVI, e.g., preferences for instruction as well as the CVI experience. For all participants, this was their first exposure to CVI.

4. Results and Discussion

4.1 Instructor concerns

Since the instructor is unable to physically be present at the sites, there is concern that inappropriate talking may occur. For the question, "The noise level at my location was _____ distracting.", 64% indicated that it was "not distracting," 23% responded "mildly distracting," and 0% responded that it was "very distracting." This was surprising because occasionally a student would indicate that there was some off task talking during instruction.

As to the students' ability to "stay on task," 92% responded that they "usually" and "always" were able to stay on task. As to the question of exams, most respondents didn't know if there would be cheating (44%), however, various examination attempts have not been successful, resulting in the student's coming on campus for a more closely monitored testing environment.

Another instructor concern was the teacher "spontaneity" with student interactions. Because of the slight delay time and reticence of most students to be on TV, some felt the spontaneity was diminished (26%), some thought it was enhanced (16%), but most thought it was about the same (58%).

4.2 Student Attitudes

The results indicated neither overwhelming praise nor condemnation of the new CVI format. On one question, for example, 13% of the students thought the quality of instruction was "better," 11% thought the quality of instruction "worse," but the majority of students, 76%, perceived the quality of instruction as "about the same.". With most students indicating a preference for discussion oriented classes (70%) over lecture oriented classes (30%), little negative effect was indicated over instructor concerns on pacing, instructor contact, effect on student participation (etc.). One of the selling points, convenience of travel and location, was validated with 76% indicating it as a major benefit for using the CVI format. The "bottom-line" question for the students was, "Will you take a future course by compressed video?" An overwhelming 85% indicated that they would take another CVI course, and 50% gave a high rating to CVI.

4.3 Course Improvements

It appears that at least half of the students (52%) would have wanted the instructor to rotate between sites for more personal contact. They also preferred a lecture and discussion format (74%), and felt that CVI is best suited for both a lecture and discussion format (65%). They also prefer a cooperative classroom climate (51%) over a competitive climate (2%), but with a close second preference for a mixed cooperative/competitive climate (47%).

4.4 Conclusion

The results of the survey suggest that although CVI does not necessarily improve instruction, the convenience of having various site locations is highly valued by the students. The data, as well as communication with instructors, also recommends using cooperative group-work projects during class time to foster student interactions. As student involvement increases and affiliation needs are met through the group work, a good mix of lecture and discussion is achieved. The work-sheet projects also provide material for "portfolio assessment" used in grading. For some students who require more monitoring in off-site centers, the use of an "end of class quiz" helps with on-task motivation as well as ensuring full class time attendance. (See Table 1 below for further response information.)

4.5 Survey and Results

Table 1: Anonymous Compressed Video Course Survey (N = 109)

Please respond to the following questions by either *circling* your preferred answer **or** *marking* it on a *ScanTron* sheet (if provided).

1. The compressed video equipment (microphone, audio, image, document camera, etc.) was
a. reliable *most* of the time. **90%** b. reliable *some* of the time. **10%** c. unreliable **0%**

2. Do you prefer that the instructor rotate between sites during the semester, allowing for more personal contact?
a. yes, definitely **52%** b. undecided **12%** c. no, its not necessary **36%**

3. Did you contact your instructor during the semester through the use of
a. telephone **36%** b. e-mail **2%** c. neither because I didn't need to contact the instructor. **62%**

4. The site manager was friendly & cooperative.
a. Yes **100%** b. No **0%**

5. The site manager was knowledgeable and well trained.
a. Yes **100%** b. No **0%**

6. The noise level (students visiting, etc.) at my location was ...
a. very distracting **0%** b. mildly distracting **23%**
c. not distracting **64%** d. N/A (instructor's site) **10%**

7. In class I was _____ able to stay on task ...
a. always **42%** b. usually **50%** c. moderately **8%** d. rarely **0%**

8. In my opinion, the compressed video format is best suited for
a. lectures **32%** b. discussions **4%** c. both lecture and discussion **65%**

9. Will you take a future course by compressed video?
a. Yes **68%** b. No **0%** c. Maybe **16%** d. Yes, but only if no other option is available **17%**

The compressed video format is _____ than the format of "regular" classes on ...

10. a. better **15%**	b. about the same **70%**	c. worse **15%**	... organization of the class.
11. a. better **12%**	b. about the same **48%**	c. worse **40%**	... student/instructor interaction.
12. a. better **13%**	b. about the same **76%**	c. worse **11%**	... quality of instruction.
13. a. better **76%**	b. about the same **20%**	c. worse **05%**	... convenience.
14. a. better **16%**	b. about the same **59%**	c. worse **25%**	... sharing of documents.
15. a. better **19%**	b. about the same **72%**	c. worse **09%**	... pacing of class.
16. a. better **36%**	b. about the same **54%**	c. worse **11%**	... use of a variety of media.

17. I prefer classes that are more oriented towards ...

a. student centered/group work **17%**
b. mixed student/teacher & group work/lectures **56%**
c. teacher centered/lectures **27%**

18. I prefer classes that are more ...
a. discussion oriented **70%** b. lecture oriented **30%**

19. I prefer classes that are based more on _____ learning styles.
a. cooperative **51%** b. mixed cooperative/competitive **47%** c. competitive **2%**

Compressed Video classes ...
20. have a _____ effect on *instructor contact with students during class.*
a. positive **25%** b. neutral (neither positive or negative) **47%** c negative **28%**

21. have a _____ effect on *organization of materials during class*
a. positive **30%** b. neutral (neither positive or negative) **53%** c negative **17%**

22. have a _____ effect on *student response or participation*
a. positive **29%** b. neutral (neither positive or negative) **48%** c negative **24%**

23. Overall, I would rate the compressed video format as an instructional medium
a. high **50%** b. medium **42%** c. low **9%**

I am taking this telecourse because ...

24. it fits best with my work schedule.	a. Yes	**85%**	b. No	**15%**
25. it fits best with my family responsibilities.	a. Yes	**78%**	b. No	**22%**
26. it helps with current transportation limitations.	a. Yes	**82%**	b. No	**18%**
27. it was not offered at any other time this semester.	a. Yes	**43%**	b. No	**57%**

I found out about the JSU telecourse through a

28. friend.	a. Yes	**22%**	b. No	**78%**
29. parent or relative.	a. Yes	**03%**	b. No	**97%**
30. JSU faculty/staff.	a. Yes	**63%**	b. No	**37%**
31. brochure, schedule, pamphlet.	a. Yes	**43%**	b. No	**57%**
32. newspaper ad, or article.	a. Yes	**03%**	b. No	**97%**
33. radio, or TV announce.	a. Yes	**01%**	b. No	**99%**

34. Within the compressed video format, I *prefer* to be at
a. the instructor's site. **30%** b. a distant site. **14%** c. either site (doesn't matter). **56%**

35. I think *graduate* teaching is best served with a _______________ format.
a. lecture **17%** b. discussion **9%** c. both lecture and discussion **74%**

36. Exams in a distant site would probably be more susceptible to cheating.
a. yes **20%** b. no **36%** c. I don't know. **44%**

37. With the compressed video format, my "learning" (concept acquisition, _not grade_) was
a. higher **11%** b. about the same **79%** c. lower **9%**
38. With the compressed video format, teacher "spontaneity" with student interactions was ...
a. enhanced **16%** b. about the same **58%** c. diminished **26%**

39. I was at ... a. the instructor's site **11%** b. a distant site **89%**

40. I am a ... a. male **34%** b. female **66%**

41. My ethnic origin is ,,,

a. Afro-American **14%** b. American Indian **2%** c. Caucasian **82%**
d. Hispanic **0%** e. Other **2%**

42. My age is ...

a. 20-30 **21%** b. 31-40 **36%** c. 41-50 **34%**
d. 51-60 **8%** e. 61-70 **0%**

(Please write any comments on a separate sheet of paper.)

A Multi-Discipline, Multi-Genre Digital Library for Research and Education

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Abstract: We describe NCSTRL+, a unified, canonical digital library for educational and scientific and technical information (STI). NCSTRL+ is based on the Networked Computer Science Technical Report Library (NCSTRL), a World Wide Web (WWW) accessible digital library (DL) that provides access to over 100 university departments and laboratories. NCSTRL+ implements two new technologies: cluster functionality and publishing "buckets". We have extended the Dienst protocol, the protocol underlying NCSTRL, to provide the ability to "cluster" independent collections into a logically centralized digital library based upon subject category classification, type of organization, and genres of material. The concept of "buckets" provides a mechanism for publishing and managing logically linked entities with multiple data formats. The NCSTRL+ prototype DL contains the holdings of NCSTRL and the NASA Technical Report Server (NTRS). The prototype demonstrates the feasibility of publishing into a multi-cluster DL, searching across clusters, and storing and presenting buckets of information.

1. Introduction

Digital libraries (DLs) are an important research topic in many educational and scientific communities and have already become integral part of education at all levels. We have learned of many instances where undergraduate and graduate engineering courses are now supplemented with NASA research results that were previously difficult to obtain. DLs have allowed resource limited colleges and universities access to a wealth of research in a variety of disciplines. However access to these DLs is not as easy users would like. Digital library projects are partitioned by both the discipline they serve (computer science, aeronautics, physics, etc.) and by the format of their holdings (technical reports, video, software, etc.). A recent survey found over 10 existing or recent different World Wide Web (WWW) oriented digital library projects spanning over 5 different disciplines [Esler & Nelson 1998]. In short, each educational and scientific community is hand crafting their own digital library infrastructure.

There are two significant problems with current digital libraries. First, interdisciplinary research and education are difficult because the collective knowledge of each discipline is stored in incompatible DLs that are known only to the specialists in the subject. The second significant problem is that although technical information as well as educational materials created consists of manuscripts, software, datasets, etc., the manuscript receives the majority of attention, and the other components are often discarded [Sobieszczanski -Sobieski 1994].

Old Dominion University and NASA Langley Research Center have established NCSTRL+ to address both of these problems. NCSTRL+ is based on the Networked Computer Science Technical Report Library (NCSTRL) [Davis et al. 1995], which is a highly successful digital library offering access to over 100 university departments and laboratory since 1994, and is implemented using the Dienst protocol [Lagoze et al. 1995]. At the development stage, NCSTRL+ will initially include selected holdings from the NASA Technical Report Server (NTRS) [Nelson et al. 1995] and NCSTRL, providing *clusters* of collections along the dimension of disciplines such as aeronautics, space science, mathematics, computer science, and physics, as well as clusters along the dimension of publishing organization and genre, such as project reports, journal articles, theses, etc. NCSTRL+ holdings will be published in *buckets* [Nelson et al. 1997], an object-oriented construct for creating and managing collections of logically related information units as a single object. A bucket can contain both different data syntax (PostScript, PDF, Word, etc.) and different data semantics (manuscripts, data files, images, software, etc.)

2. Background

NCSTRL+ has a long lineage. In 1992, the ARPA-funded CS-TR project began [Kahn 1995] as did the Langley Technical Report Server (LTRS) [Nelson et al. 1994]. In 1993, the Wide Area Technical Report Server (WATERS) [Maly et al. 1994] shared a code base with LTRS. In 1994, LTRS launched the NTRS, and the CS-TR and WATERS projects formed the basis for the current NCSTRL. In 1997, NTRS and NCSTRL formed the basis for NCSTRL+. We chose to implement NCSTRL+ using Dienst instead of other digital library protocols such as TRSkit [Nelson & Esler, 1997] because of Dienst's success in several years of production in NCSTRL. Dienst appears to be the most scalable, flexible, and extensible of digital library systems we surveyed [Esler & Nelson 1998]. Dienst also serves as the basis for other digital library projects, including: the Electronic Thesis and Dissertation Project [Fox et al. 1996], the University of Virginia undergraduate engineering thesis project [UVa SEAS 1997] and the ACM SIGIR conference proceedings project (which requires ACM authentication) [ACM 1997].

Our buckets are similar in concept to the "digital objects" first proposed in [Kahn & Wilensky 1995]. It is important to note that many services have had "proto-buckets" in operation for some time. However, they provide only different formats of a single manuscript, or may support the concept of separate pages within a manuscript. They do not support an interface to a collection of related objects such as the manuscript, software, datasets, etc. We chose the term "buckets" because related terms such as "objects", "packages" and "containers" are greatly overloaded in the computer science realm and because "buckets" provide a clear visual metaphor for the concept when speaking with non-computer scientists.

3. Clusters of Dienst Servers

Clusters are a way of aggregating logically grouped sub-collections in a DL along some criteria. NCSTRL+ provides 3 clusters: organization, data genre, and subject category (see [Fig. 3] for an example). *Genre* is a term provided by E. Fox in a private communication and refers to distinguishing between journal articles, technical reports, theses and dissertations, etc. For the purposes of this paper, we illustrate the concept of clusters by discussing the subject category cluster. Other clusters are implemented similarly.

Dienst currently carries no concept of subject category in its protocol, despite having provisions for specifying keywords from the title, authors, and abstract. In fact, digital libraries using the Dienst protocol such as NCSTRL have the implicit assumption that all holdings are computer science related. We propose to modify Dienst by providing *cluster* arguments to existing message verbs. We have used a set of message verb modifications to demonstrate the concept of subject category based server cluster functionality. The new clustering service will solve the general case of the problem, where our Dienst modifications will support the specific clustering around subject categories in the early stages of the NCSTRL+ prototype. The purpose of our cluster prototype is to perform experiments with an initial set of clusters and determine user response. NCSTRL+ reads its known subject categories from a preference file thus the list of subjects can be easily replaced or augmented.

4. Buckets

Buckets are a construct for creating publishing and archival entities for digital libraries. A bucket corresponds to a single logical collection of information. Buckets are designed to be highly customizable and unique. Bucket architecture is illustrated in [Fig. 1]. Large archives could have buckets with many different functionalities. Not all bucket types or applications are known at this time. However, we can describe a generalized bucket as containing many formats of the same data item (PS, Word, Framemaker, etc.) but more importantly, it can also contain collections of related non-traditional STI materials (manuscripts, software, datasets, etc.) Thus, buckets allow the digital library to address the long standing problem of ignoring software and other supportive material in favor of archiving only the manuscript [Sobieszczanski -Sobieski 1994] by providing a common mechanism to keep related STI products together. A single bucket can have multiple *packages*. Packages can correspond to the semantics of the information (manuscript, software, etc.), or can be more abstract entities such as the metadata for the entire bucket, bucket terms and conditions, pointers to other buckets or packages, etc. A single package can have several *elements*, which are typically different file formats of the same information, such as the manuscript package having both PostScript and PDF elements.

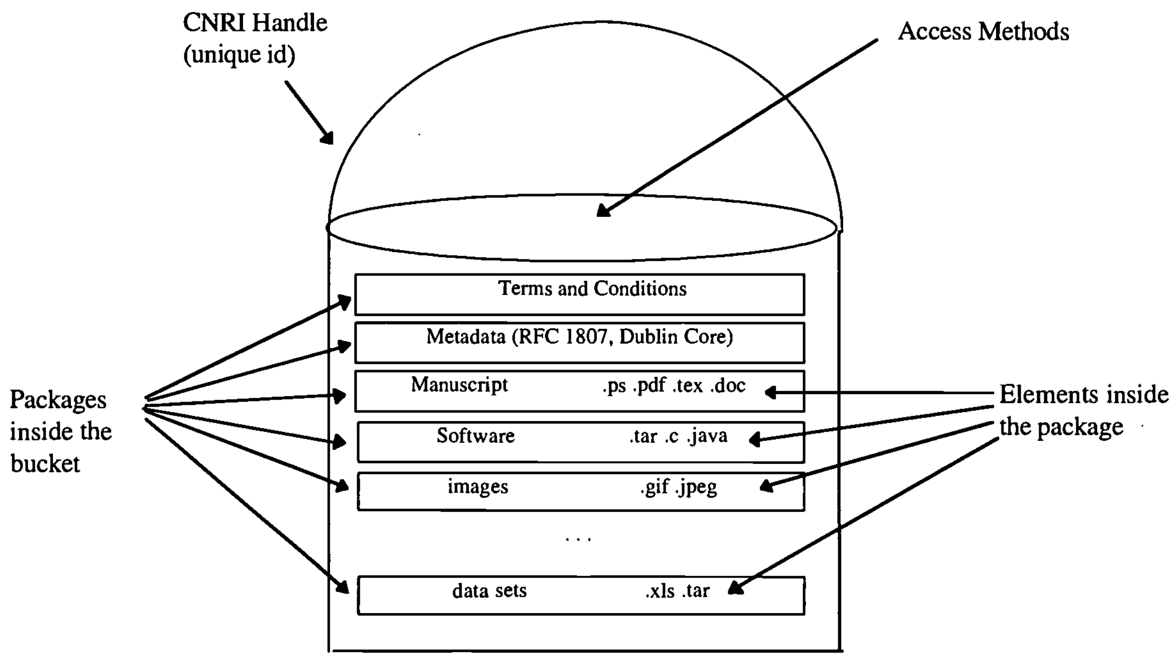

Figure 1: Bucket Architecture

4.1 Bucket Requirements

Buckets are intended to be either standalone objects or to be placed in digital libraries. They have unique ids (CNRI handles) associated with them. Buckets are intended to be useful even in repositories that are not knowledgeable about buckets in general, or possibly just not about the specific form of buckets. Buckets should not lose functionality when removed from their repository. The envisioned scenario is that NCSTRL+ will eventually have moderate numbers of (10s - 100s of thousands) of intelligent, custom buckets instead of large numbers (millions) of homogenous buckets. With buckets, the repository intelligence and functionality can be split between the repository and individual buckets. This could be most useful when individual buckets require custom terms and conditions for access (security, payment, etc.). A bucket gains some repository intelligence as it is extracted from the archive en route to becoming a standalone bucket. A full discussion of bucket functionality can be found in [Nelson et al 1997].

4.2 Bucket Tools

There are two main tools for bucket use. One is the *author tool* [Fig. 2], which allows the author to construct a bucket with no programming knowledge. Here, the author specifies the metadata for the entire bucket, adds packages to bucket, adds elements to the packages, provides metadata for the packages, and selects applicable clusters (which lead to the cluster options available as shown in [Fig. 3]. The author tool gathers the various packages into a single component and parses the packages based on rules defined at the author's site. Many of the options of the author tool will be set locally via the second bucket tool, the *management tool*. The management tool provides an interface to allow site managers to configure the default settings for all authors at that site. The management tool also provides an interface to query and update buckets at a given repository. Additional methods can be added to buckets residing in a repository by invoking the `add_method` on them and transmitting the new code. From this interface, the manager can halt the archive and perform operations on it, including updating or adding packages to individual buckets, updating or adding methods to groups of buckets, and performing other archival management functions.

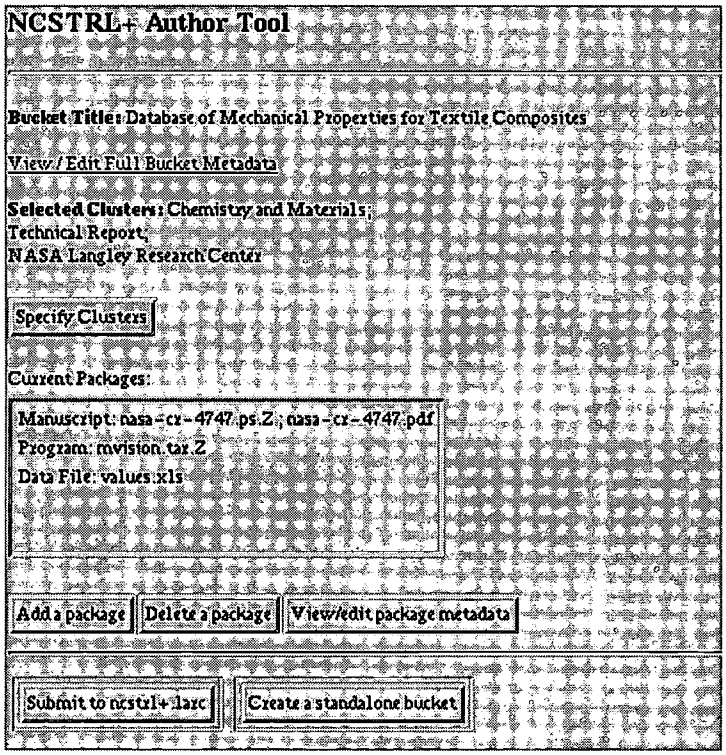

Figure 2: Author Tool

5. Using NCSTRL+

5.1 Searching NCSTRL+

NCSTRL+ searching is similar to searching NCSTRL, with the addition of specifying desired clusters to search. How the advanced fielded search form of NCSTRL+ is modified, allowing the selection of desired subject categories and data genres, is shown in [Fig. 3]. A search results page includes the keyword and cluster hit results. The user will select the desired bucket from this page. At that point, the bucket will return the defined default initial interface of the bucket, which will be dependent on the bucket contents and the rules present. In practice, the bucket presentation will look largely similar to the choices available to current users of NCSTRL. This is especially true if the buckets in which they are interested only contain various manuscript formats. However, the real benefit is the richer presentation formats available if the bucket has non-manuscript packages. The bucket interface is similar to NCSTRL, with the exception that the additional data semantics are presented (software, datasets, etc.).

5.2 Publishing into NCSTRL+

The goal of NCSTRL+ is to produce the least intrusive interface possible to the author. The authoring process for NCSTRL+ is to be as similar to authoring into NCSTRL as possible. Additions include the ability to add to a bucket multiple data semantics and formats through using multiple selection boxes to select local files. Publishing a manuscript in NCSTRL is equivalent to publishing a package in NCSTRL+, and publishing a bucket is the sum of publishing all of its packages. The author also has to choose the appropriate cluster to place the new bucket in. This step can be skipped if the site manager has defined a default, or if authors have saved a value already in their preferences.

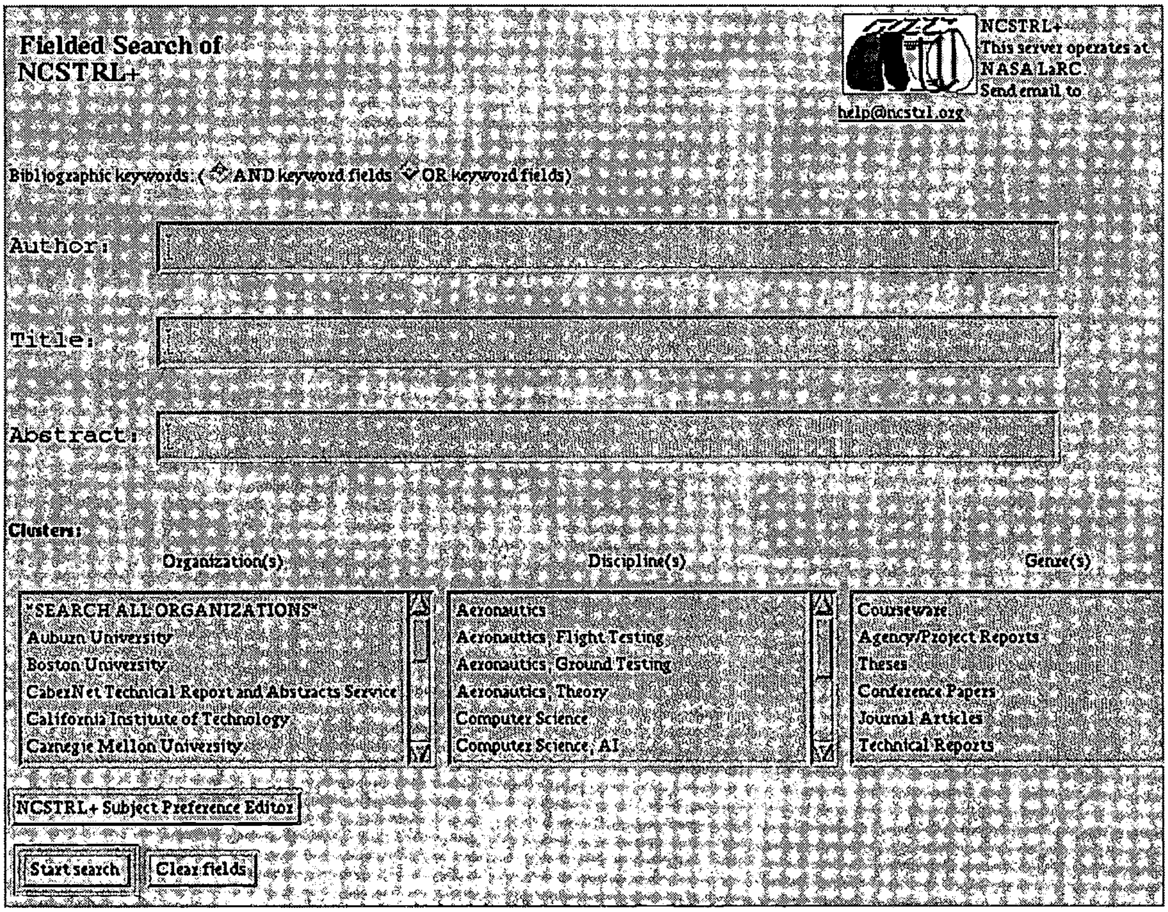

Figure 3: The Fielded Search Screen of NCSTRL+

6. Status and Future Work

We are using the author tool to populate NCSTRL+ to gain insight on how to improve its operation. We are starting with buckets authored at Old Dominion University and NASA Langley Research Center and are choosing the initial entries to be "full" buckets, with special emphasis on buckets relating to NSF projects for ODU and for windtunnel and other experimental data for NASA. Until NCSTRL+ becomes a full production system, we are primarily seeking rich functionality buckets that contain diverse sets of packages.

It is also important to note that adding a subject category mechanism to NCSTRL+ provides the necessary groundwork for additional services for digital libraries using Dienst. These could include subject-based browsing of NCSTRL+ holdings, as well as selected dissemination of information (SDI). This would be most useful if users were offered a subscription option to receive digested updates (i.e., e-mail messages) of new additions to NCSTRL+ in specified subject areas. The initial defined subject categories for NCSTRL+ and cross-listing them with other subject-specific categorization schemes is intended to provide a working framework for evaluating the prototype. As more experience in NCSTRL+'s use is gained, the fine tuning of the subject categories and appropriate cross listing becomes an area that would benefit from the attention of a professional cataloger.

7. Conclusions

To meet the increased requirements for multidisciplinary activities in educational and scientific communities, we have prototypes of NCSTRL+ and are in the process of full implementation. The most significant technology from this project is the concept of buckets as a construct to capture multiple data formats and genres in an intuitive manner. NCSTRL+ provides a platform for experimentation for testing user response to multidiscipline clusters and logical collections of STI. We are in the process of experimenting with users at NASA and Old Dominion University. From the users' perspective, the publishing and searching interfaces are largely unchanged. However, it is unknown what impact the cluster and bucket modifications have on network load, search and retrieval times, the users' perceived quality of searching multiple clusters, etc. To determine these unknowns, NCSTRL+ will have to grow to a large enough size to be considered a useful production system. The authors seek other users and participants for NCSTRL+.

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Setting Requirements for Learning Software

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Abstract: Strictly defined system requirements are a necessary precondition for system modelling as well as for the application of various specification methods during the development of learning software. This paper focuses on the procedure of setting these requirements. The fact that the development of learning software is particularly interdisciplinary process makes the strict definition of system requirements extremely difficult. The method of requirement classification described in this paper takes into account the most important groups of system requirements and presents a simple way for their adjustment for concrete learning systems. The use of this method not only forms a sound basis for a formal system specification but also prevents the requirements from involuntary transformations during the development. This guarantees that the desired results will be achieved at the end of the development process.

1. Introduction

The development of learning software is a particularly interdisciplinary process. A learning system for anorganic chemistry, for example, does not only require knowledge of the domain chemistry. Its didactic concepts are determined by experts in the field of pedagogics and cognitive psychology, subsequently modelled upon abstract mathematical theories and finally implemented by computer scientists and programmers. So, the development of such systems is influenced by a number of domains or fields of science, which sometimes have very little in common. This situation is typical not only for learning systems, but for interactive systems (of which learning systems form a subclass) in general [Monk & Gilbert 1995].

The interdisciplinarity of learning systems is one of the main reasons for the high development costs of this kind of software. The problems for the developer begin already with the very first step of development: the analysis of requirements. It is extremely difficult to select and assess the relevant requirements from the stream of wishes, needs, and system goals presented by the different persons involved in the development process. It is even more difficult to become aware of all interconnections and dependencies that exist between all requirements. However, the appropiate assessment and selection of the system requirements form the basis for all further steps of the development of the learning system. Hence, a mistake during this phase has severe consequences. Such mistakes are a main reason for the high number of development iterations (i.e. developing-testing-redeveloping cycles) needed for the production of learning software (see also [Roast 1994]).

The importance of a more strict procedure for setting requirements is recognised by [Duke & Harisson 1995] in the context of interactive systems in general. Because learning systems can be viewed as a subclass of interactive systems [Nemirovski & Schlageter, 1997], it is possible to apply this statement to a more strictly defined domain.

A classification of all the typical requirements for learning software would help developers in the same way as a fill-in form helps a user to formulate a query to a database system. And not only this. If such a classification is given in a specific form, it is possible to formalize the system requirements using a formal notation such as VDM or Z. This allows to make the modelling process, the further refinement, and the implementation of the learning system more precise [Harrison & Duke 1995], [Took, 1995] and thus reduce the number of mistakes and development iterations. In this paper we will present a classification that distinguishes between three types of requirements for learning Software. This division is substantiated partly by the importance of the requirements and partly by the sequence of their setting.

2. The domain: What is Learning Software?

The purpose of learning software is to support the learner in acquiring knowledge. However, this can be done in many different ways, resulting in different types of learning software. According to [Barnard & Sandberg 1995] learning software can be classified with respect to the aspects of the socio-cultural niche of the learner that is taken into consideration by the software. By the learner's socio-cultural niche they understand not only the

learning material but also the teacher (human or artificial), the learner model (on-line or off-line), the fellow learners with whom the learner can communicate, the learning tools that faciliate the learning process, and external information sources.
Baumgartner and Payr [Baumgartner & Payr 1994] use a sophisticated cube-model to classify learning software. The three axes of the cube represent the learning goals, the learning strategies, and the learning level. The learning goals determine what kind of knowledge the learner is supposed to acquire (context-free rules, context dependent rules, assessing complex situations, problem solving, pattern recognition.) The learning strategies describe whether the learner is taught, tutored or coached by the learning software. Finally, the level of learning depicts the capabilities that are needed in order to use the software (e.g. recalling facts, applying rules, making decisions, discovering connections, developing strategies.)
The classifications of learning software described above are typical examples of this domain. There exist other classifications in literature that vary with respect to the extension of the term 'learning software' and the number and type of suggested subclasses. Furthermore, it can be necessary to adapt such a classification to the needs of a particular learning domain. This situation makes it very difficult to formulate general statements about learning software. In spite of this fact the classification of system requirements defined in the next section of this paper attempts to be more or less universally applicable. In order to be able to make a general assertion it is necessary to describe the fundamental requirements for learning software on a relatively high level of abstraction. For the development of a specific learning software these general requirements have to be given a particular interpretation that reflects the specific circumstances.

3. Classification of Requirements for Learning Software

There are many different principles that can be used for the classification of requirements for learning software. The role that the requirements have in the development process depends on the point of view from which this software is regarded. For the educationist the choice of learning methods used in the learning system is the most important criterion; for the system analyser it is the technology the system is based on; for the sociologists it may be the definition of the user group that is supposed to use the software, etc.
The classification of requirements for any kind of software must correspond to the aim of the software. In the case of learning software the aim is to provide a highly efficient way of learning and at the same time keep the development costs low. For the classification of requirements presented in this paper we assume that the ability to correctly reflect the learning domain and present it to the user with minimal distortion is the main goal of a learning system. Therefore, the central group of requirements for learning software has to define a view on the domain which will be used in the presentation. The other requirements specify this view step by step, bringing more details to the definition. Each group of requirements introduced here describe the system properties in terms comprehensible for the corresponding group of developers. The *methodical* requirements reflect the way the domain should be presented from the educational point of view; and the *interface* requirements focus on the methods of this representation with regard to the media of presentation. The three groups of requirements are shown in Figure 3.1.

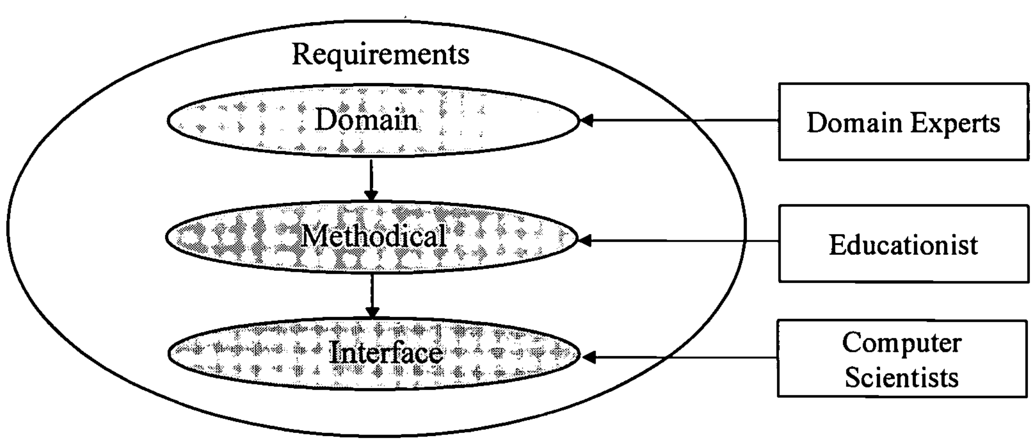

Figure 3.1: Classification of requirements

- *Domain requirements* include all requirements that result from the domain of the learning software. These requirements answer the question „What should the user learn?“ Therefore, the field of interest of this group of requirements are the contents and the goals of learning. The most important requirement of this class is the *reachability of the learning goals*. This means that the user should be able to gain the knowledge or acquire the skills that are defined as learning goals through the contents offered to him by the considered system.

- The second group of requirements, the *methodical requirements*, answer mainly the question „How should the user learn?". The field of interest of this group of requirements is concerning the general ideas of learning methods, which take into account the media used for learning as well as the selected learning paradigm such as behaviourism, cognitivism, or constructivism. (An overview of these learning paradigms can be found in [Baumgartner & Payer 1994]). On this level of abstraction we have to consider first of all the requirement of *strict definition of the learning means*. This means that all learning procedures as well as all elements of the learning environment have to be explicitly defined. Often small changes in the learning environment lead to considerably changes of the general concept and methodology of the system.
  The means of control for the selected method of learning have to be defined strictly as well. The following requirements help to give such a definition: *Well determined examination of the user's learning success*. Here we do not mean an examination of how well the user has understood the material. Sometimes this is neither possible nor sensible. The requirement should be interpreted in a weaker manner: it demands that the user's recent actions can be classified in relation to the structure of the learning domain. (For example, scoring the user's actions on a scale from 1 to 100.) An another requirement is *exact assessment* (Paul, 94), which requires that the information demanded by the previous requirement is made available to the user. The requirement of *effective fault diagnosis* [Lindgaard 1995] demands that the user is given a detailed explanation of her mistakes.
- The third group of requirements (*Interface requirements*) reflects the characteristics of the media used for the implementation of learning systems. It considers the properties of the objects given to the user to express her needs and wishes or to interpret the behaviour of the system. This corresponds to the traditional interpretation of interaction. Therefore, the general principles of interaction (as defined by [Dix 1991] must be fulfilled. These principles are: *predictability* (the user must be able to predict the consequences of her most recent action), *observability* (the user must be able to perceive all results of her actions from the current state of display), and *reachability* (objects or actions the user wants to use must be available to her.)

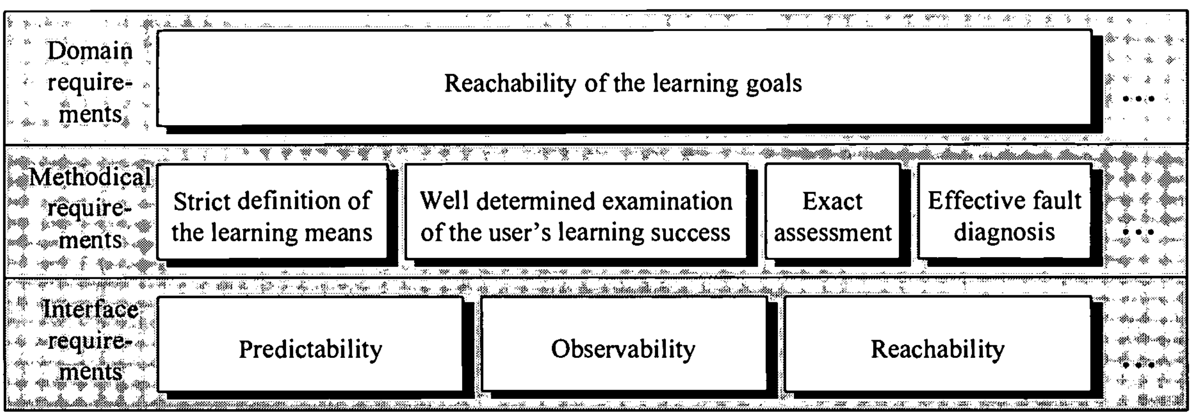

Figure 3.2: Requirements for learning software

4. Tasks as a way of applying of the requirements to learning software.

How can the requirements decribed above be applied practically? Generally, learning software makes use of a variety of different approaches for learning and teaching. Therefore, it does usually not make much sense to set an abstract requirement to a learning system as a whole. It is rarely possible to put such an abstract requirement in concrete terms for the entire system. It is much more promising to apply the palette of requirements to a local learning approaches used in the considered learning system. We will call local such learning approaches *learning tasks* or simply *tasks* for the remainder of this paper.

The question is now, how the three groups of requirements described in the previous section can be applied to a certain learning task. Take, for example, the task 'solving of a quadratic equation.' The general domain requirement (*reachability of the learning goal*) demands in this case it must be possible to solve the equation using the mathematical methods defined by the software. For a quadratic equation one could use the quadratic extension method or solve the discriminant.

The methodical requirement of *strict definition of the learning means* defines how the quadratic equation is solved, e.g. by answering multiple choice questions, by filling in the empty fields in a prepared solution form, by writing down the solution with the help of an ASCII editor, by solving the task with a formula editor, etc. The

requirement of *determined examination of the user's learning success* excludes all situations in which the user suggests a solution of the equation that cannot be classified by the system as correct or incorrect. The requirement of *exact assessment* demands that the score for the proposed solution reflects the quality of the given answer (which depends, e.g., on the number of mistakes made by the user). The interpretation of the requirement of *effective fault diagnosis* depends much more on the specific form of the solution than the interpretation of the requirements discussed earlier in this paragraph. When using a formula editor, for example, the incorrect part of the mathematical expression could be highlighted.
For description of the *Interface requirements* let us again consider a formula editor as a means of solving the quadratic equation. In this case the requirement of *predictability* means that the effect of formula editing has to correspond to the user's expectations syntactically as well as semantically. An insert operation, for example, should take place where the user expects it, i.e. at the current cursor position. The requirement of *observability* demands the full perceptibility of the editing results as well as of the assessment results. All important parts of solution or its diagnosis should be observable by the user. *Reachability* means that all the actions which appear to the user to be feasible should be available. The user should be able, for example, to edit the area that was highlighted by the diagnosis procedure.

5. Three models of instructional design

After we have given a description of the three groups of requirements for learning software, we will now show how our classification corresponds to modern concepts of computer based learning. We selected three different approaches of instructional design that represent a wide variety of didactical concepts. For these three approaches we demonstrate how their specific characteristics can be made tally with the above given classification of requirements.
Following Schott [Schott 1991] we use the term *Instructional Design* (ID) to describe the systematic and theoretically grounded development of learning systems (comprising not only the process of development but also the result of this process, e.g. a particular learning software.) There are various models of instructional design that stress different didactical concepts. Three models models that have received a fair amount of attention recently are *Anchored Instruction*, *Cognitive Apprenticeship*, and *Goal-Based Scenarios*. We will briefly summarize the main aspects of these models (a good overview can be found in [Simon 1997]):

Anchored Instruction
Many traditionally learning approaches face the problem of 'inert knowledge', i.e. the difficulty of learners to transfer the acquired knowledge to new, unfamiliar situations. The anchored instruction model attempts to solve this problem by creating an anchor that attracts the interests of the learner and allows her to identify and define the relevant tasks. The problem that has to be solved is presented to the learner in form of a stimulating, case-based story. According to the *Cognition and Technology Group at Vanderbilt* [CTGV1991] the anchored instruction model is based on the following seven design principles:

- Video-based format of presentation of the case-based stories
- Presentation of information within a narrative structure, i.e. the task that has to be solved is embedded in a meaningful context ('well-formed story')
- Generative forms of learning, i.e. the presented stories are complete except for the solution, which has to be created by the learners themselves
- Embedded data design, i.e. all information necessary for solving the task is implicitly contained in the story
- Use of sufficiently complex problems in order to give the learner the opportunity to learn how to deal with complex situations
- Use of pairs of corresponding stories in order to help the learner to generalize the relevant knowledge and to abstract from a specific context
- Design of stories that are not restricted to a specific complex problem but that include connections to other areas of the curriculum as well.

Cognitive Apprenticeship
The proponents of the cognitive apprenticeship model hold the view that the traditional form of school education is to abstract and theoretical. Learners acquire only 'brittle skills' that cannot be adequatly applied to real-life situtations. The advocates of this model of instructional design therefore suggest to transform the traditional form of school education into a form of 'cognitive apprenticeship' (similar to the apprenticeship in other professions.) Learners should solve realistic tasks that are embedded in an authentic context (embedded learning). Furthermore, learners should learn from and be guided by experts in the specific areas and thus acquire the needed cognitive and metacognitive skills to solve complex and realistic tasks. According to [Collins et al. 1989] the design parameters of cognitive apprenticeship can be divided along four dimensions:

- Content: This dimension comprises domain specific knowledge, heuristic strategies, controll strategies, and learning strategies.
- Methods: The teaching methods that are used, such as modelling, coaching, scuffolding, articulation, reflection, and exploration.
- Sequencing of learning tasks: The three principles, by which the learning tasks are presented to the learner, namely increasing complexity, increasing diversity, and global before local skills.
- Social context of learning: Certain aspects of the social organisation of appreticeship that are important for the learning process (situated learning, culture of expert practice, intrinsic motivation, exploiting cooperation, exploiting competition.)

Goal-Based Scenarios

The proponents of goal-based scenarios (GBS) hold the view that every human action involves the pursuit of a goal [Schank et al. 1993/94]. Learning, as a specific form of human action, is not different. Intrinsic goals (e.g. increasing one's own capacity to act and understand) create the motivation to learn. The traditional form of education fails to make use of the intrinsic goals of students and thus has to rely on less motivating extrinsic goals (e.g. getting good grates or avoiding punishment.) The aim of goal-based scenarios is to create a learning environment in which the learners are given a goal that coincides with their intrinsic goals and which can be reached by acquiring the desired skills. A goal-based scenario consists of four components:

- Mission
  The mission is the goal that the learner is supposed to reach within the GBS. The goal should be plausible, consistent, and chosen in such a way that it corresponds to the learners' own goals. While the steps necessary to reach this goal should mediate the desired skills, it should be possible to fulfill the mission in different ways.
- Mission focus
  The mission focus defines the form of organisation that the activities of the learner can take, e.g. designing, explaining, controlling, discovering. The learners should feel responsible for the results they cause.
- Cover story
  The cover story serves as a framework in which the mission can be fulfilled. The story should be plausible and motivating, describe a situation in which the skills that are to be learned are needed, and provide a context in which these skills can be acquired readily. The cover story can be complimented by additional materials.
- Scenario operations
  Scenario operations are the activities that are available to the learner in order to fulfill his mission. They should be consistent with the pursuited goal and the cover story, and give the learner a sufficient variety of options not only to reach his goal but also to make mistakes. The consequences of all operations should be understandable. Furthermore, the learner should not be burdened with actions that are not central for the learning process.

The following table shows how the components of the different instructional design models can be mapped to the above presented classification of requirements:

Type of requirement / ID model	Domain reqirements	Methodical requirements	Interface requirements
Anchored instruction	• Sufficient complexity • Connections to other areas	• Narrative structure • Generative forms of learning • Embedded data design • Corresponding stories	• Video-based format
Cognitive apprenticeship	• Content	• Methods • Sequencing of learning tasks • Social context of learning	–
Goal-based scenarios	• Mission	• Mission focus • Cover story	• Scenario operations

Table 5.1: Classification of components of different instructional design models

The fact that no interface requirements are defined for the cognitive apprenticeship model does not mean that these requirements do not exists. They are just not determined strictly by this model, but will be set according to the specific form of the concrete application.
The purpose of this section was to show that the discussed requirement classification can be applied to three rather different didactical approaches. We did not attempt to prove that this is possible for all models of instructional design, though our experiences suggests that it can be done for the vast majority of models.

6. Conclusion

The methodology for setting requirements for learning software described in this paper corresponds to modern concepts of instructional design and can be readily applied in the practise. Furthermore, this methodology displays the following advantages for the development of learning systems:

- *Dividing up of responsibilities* - Each group of requirements presented in this paper defines a certain level of abstraction. Each level determines a class of system properties which belongs to the area of competence of the corresponding group of developers (domain experts, educationists, computer scientists.) This enables an optimal division of responsibilities between the different groups of developers.
- *Low development costs* - The strict definition of the system requirements make it possible to use formal methods of specification (e.g. methods from HCI theory.) In this way a clear definition of the connections between the different levels of abstractions can be given and formal verification methods can be applied. All this increases the efficiency and thereby decreases the costs of development. (The application of HCI methods in the case of coached training systems is demonstrated in [Nemirovski & Schlageter 1997].)
- *Satisfaction of demands* - The definition of requirements according to the above described classification and the application of formal development methods make it possible to take into consideration the system requirements during the whole time of development. This guarantees that the resulting learning system will fulfill all demands set by the different groups of developers.

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It's Easy to be Wise after the Event: Concepts for Redesigning an Educational System on Logistics Derived from Reflecting its Development and Use

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Abstract: Often the development of an attractive multimedia-based educational system is a long-lasting and lavish process. Especially, if the authoring process is primarily in the hand of the educational system's potential users (the teachers) who are often not very experienced in developing those systems, their support by design guidelines and easy-to-use authoring tools becomes more significant. Besides this, it is necessary to concern oneself repeatedly with the own way of action and its results for deriving experience. Following the example of an educational system on logistics, the contribution will show, how this self-reflection of the educational system's development and use has led to a concept for its future-orientated redesigning and also for a more efficient author-supporting infrastructure.

Initial Situation

As result of a developmental process lasting several years, the first component of a multimedia-based educational system on logistics was created by prototype implementation of a module on warehousing in German and English language [see Neumann, Ziems, and Höpner 1995, or Ziems and Neumann 1997]. The system is tailor-made for the specific interests of university-level logistics education. It imparts the fundamental knowledge of facts and methods as well as the integrated logistical thought and action orientated towards success. Above all, it presents knowledge concerning possible applications and easily to comprehend by means of procedures enabling experiments. Besides this, the student is supported in using his/her knowledge actively. The methodical-didactic structuring and alternative presentation of logistics knowledge as well as the design of navigation and interaction possibilities are suited to the system's use for self-studies and as a work of reference as well as to support lectures, exercises, and practical training.

The educational system is tested, used and evaluated at the University of Magdeburg but also within a European network of at the moment 24 universities, colleges, and training centers from 13 countries. For the most part, the students met multimedia-based educational systems for the first time. Their opinions, critics, and wishes recorded within interviews and by questionnaires were analyzed together with pedagogical experts to recognize acceptance problems and needs for the educational system's further developments as well as for the way of its integration into the educational process. During the developmental process we gained an increasing experience from our work and improved our knowledge about ideas, approaches, activities, and results from other people's work. Because of this, demands and request for the educational system's functionality and design as well as for the authoring process's way of action and support by appropriate tools were grown as well. Finally, these experiences led to the decision to redesign both the educational system according to contents, methodical-didactic, functional, and design aspects and the concepts and infrastructure supporting the developmental process by making use of the improved hardware and software basis as well as of ideas and concepts derived from the system's development and use.

Experiences from Developing and Using the Educational System

The educational system on logistics was developed by a team of logisticians and computer scientists. As a first step the knowledge available in one's own scripts for lectures, available technical literature as well as graphics, photographs, video and animation sequences was sifted through, selected and structured. Even in this phase, there was a number of questions e. g. for

- the appropriate proportion between texts and pictures, between static and dynamic knowledge presentations,
- the sensible integration of possibilities for a user-specific interaction,
- the appropriate handling and use of the many and diverse photographs and videos, or
- possible ways to avoid conflicts with third-party copyrights of material.

Unfortunately, there was no media expert in the team and guidelines related to this kind of questions were difficult to find, to understand, and to handle. In addition to this, their application in different methodical-didactic scenarios and their effects to varying types of learners as described in [CSUP 1992] were seldom taken into account. Before this background, a repeated reflection to the following fundamental question was of great help for the developmental process: *What are the advantages, and what are differences in knowledge presentation and use of multimedia-based designs in comparison with the traditional print medium?*

To guarantee an efficient authoring process a joint communication basis had to be developed for the cooperation of authors from different fields of knowledge and different worlds of thinking like logisticians and computer scientists. Here, simple *guidelines and a story board* were very helpful for structuring screen pages and designing their elements, for drafting, discussing and implementing basic layouts, their multimedia elements as well as for integrating all links and possibilities for user-interaction required. About it, the use of only four different *basic layouts* for the pages has proved to be positive. The students were quickly quite well acquainted of the new media and have used the educational system with curiosity, inquisitiveness, and interest. This process was also supported by providing *alternative possibilities for navigation* like hyperlinks, search functionality, or navigation buttons and for acquiring additional information about particularly highlighted keywords. *Calculation exercises* of a varying complexity and with many and diverse possibilities for experiments were offered in relation to a particular context or could be chosen from a separate pool of exercises. That has achieved the educational system's intensive use for self-studies and in phases of preparing for examinations. But the students explained also additional wishes to have more comfort and support. Amongst other things they were related to provide possibilities for a context-specific adding of *user-own comments, remarks or questions* on integrated note-pads and to give a better on-line support to the student for solving complex exercises.

During the authoring process *language-independent components* like e. g. graphics, photographs, videos, or animation without additional explanations and *language-specific components* like e. g. texts, tables, formulae, or explanation elements of graphic presentations were separately saved. This has produced just as positive effects as the concept to separate elementary multimedia resources strictly from possible relations and links that was consequently pursued at any time. This way of action was of considerable importance for developing the German and English versions in parallel. It also guarantees that the educational system is open for a translation into further languages. On the other hand this concept of putting all software components into separate modules of external files made it also clear that the chosen authoring system (Multimedia Toolbook 3.0) was inadequate for supporting those ways of actions. Import and export functions necessary for embedding these modules are only partly provided in a satisfactory form. For that reason a time-consuming development and implementation of own import filters became necessary.

In retrospect we can consider that the integration of alternative forms of knowledge presentation (e. g. text vs. picture vs. video), of alternative technologies for search and navigation (e. g. chapter-based structure, structure map, search) and of alternative tests and exercises has had an exceptional favorable effect. According to our experience, in this way there is a constant demand for user decisions and interactions corresponding to his/her individual learning habit. As a result it is possible to contradict very effectively the still existing image of educational systems to be just "page-turning machines" and to consider that the time, staff, and technical effort needed for their development is justified. Finally, the work done for the first module has shown that the complete integration of an entire field of knowledge into a multimedia-based educational system represents a tremendous effort. Because of the greater range of possibilities for presenting knowledge and for giving access to the learner, it is clearly more substantial than writing a comparable textbook. Before that background the developmental infrastructure must be able to support a future joint authoring process of several distributed logistics educators and experts. For this, the present state of information and communication technologies as well as net services offered to the customers already provides a main pre-condition and opens up new possibilities for organizing this process in a cooperative way.

Once Again from the Beginning: Ideas and Concepts for Redesigning

On the basis of results from evaluation, reconstruction and self-reflection the general concept for an educational system on logistics was newly thought over. In addition to this, the warehousing module's redesign was planned to increase its rate of acceptance. Also a concept for a more efficient way of actions and a better support of the developmental and authoring process by the improvement of existing or the development of new tools was worked out. This process of looking for ideas and developing concepts was carried out not only by the previous team of authors and developers, but it was also supported by the educational system's user group as well as by a group of interested pedagogical and psychological experts, designers, media experts, linguists, computer scientists and multimedia authors for different fields of knowledge organized in a regional association for research on the development and use of educational multimedia. With that, a process of fully redesigning and expanding the educational system as well as developing components for a computer-based integrating authoring infrastructure was started and has already led to first prototype implementations tested and evaluated successfully. Within the following sections the special features of examples for those implementations are presented and discussed.

Expansion and Modification of the Educational System

Works to expand and modify the first component of the educational system on logistics are mainly focused to

- increase the acceptance and user-friendliness by reorganizing the educational system's structure and reworking its user-interface,
- support more flexible teaching and learning processes by providing learner-specific possibilities for navigation and interaction and producing individual feedback,
- extend the group of users by integrating the module into distance learning courses, by adapting it to the demands of a non-university qualification and training, and by creating the pre-conditions for alternative forms of learner-learner and teacher-learner communication.

Since the previous concept followed strongly the structure of traditional textbooks it is less suitable for supporting the use of particular pages or sequences of pages in flexible educational processes with individual learning paths. Instead of this page-based approach the knowledge is now organized in a *structure of nodes and edges* of different levels of detail similar to the concept map approach described in [Zeiliger, Reggers, and Peeters 1996]. The nodes represent knowledge units of definite complexity, whereas the edges describe the relations between them. Nodes of a higher degree of complexity like e. g. knowledge complexes consist internally again of structures of nodes and edges. The smallest knowledge unit represented by a node includes the knowledge of a screen page, which results from placing elementary multimedia objects like e. g. texts, graphics, photographs, videos, or animation in standardized layouts by setting parameters. The main advantage of this approach consists in the fact that the knowledge can be structured now both top-down and bottom-up. Besides this, knowledge units of different levels of detail can be combined according to educational targets and levels. In addition to the effects on the authoring process the modified structure of the educational system opens up new possibilities for learner navigation and guidance. Depending on the educational targets and levels as well as interests of the learner, a node could also be excluded from the learning process.

The degree of guiding a learner and if necessary also the degree of one's freedom in navigation as well as the tests' and exercises' degree of difficulty are established as usual by the *learner's self-classification* when starting a session. Learners are classified according to both his/her familiarity with the software (beginner, advanced level, expert) and his/her prior knowledge as well as with respect to his/her learning target (overview over a wide range of knowledge or over particular fields of knowledge, detailed knowledge about particular fields of knowledge or about a specific fact etc.). In addition to this, the learner's behavior according to the frequency of using helps (e. g. in the form of looking for definitions of terms) and preferring alternative or complementary presentations (e. g. textual or pictorial information) is recorded in a log-file. These information are graphically presented, analyzed by using statistical methods and interpreted by taking the learner's self-assessment (prior knowledge, preferences, learning target) as well as information from previous sessions into account (investigation of preferences). As a result the form of presenting knowledge is automatically suited to the learner's subjective preference of getting access to the knowledge.

In addition to the automatic recording in a log-file, the learner's behavior but also his/her progress in learning can be determined from comments, questions, or extracts from content formulated by the learner himself/herself. This *unplugged, context-specific expression of the learner's opinion* is directly linked to a particular screen page either by bookmarks or by using the NOTICE button depending on the kind of information. Whereas bookmarks only identify certain knowledge units interesting, important, or necessary to be examined from the learner's point of view, the NOTICE button enables to write down and save any notes within a separate window. As a standard the corresponding screen page's long name is copied to the note-pad. By use of a guiding dialogue the learner can now add further information about the context as well as his/her notes. Those notes can

- refer to the *authoring process* if including comments to the author about the screen page's design, presentation, clarity, or comprehensibility,
- concern the *educational process* if summarizing questions or remarks about the subject for being answered or furnished with a commentary by the teacher,
- serve the collection of *knowledge about facts* in the form of extracts, e. g. for own study works or presentations.

This kind and purpose of a note is also described within the guiding dialogue by selecting it from a menu to clearly relate each particular note. First, all notes are private and belong to the learner. It is always up to the learner whether to make further use of them or not. As a matter of principle no note is automatically forwarded to anybody else. If the learner wants to submit some or all notes to an author or teacher he/she can print them or send them electronically via an integrated communication interface.

Amongst other things the possibility for printing something out was also considerably extended according to functionality and user-friendliness. Instead of producing snapshots by printing the screen as it was in the educational system's first version, the learner is now able to select any element of the educational system and copy it into a different MS Windows application or into a standard printer's copy. These elements, i. e. text phrases, graphics, or photographs as well as notes or results of exercises and tests (but now snapshots from video or animation sequences), could come from different screen pages. In this way the learner can now build simply designed, individual presentations of selected parts of content (e. g. for a study paper or a talk). The implementation of this functionality was deliberately done without providing the pre-conditions for developing lavish presentations or many and diverse printer's copies, because there are already several professional commercial software packages for this purpose. On the contrary, it is just a simple way to support exchange and discussion. In future, the system should also receive a *flexible communication interface* adaptable to the student's hardware and software basis as well as to his/her pre-conditions in infrastructure. In this way, the student will be able to communicate electronically with other students (e. g. by e-mail, on-line fax, or other net services) or to send questions or comments put together in notes as well as solutions of test questions or exercises to the teacher. If a student has no direct access to a communication network he/she can fall back on conventional, paper-based forms of communication (e. g. mail or fax services) or phases of personal presence at the university by using the improved print function.

Possibilities for a Better and More Effective Authors' Support

Our experience from developing the educational system on logistics have clearly shown that the authoring system used for that purpose often did not cope with the demands resulting from the educational system's development and use. In this way bad authoring systems enable only the development of bad educational systems that are organized as supporting infrastructure for turning screen pages and for confronting a learner with multiple-choice questions [see Korcuska 1996]. In comparison with that good authoring systems enable the development of good and action-orientated educational systems (learning by doing). They are able to capture the author's knowledge and experience to be slipped into the authoring process. Before this background, in [Korcuska 1996] authoring systems existing at present (especially those which belong to the HyperCard category) are assessed as bad and not very suitable to really support the author during the authoring process, because these systems mainly understand computers and not education. In opposite to this he promotes "software factories" providing highly complex do-it-yourself objects that also contain pedagogical knowledge and guide authors through the whole process on the conceptual level. In addition to this, it is helpful if an educational system's components and modules created by an author could be managed effectively and made them reusable. For that reason our work for creating a comfortable developmental infrastructure supporting the authoring process mainly concentrates on

- expanding and explaining those conventions for structuring and designing the educational system and its elements, which were used up to now and have proven to be good,
- putting further knowledge of facts and methods into modular form according to content and formal aspects and documenting it in a way that one can search for it, as well as
- supporting the collection, management and finding of resources by a resource pool with a comfortable management system.

The *resource pool* as kernel of this developmental infrastructure contains different classes of resources necessary for the development of multimedia-based educational systems [see Subrahmanian and Jajodia 1996]:

- *Knowledge resources* of varying complexity contain modular knowledge within presentation objects (complete multimedia data that can be presented by use of tools for reproducing media) and application modules (executable software that generates presentable multimedia data with the help of suitable tools).
- *Concept resources* include on the one hand methodical-didactic basic conceptions for the educational process and on the other hand completely described, problem-specific teaching concepts (concept maps, story boards).
- By *layout resources* e. g. user-interfaces are understood that are standardized for different functions and that can be described by setting parameters.
- *Navigation resources* are modules of a specific authoring system for controlling an educational application in various forms (e. g. history, summary of contents, buttons).
- As *management resources* e. g. modules for managing a user's status, routines for evaluating and analyzing user-interactions, or models for restricting interactions are described.
- *Tools* summarize help functions like e. g. equation interpreter or calculator.

To guarantee its applicability and searchability each resource has to be completed by a *detailed description*, which is adapted according to content and structure to the characteristic specific to the corresponding class of resources. For example, a knowledge resource's description contains at least file name, knowledge characteristics (on the basis of related descriptors), characteristics of presentation form or knowledge (including the author's copyright). If necessary, different purpose-orientated views specific to the corresponding author can be related to a resource. During the authoring process the developer of a particular educational application can use existing resources and link them according to the point of view of content and methodical-didactic aspects. In this way single screen pages are formed by linking knowledge resources with layout resources, navigation resources and tools. If these pages are linked in sequences or networks by use of a concept resource and completed by the appropriate management resources learning paths are built.

For saving and selecting resources the author uses a *management system*, which forms the resource pool's interface to the developmental infrastructure. This interface includes amongst others

- the *link management system*, which manages links between resources as separate objects with individual characteristics,
- *control functions* for guaranteeing data consistence for the resources,
- comfortable *search functions* for a user-friendly access to resources,
- *safety functions*, which check the access to resources and links by controlling user-rights.

In addition to this, in the *developmental infrastructure* itself there functions for

- adapting elementary knowledge to texts, pictures, animation, or videos by logisticians (editor),
- developing interactive teaching and learning applications that includes knowledge separated for defined target groups (learners) by use of available knowledge units (authoring system),
- supporting communication between distributed authors within a cooperative authoring process (communication infrastructure),
- using applications developed before individually by teachers and learners in lectures, exercises, self-studies, or as book of reference (presentation system)

are integrated. With that authors can effectively develop educational systems on the basis of their own content, methodical-didactic and design concepts. But as the main pre-condition the resource pool must offer a substantial as well as many and diverse stock of resources. Because of the existing network of European logistics educators this problem is solved for the logistics field of knowledge and a permanent use, expansion, and updating of the resources is guaranteed.

Conclusions

When using this developmental infrastructure for redesigning the educational system on logistics the effects occurred as expected. The main advantage consisted in the fact, that the authors mainly could concentrate on activities like searching for, selecting and editing elementary resources and knowledge units of varying complexity as well as putting modules resulting from this together by use of an authoring system. Because of this, time necessary for the developments during the authoring process could considerably be reduced, although the educational system contains now more flexible learning paths, a more substantial knowledge of facts and methods, and a larger number of multimedia illustrations. The resource pool as kernel of the developmental infrastructure has been proved to be a central source and store of special knowledge within a cooperative authoring process. Now elementary and complex multimedia resources and modules of educational systems can be purposefully saved and reused from different users' points of view. This possibility opens up a variety of applications nearly unlimited according to content, target group, purpose, and technical demands, which goes far beyond the development of educational systems.

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Developing a WWW Resource Centre for Acquiring and Accessing Open Learning Materials on Research Methods (ReMOTE)

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1. Introduction

In January 1997 the ReMOTE (*Research Methods Online Teaching Environment*) project received funding for a 12 month period, its purpose to develop a World Wide Web (WWW) site devoted to the teaching of Research Methods, unifying access to a wide range of teaching materials.

2. Background and Rationale

Virtually all UK Higher Education Institutions teach Research Methods, either at the latter stages of undergraduate study or in postgraduate programmes, where Research Methods is seen as a key component in preparing students to undertake study leading to an MA or MSc qualification. Typically the topic is taught as a programme of lectures and seminars.

The key features of Research Methods which make it an appropriate area to develop as an Internet resource are that:

- it is generic and transferable. The end product will be applicable throughout RGU and all HEIs across a wide range of courses.
- because of the wide range of potential topics which it is designed to support, students find that they may have to concentrate their efforts unevenly on different components within Research Methods: some may, for example, require more detail on quantitative analysis, whilst others do not need to study this topic in such depth because it will not be applicable to the type of dissertations or projects in which they are engaged. It is envisaged that the basic units will be extensible to allow students to explore in greater depth areas of the subject which are of interest to them whilst clearly making them aware of the knowledge and procedural requirements for achieving credits on the course, by exploring web links to more specialist sources. As such, the system will be particularly useful on postgraduate programmes of study, where students may require simply to upgrade some specific skills or techniques and can do so on an Open Learning basis.
- the environment in which the project will be operating (the WWW) is one which is intrinsically important in conducting practical research and the mechanism of delivery can be viewed as an important part of the learning process itself.

It is therefore apparent that such a widely applicable skill as Research Methods, and such a ubiquitous medium of delivery as the WWW are ideally suited for the development of a resource centre which will be of global utility.

Although not explicitly stated within the project's remit, it was recognised early on that the approach adopted was consistent with the broader goals of making use of the Internet in order to enhance:

- the quality of learning

- educational opportunities
- profit
- student numbers and
- staff productivity [1]

Currently there are several WWW resources available for teaching Research Methods or facilitating the research process, the former typically concentrate on a subset of skills appropriate to a particular discipline or a single aspect of Research Methods, while the latter (e.g. SOSIG[2]) tend to offer sites of use to researchers, and a few selected sites for teaching the subject. Pachnowski et al.[3] provide a useful discussion of some of the sites available which provide databases and examples of surveys of resources (e.g. the US Census Bureau http://www.census.gov/) and the Gallup Organization http://www.gallup.com/) but does not provide any detailed guidance on application of these resources in teaching. Useful resources are also provided by a range of directories - the Educator's Internet Yellow Pages[4] being a particularly good starting point. More specifically related to Research Methods work by Cozby[5] provides an excellent guide to resources - each chapter of the book directing the student to a wide range of web resources and there are a number of web sites which give detailed tutorials on specific Research Methods concerns or techniques (e.g. BeLue's Choosing a research design http://trochim.human.cornell.edu/tutorial/belue/belue.htm and Burn's pages on Securing internal validity http://trochim.human.cornell.edu/tutorial/burns/int.html).

The aim of ReMOTE is to provide an infrastructure which allows direct link to specialist sources which will enable the use of existing materials as "plug ins" when developing tailored Research Methods courses e.g. the use of links to the existing materials in the same way as references to the sources would normally be given in paper based documents. It will also allow interactive CAL packages, which are available freely via the WWW, to be conveniently downloaded and used in teaching or self-study. The researchers will then go on to test the effectiveness of the approach and study the manner in which the ReMOTE pages are used by staff and students within the University.

3. Development

The development of the WWW site required the identification of a wide range of Research Methods materials suitable for inclusion. One of the main aims for the methodology of the development for this project was perceived to be the need to provide rapid delivery of a working model which would act as a catalyst in stimulating ideas and feedback from academic staff who were not necessarily aware of what was achievable in this medium, but who nonetheless had significant teaching resources which could be used in developing the directory of learning materials (a process known as *Rapid Prototyping*, favoured by courseware designers[6] and suited to the HTML development environment). Thus at an early stage, the deliverables of two previously funded faculty projects which were identified as covering significant portions of the subject area in question, were deemed to be suitable for conversion into WWW format:

- **Self Study Learning Package** for students studying Research Methods in the social sciences: produced by the Robert Gordon University School of Public Administration and Law, and consisting of ten learning papers, each covering a discrete aspect of the subject.
- **Communication Skills Guide**, produced by William Robb for the Faculty of Management, consisting of a series of lessons in presenting written and spoken information.

Both packages were in printed format, but also existed in electronic format and would not therefore require laborious *verbatim* retyping.

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[5] Cozby, Paul C. Methods in Behavioural Research. 6th edition. 1997.

[6] Wilson, B. G., Jonassen, D. H., & Cole, P. (1993). Cognitive approaches to instructional design. In G. M. Piskurich (Ed.), The ASTD handbook of instructional technology (pp. 21.1-21.22). New York: McGraw-Hill. Also available at: *http://www.cudenver.edu/~bwilson*

Further materials developed elsewhere were also to be considered for inclusion on the server where permission and copyright clearance could be obtained. It was already known that some materials developed elsewhere already existed in electronic format and might be suited to conversion or at least dissemination via the WWW; the amount of material, developed in isolation by lecturers at diverse institutions can only be speculated at. The overall effect of this approach was successful with some individuals responding enthusiastically to the possibility of making their own notes and lectures available on the WWW.

2.1 Requests for WWW Links

A significant further part of the final deliverable is a collection of WWW links to already-existing materials elsewhere on the WWW. In order to identify materials for evaluation and possible inclusion in the site, input was solicited from a variety of email discussion lists and online forums which have an interest in web site development and teaching Research Methods. An announcement of the project's intentions, coupled with a request for contributions, was sent out to:

- Mailbase: UK Higher Education's electronic discussions host. A number of lists were identified which might have an interest in the development of such a resource, including:
    - lis-link@mailbase.ac.uk
    - lis-infoskills@mailbase.ac.uk,
    - computer-assisted-learning@mailbase.ac.uk

- Other email lists and electronic forums, including:
    - nettrain@listserv.acsu.buffalo.edu

A number of responses to this message were received, generally of an enthusiastic nature, although most revolved around the theme of "please let me know when it's ready". However, several worthwhile resources on the WWW were communicated, and some sites and individuals promised to donate materials, or to look into the practicalities of doing so. Similar messages were sent to individual sources which it was known had produced materials which might be suited to WWW conversion e.g. the PROCARE project at Southampton University. As in the case of the individuals who responded to the initial request offering their own materials for the site, enthusiastic initial responses have been followed by long periods of silence: in the case of PROCARE, copyright clearance deliberations at board level have thus far prevented any progress.

3.2 Searching on the WWW

In addition to asking interest groups to provide references, further materials - finally forming the bulk of the directory - were located using WWW searching techniques. Many materials were located via previously located WWW sites, which often include a list of links to other related sites ("further reading"). This has the advantage of the implicit recommendation by the link-maker in referring to the materials, but also restricts the user to what the individual author has himself already found.

Searching was therefore extended to Internet directories[7] and search engines[8] e.g. Yahoo, The Argus Clearinghouse, AltaVista, Excite, Infoseek. This is a less focused method of identifying suitable resources than by individual recommendations, but has the potential to identify a much wider range of resources, and the majority of the directory's contents have been located by this method.

3.3 Design

[7] Directories are here defined as those WWW indexing services which are chosen and classified by human indexers, including Yahoo (http://www.yahoo.com) and the Argus Clearinghouse (http://www.clearinghouse.com)

[8] Search engines are defined as those WWW indexing services which identify and index resources by purely automatic means, retrieving matching documents on the basis of keyword matches rather than defined categorisations e.g. AltaVista (http://www.altavista.com), Excite (http://www.excite.com) and Infoseek (http://www.infoseek.com)

The structural and graphical design of the site required careful consideration in order to achieve a consistent and logical appearance. The factors which required to be taken into consideration included the goals of the potential users and of the university itself:

- **User Goals**:
  - Navigability: use of logical structures to maximise the ease of use with which a user can locate the information they require, and to prevent them becoming "lost" in a complex structure of information
  - Clarity: the need for all of the possibilities to be presented in an intuitive and visible manner, making it clear at each stage - without the need for undue searching or experimentation on the user's part - exactly what information can be reached from the current point
  - Attention to design: with all of the alternative sources of information on the WWW, it must be made obvious to the user that the resource has not been developed as a part-time "pet project" by an individual. A professionally designed look will:
    - be appealing on a visual level
    - engender confidence that this is a quality resource

- **Institutional Goals**:
  - the need to establish ownership and a corporate identity; to remind users (albeit sub- or semi-consciously) that the Robert Gordon University is providing this resource
  - to provide a robust structure for the resource which will accommodate future changes and additions to the site in a logical manner without the need for excessive re-working of existing structures
  - to provide quality information in a manner which:
    - enhances the pedagogical aims of the university
    - enhances the profile of the university as an innovator in the use of novel techniques for information delivery

On a practical level, these issues fall into two broad categories:

- Structural design
- Graphic design

3.3.1 Structure of the Site

The site is built on a hierarchical plan, where the most general resources contain links to the more specific ones. The home page serves to inform users of the purpose of the site and give access to the broad categories (not to the actual materials). The pages on the next level down unify access to i) materials on the server; ii) online courses and iii) the list of categories of materials from the WWW. In the case of (iii), the actual WWW resources are accessed after choosing the category required. In the case of (ii), the individual courses refer to the materials from (i) and (ii). Pages on the top two level of the hierarchy link clearly to each other, so that a user does not have to retreat back to the home page every time a different section is required.

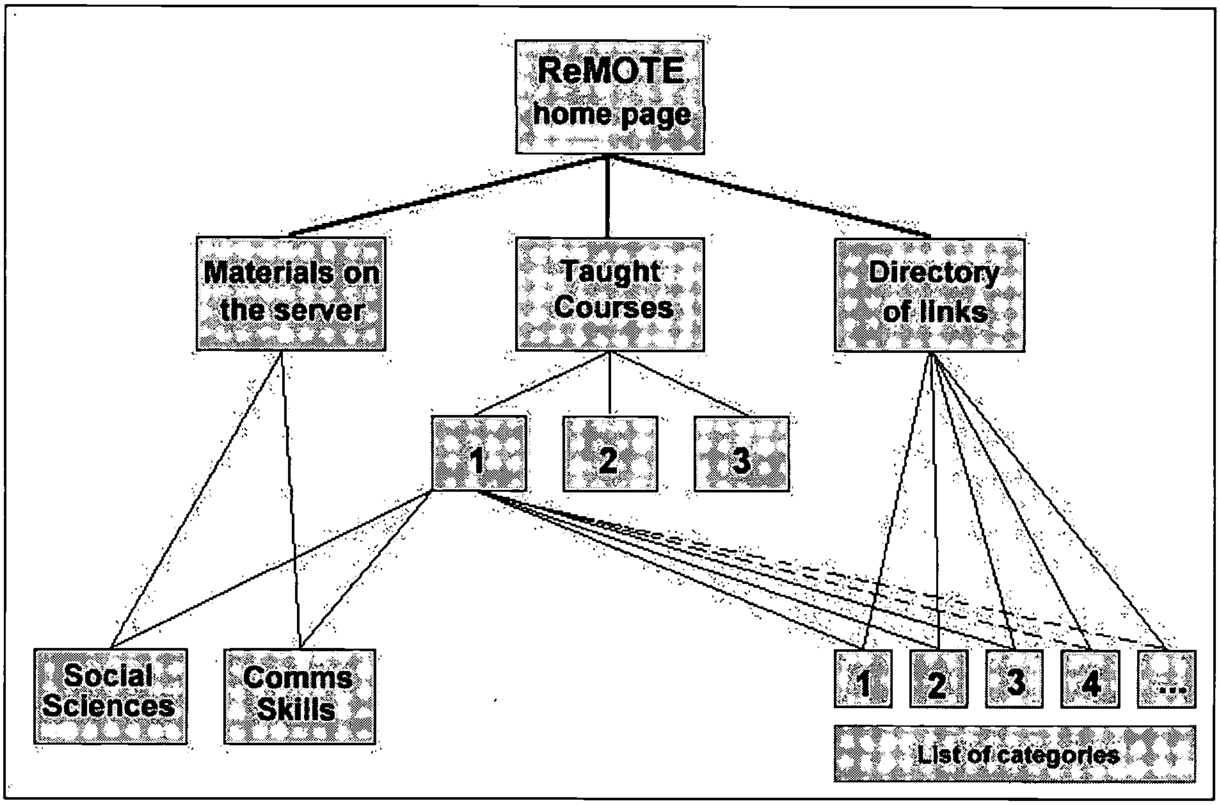

Fig 1: Structure of the site

The materials which have been installed on the server are structured in a manner reflecting as far as is possible that of the original materials. There have been some necessary alterations in terms of navigation e.g. the addition of hypertext contents pages.

3.3.2 Graphic Design
3.3.2.1 Graphic Design: Identity

It was decided that the three essential elements to convey as clearly as possible to users were:

- The pedagogical purpose of the site: i.e. the teaching of Research Methods skills
- The use of technology (the WWW) to enable distance or independent learning
- Institutional ownership of the resource

With these in mind, the site's opening page (see fig. 2) was designed to convey these immediately and intuitively:

- The banner graphic uses considerable corporate and research-appropriate imagery:
  - the underlying graphic consists of photographs taken from the 1998 Prospectus which illustrate elements of research: themes represented include use of telephones, interpersonal skills, technology (computer keyboard, CD-ROMs, floppy discs), libraries, study, books, files etc.
  - The RGU shield and corporate colours are prominent

- The title *ReMOTE* itself is an acronym constructed from the words "Research Methods Online Teaching Environment". The use of the term "remote" also reinforces the distance learning aspect.

- The site content is overlaid on a background consisting of the undulating margin seen on numerous RGU publications, with the individual elements of the RGU shield (castle, boar's head, cog, sphere and torch) continuing to the right hand side. The undulating margin serves a functional purpose, containing the navigation "buttons" which enable the user to access the site

These graphic themes run throughout the contents of the site, and provide a consistent look and feel: it is easy for a user to tell which pages are a part of the ReMOTE site.

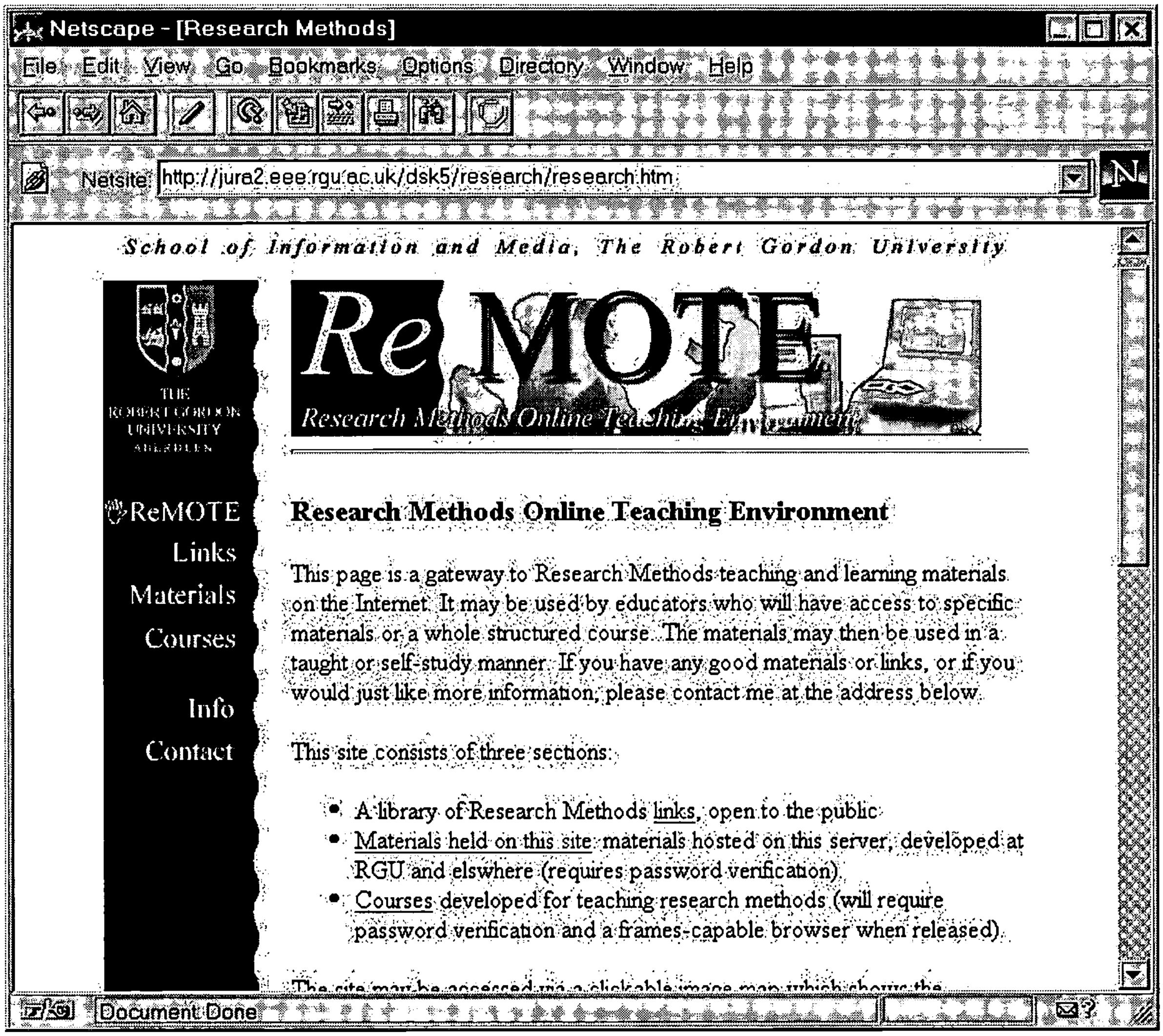

Fig 2: The ReMOTE opening screen

3.3.2.2 Graphic Design: Functionality

In addition to fostering a strong sense of purpose, technology and ownership ("PTO" identity), many of the graphics have a functional purpose. A decision was made that the non-use of graphics should, wherever possible, not inhibit use of the site: non-graphical browsers are still in use and browsing on standard browsers may be speeded by switching off graphics. Therefore functional graphics in the site are of a simple nature, generally only renditions of text with some embellishment e.g.

- **Navigation:** the navigation buttons in the left hand margin, where the current page is highlighted in green with a tick beside it to make it absolutely clear to the user where they currently are in the structure. The functionality will be only marginally less clear if browsing in text only.
- **Pedagogy:** in the actual learning materials, graphics do have an essential purpose. Where they are necessary, they have been kept to the minimum size for legibility on displays of varying resolution. However, the issues which can be discussed here are purely technical, since the use and design of these graphics are issues for the materials' authors.

3.4 Content of ReMOTE:

The contents will be dealt with in three parts:

- The directory of links to other WWW materials
- The materials actually hosted on the server (self study papers for the social sciences and the Communication Skills Guide)
- Courses under development using the above materials

3.4.1 Directory entries

Due to the extensive nature of the directory of links, it has been subdivided into categories for each aspect of Research Methods. Each category of the directory has a separate page, accessed from the main directory page:

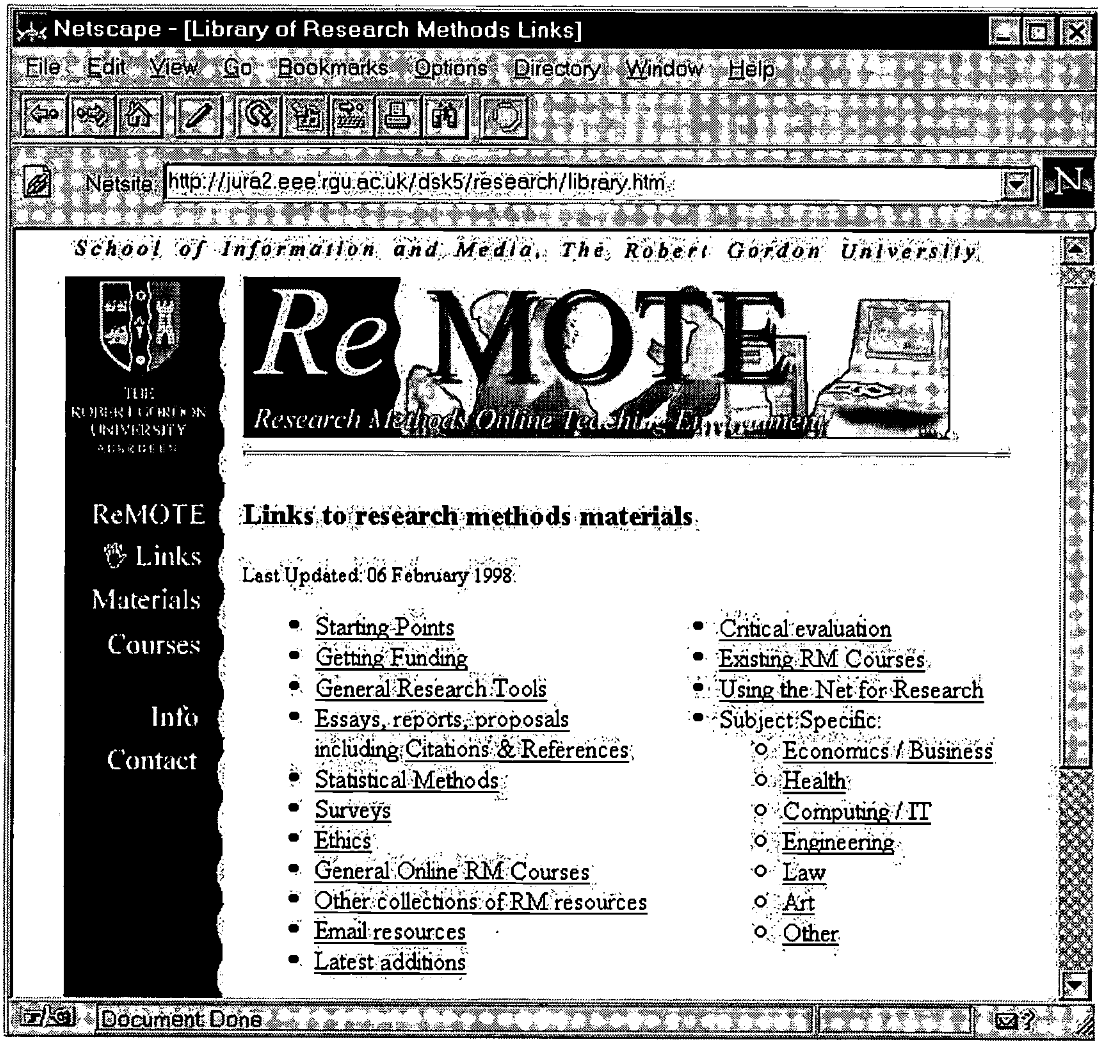

Fig 3: Categories in the directory of WWW links

The format for directory entries is based on the style used in the *NetLearn* project[9]. The resource title is given as a hypertext link, followed by a brief abstract describing the resource, its coverage, target group etc. and finally some categorisation information. The information given should be enough to tell the user whether the resource is likely to contain the type of information which they might find useful *(fig 4)*.

[9] NetLearn: a directory of resources for teaching and learning the internet. URL: http://www.rgu.ac.uk/sim/research/netlearn/callist.htm

STEPS Project, University of Glasgow. Downloadable CAL modules for the teaching and learning of statistics, specifically applied to the following areas: Biology, Business, Geography, Psychology. Suitable for PCs, also some MAC material. The packages utilise graphic and interactive techniques. *TYPE: materials, downloadable CAL software*

Fig 4: an example directory entry

There are a number of drawbacks to the directory in its current form:

- It is not searchable as a database would be. The name, URL, Description and categorisation information could all be used as fields in a database, but at present this is not possible.
- Resources may fit into more than one category, resulting in duplication
- Updating the directory must be done manually by editing the relevant HTML document: with the amount of information requiring updating, this is unwieldy and prone to errors.

If the directory is to be maintained and promoted as a feature in the future, some investigation must be made into the possibility of converting the information into a database format accessible through a WWW front-end. This would not only make the user's job searching for relevant materials easier, but also the maintainer's job of adding, amending or deleting resources. Scope would then also exist for the addition of a "user comment" feature, where users could add their own annotations as to the usefulness of any individual resource.

3.4.2 Materials hosted on the server

The materials hosted on the server currently consist of two extensive packages which have been converted from paper-based versions:

- Self Study Learning Papers for the Social Sciences (originally produced by the School of Public Administration and Law). This consists of ten learning papers, each focusing on a particular aspect of research.
- Communication Skills Guide (originally produced by Mr. William Robb for the Faculty of Management)

Both packages were deemed suitable for conversion to WWW format due, foremost, to their subject matter and the depth in which this was tackled. They complemented each other in that the former was a 10-step guide to doing research in the social sciences, while the latter presented an in depth tutorial on the presentation and communication of information. In addition to this, both already existed in electronic formats, having been created on word processing and desktop publishing programs, and would not therefore require laborious re-typing of the original text. Each package consisted of over 100 pages of mixed text and illustrations.

First to be tackled was the Social Sciences package. The approach taken was to use a conversion utility (Microsoft Internet Assistant, or IA) which would take existing Word documents as input, converting them into HTML. The process of conversion with IA took only a few hours, but immediately presented problems: each individual Word document was converted into a single HTML document, which was not navigable and required to be broken into sections which would then have to be linked together. The HTML output by IA was also non-standard, and attempted a very literal interpretation of the *look* of the document when what was required was a representation of its structure and meaning. The parameters of paper and the WWW are not compatible, and the document has required considerable restructuring to make it manageable, and the inclusion of navigational facilities for locating and moving between documents - most notably tables of contents constructed of hypertext links to all of the available pages.

A great number of further problems remained to be rectified due to the shortcomings of IA: many graphics had been discarded, others required re-sizing to make them legible on differing display resolutions and complex text formatting needed to be reinstated. An initial version was presentable after a week of work, but finding and correcting errors produced by IA required much longer, and the assistance of the original authors who were much more familiar with their material. The existence of a template into which content could be "poured" and links added automatically would have saved many days of effort: a single change in style often requires every page to be altered slightly, and there are well over 100 pages in the package.

The final product retains the original material's content 100%, but represented by a different structure suitable for the WWW. The materials are broken down into smaller sections and direct access given to each through tables of contents (a device not used in the original materials). Although changes to the material were not within the scope of the project, in the future it is envisaged that they will gradually be altered to suit their new medium more closely, for example by the inclusion of links to outside WWW materials which might be referenced in the same way as texts would be in a conventional paper.

The Communication Skills Guide required a different approach, as it had been created using Claris Works for the Apple Macintosh computer, which was not compatible with the PC software in use at SIM. The process was aided by the assistance of the Central Printing Unit who copied the text of each constituent file manually into a format which could be read by Word for Windows as used in SIM. The conversion was then undertaken by the manual addition of HTML tags. Navigational enhancements were made in a similar manner to the Social Sciences package, and some additional interactive and graphical features added which introduce a more personable style and stimulus throughout.

3.4.3 Courses

The final element of the site is the development of courses, tailored specifically towards teaching Research Methods in particular disciplines. Materials from the rest of the site may be built into a course, or a list of references, chosen by the lecturer concerned. These may be integrated with the lecturer's own materials and used either as a replacement for or extension to normal modes of tuition: it may be prescribed as an activity or coursework, or it may simply be used for "extended references".

The use of the HTML *frames* facility is fundamental to this section. In using this, a left-hand column on the screen is used purely as an index for the actual materials. These materials are called up on the main portion of the screen when an item from the index is chosen. Therefore, if the majority of material to be used consists of existing WWW pages, there is a minimal requirement for writing HTML - this will consist of nothing more than a plain list of URLs.

One of the project's original stated aims was to develop such a resource for the Postgraduate Diploma in Information Analysis (PGIA). This is now under development: the standard course information has been put into HTML including the Course Unit Descriptor (CUD) and bibliography, plus references to the Social Sciences package, Communication Skills Guide and selected lecture notes/OHPs. Suitable areas for online study will be identified in co-operation with the lecturers responsible for teaching the Research Methods module and the resulting module is expected to be tested with students in the second semester of the 1997/8 academic session.

4. Next Steps

The site will be announced to a wider audience, initially on a trial basis to elicit feedback and constructive criticism from a section of the academic community. The announcement will be made on a number of Mailbase electronic discussion lists including those previously mentioned, and to a number of selected individuals who are producing materials in the same area. Immediately prior to this, the site will undergo a process of revision in which consistency of style will be ensured, integrity of links checked and existing resources properly documented (there are some links which have not yet been fully investigated and abstracted).

Testing with students will take place during 1998. Suitable online materials will be identified in conjunction with the relevant lecturers, and evaluation instruments applied to test the medium's effectiveness. Evaluation checklists and questionnaires from the LTDI[10] have been obtained and will be adapted for use.

The site will at all times continue to be extended, modified and enhanced in line with feedback from the user community and as new resources are discovered.

4.1 Recommendations

[10] LTDI: Learning Technology Dissemination Initiative, established by SHEFC in August 1994 to support and encourage staff in the integration of technology with teaching. See URL: *http://www.icbl.hw.ac.uk/ltdi*

As noted above, the directory feature would be enhanced from the point of view of both of the user and maintainer by the integration of a database for storing the entries and a WWW front end which will make the directory searchable. This will enable greater flexibility, ease of use and functionality. The use of databases on the world wide web should be investigated further: it is envisaged that implementation of such a system would be inexpensive, the only major cost being the time which it would take to set up initially.

Secondly, the requirement for consistency throughout the pages points to the requirement for a system of document management: currently, pages are constructed in a simple text editor with HTML encoding done by hand. This means that any change in the overall design of pages must be individually applied to each and every page affected, a repetitive and error prone process. Software which is capable of developing and using templates which can then be filled with appropriate content would eliminate a considerable amount of low-level repetitive work and make changes much more quickly and reliably.

If large suites of web pages are in the future to be maintained with current information, both of the above issues must be considered: it will not be possible to compete with similar providers, nor to maintain extensive lists of up to date information without an automated system of document management

5. Accessing the ReMOTE site

At the time of writing the site is in a pre-release state: it has been announced to, and is in use by staff and students within RGU on an informal testing basis. Prior to announcing ReMOTE to the wider world, some additional resources are to be added, access restrictions placed on certain materials and the graphic aspects finalised. The site can be found at URL: *http://jura2.eee.rgu.ac.uk/dsk5/research*

Human Communication using Eye Movement

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Abstract: The refinement of measurement and analysis of man-machine communication using eye movement is reported. Next , we report our development of new human communication environment in which two testee put on eye mark recorder communicate each other via CRT of computer. New computer game called modified Flipper Game has been developed on this environment and the behavior of two testee are analyzed.

1.Introduction

The so-called multimedia environment on the computer gives us new possibility in education.Various subject matters on multimedia environment on the computer are being developed and used widely in a classroom now.

The behavior of a learner who communicate with multimedia environment is complicated and cannot be detected in an ordinary educational system which has mouse and keyboard as input device , so the cognitive motion of a learner cannot be used to guide a learner.Eye movement of a learner is the most important information to know the understanding level of learner about content on the environment.[Yoshikawa 92],[Furuta &Sakamoto 89]

In the preceding research, we have developed new man-machine interface in which a learner can communicate with environment using eye movement .[Fig.1-A],[Fig 1-B] ,[Nishiki et al. 97]

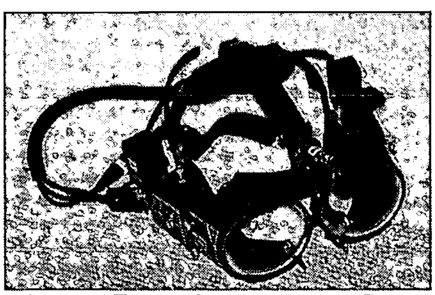

Fig.1-A:The used Eyemark Recorder:NAC EMR-600

Fig.1-B The used Eyemark Recorder: TAKEI T.K.K.2901

To obtain the fundamental aspect of this communication process, we have developed computer game called modified flipper game in which a learner can play game using eye movement.[Fig.2],[Ueno et all 96]

There is a computer game called Flipper.A player of this game moves mouse to select the squares divided on the screen, and then he can vary the color of a selected square by clicking mouse. Six colors are used in this game. The

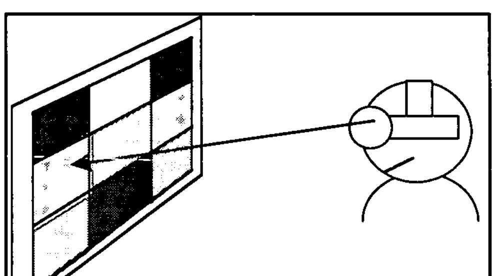

Fig.2: The Flipper Game

color of selected square changes in the cyclic sequence by player's mouse clicking. For example , purple , red ,green , blue and so on. On the other hand , the color of each square varies randomly at regular intervals in time on the CRT .When the colors of all the squares coincident , then the game is cleared. So , a player of this game must vary the color of squares as fast as possible. The player can confirm which square is selected by seeing a mouse pointer controlled by himself in this original Flipper game. We modified the original Flipper game into one which selects and changes the color of selected square using eye movement. The detail of this modified flipper game can be shown in our preceding paper,(We call this paper 1 hereafter.),we have obtained knowledge and experimental skills to understand the real time communication between a learner and system using eye movement.

Several cognitive parameters of human cognition-act process are obtained in this research. These data are necessary to prepare experiment of human communication process using two eye cameras.

And these data are necessary to describe human cognition-act schema in SIMPASI which is parallel expert system which can explain the cognition-act process of a testee who plays modified flipper game developed by us.

2. Some technical development

600 data vector are generated per second in our experiment using eye mark recorder and each vector is consists of 11 numerical data corresponding to only one eye mark of a testee.[Fig.3]. Large scale data is generated in the visual communication of the learner with system .In addition , several action data of a testee such as key input, mouse movement are added to these visual cognition data vector. In some cases, 30 numerical data are generated in each observation , so about 20000 numerical data are detected per second using one eye mark recorder. In our environment , the content of CRT varies by testee's visual action such as gazing. So,we must add more other information concerning the status of CRT to above data vector. It is not easy to analyze these data by human researcher by hand after the communication experiment has ended .

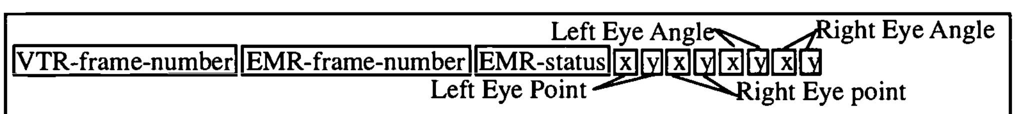

Fig.3:Eleven data obtained from one eye mark

Our final goal of the present research is to help learner using learner's real-time cognitive data such as eye movement in the communication process between learner and intelligent educational environment. The automatically acquisition of the structure of communication process from data vector is very important to understand the meaning of the complicated cognition-act process [Arbib 89] of the human testee.

And it is important to generate student model in intelligent learning environment.

The detected data of a testee who plays modified flipper game is shown in Fig. 4. These data consists of coordinate of eyes and several marks such as mouse criking and change of color generated by testee's gazing. To obtain the symbol which shows the behavior of a testee ; the rule-based analysis is necessary. At the present , we use several filters which extract the feature of visual behavior ,and then the rule-based analysis is tried in the next step.

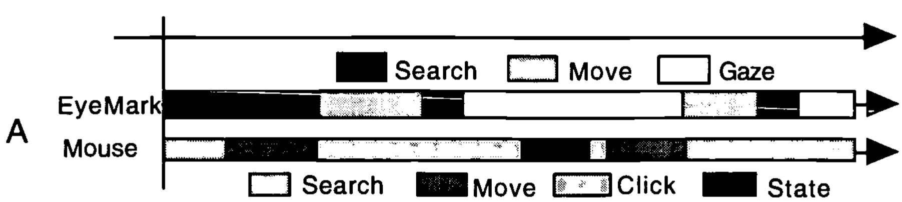

Fig.4:Realistic data vector of one testee

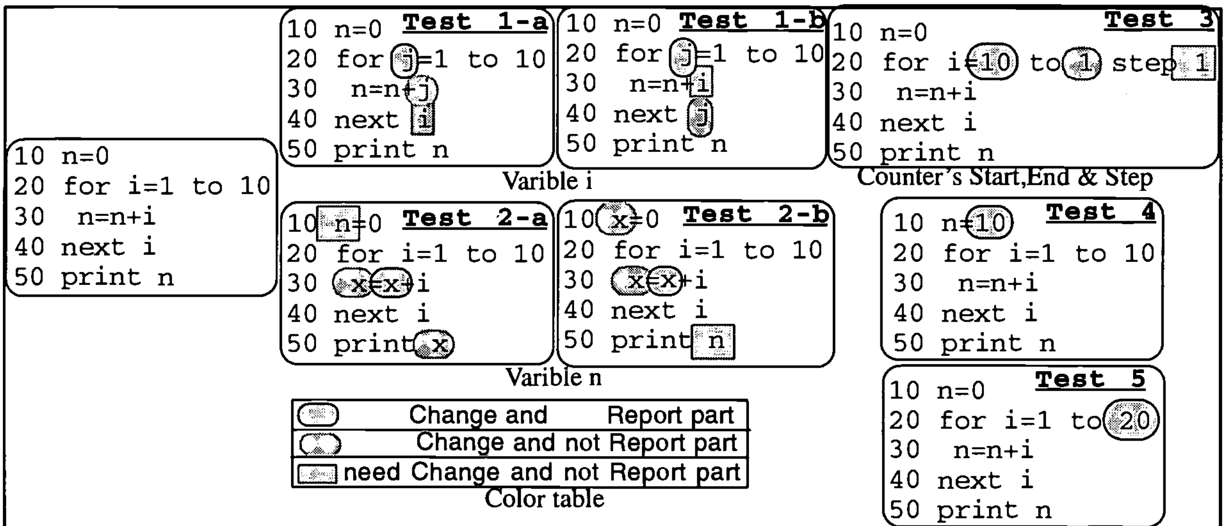

Fig.5:BASIC problem

3. Eye-movement and detection of understanding level of a learner

It is not so easy to identify the understanding level of a learner who studies computer language such as BASIC interacting with learning environment such as CAI and ITS . Many questions must be given to a learner who interacts with learning environment which assists him to study BASIC language on the computer to decide his student model critically. As the learner feels this Q/A process troublesome, the educational effectivity of learning environment on the computer is very limited.Some new methods are necessary to identify learner's understanding level withoutusing Q/A process.

The eye-movement data of a learner who is looking at BASIC programing text should have information about the understanding of the learner about BASIC language.

But,the eye movement behavior of a learner who is looking at given normal BASIC text includes many things. So,it is difficult to extract clear information about understanding of a learner from observed eye mark data.So, we have designed the following series of measurements which can extracts clear information .At first , a learner is given a problem by us to make the following program. " To obtain the summation from 1 to 10 , then show its value on the CRT." This problem is relatively easy , so our learner succeed in making the correct program shown in Fig. 5.We modified original programs made by the learner by adding only one bug to them.The modified texts are shown in Fig.5. So, we show our learner original correct program which is made by him , then next we show modified BASIC texts for only 5 sec to the learner who puts on EMR , so he must see modified text as fast as he can. But he has been familiar with these shown texts in his previous program lesson , so he can be aware of the position and kind of error in the program added by us.

We have prepared eye movement action networks about these BASIC programs to catch meaningful eye movement of a learner who is looking at modified programing text.[Fig. 6]. We can extract the meaningful eye movements of our learner by matching observed eye-movement data with a few action-object templates contained in this network.

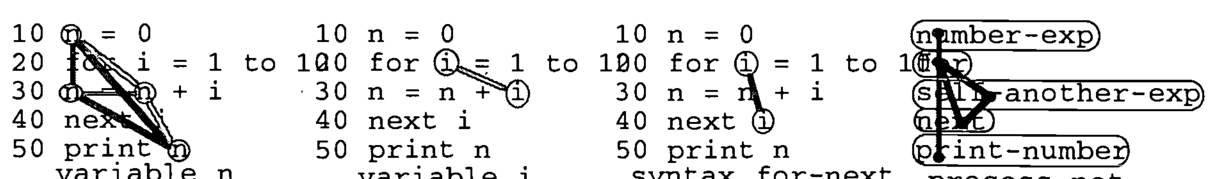

Fig.6:Eye Movement Network

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	Problem-1	Problem-2	Problem-3	Problem-4	Problem-5	Average
Testee-A	1	0.8	1	1	1	0.96
Testee-B	0.94	1	1	——	0.69	0.908
Testee-C	——	1	1	1	1	1

adapt rate of Integrate Network (rate)

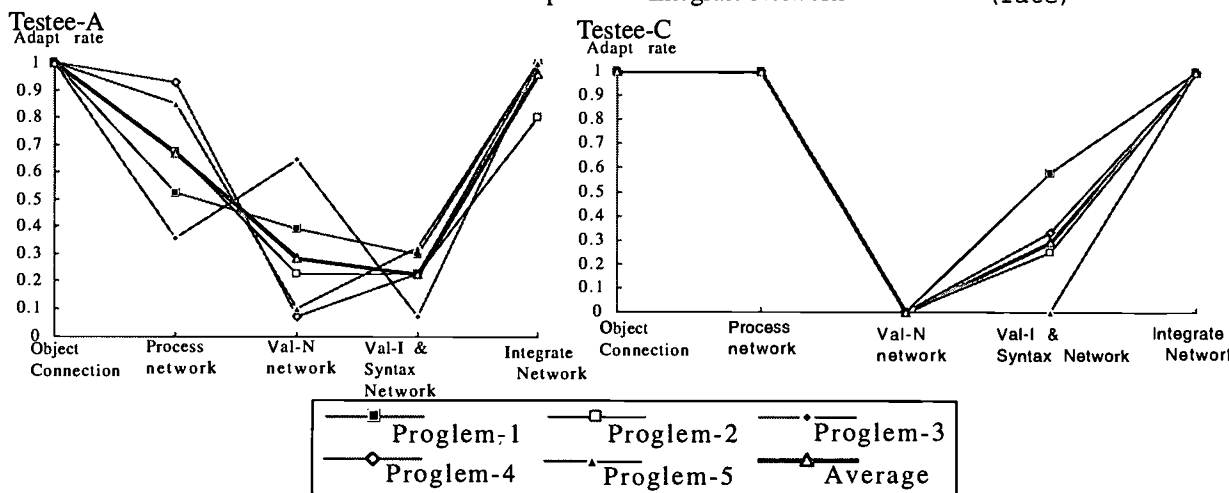

Fig.7:Result of Testee A,B &C

The results obtained from three testee A,B and C is shown in Fig. 7.Testee A is not an expert of programing , but testee C is an expert of programing.The ratio of numbers of meaningful eye movement to numbers of all eye movement of a test who is looking at five modified texts are plotted in Fig.7.

Redundant eye movements are shown for testee A , but such redundant eye movements decrease in testee C. And eye movement fluctuate for every texts for testee A , but there is no fluctuation of eye movement for testee C. Testee C seems to have steady eye movements for different texts.

We have succeeded to obtain information which gives the understanding levels of a learner from these results obtained in this measurement.[Tsubokura & Tsushima 98]

A learner is not disturbed by imposing unnecessary questions when the present method is used. This type of observation of learner using eye mark tracer does not change learner's understanding status. It has become possible to carry out undestractive observation of the learner by using

our method.This type of observation of a learner is promising to construct comfortable educational environment for a learner.

4. Introduction of one more eye mark recorder

In our preceding research, we concentrated to man-machine communication process using one eye mark recorder. But, multimedia environment is more profound and flexible communication environment in which many learners can communicate with each other via CRT of computer.

So, we extend our research into mutual human communication using eye movement in multimedia environment introducing another eye mark recorder.

In Fig. 8 , testee A communicates with testee B via CRT or Projected screen. This communication process is much more complicated than man-machine communication shown in Fig. 9.

The size of analyzed data increases and the analysis of mutual correlation between each testee's data vector is necessary in the experiment using two eye mark recorder. In order to do that , some automatic feature extraction mechanism from observed data is necessary. We have developed it using fundamental feature which is already obtained from experiment using one eye mark recorder.

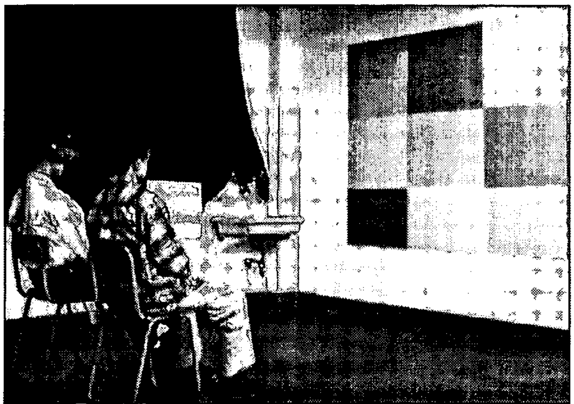

Fig.8 Present apparatus in our laboratory

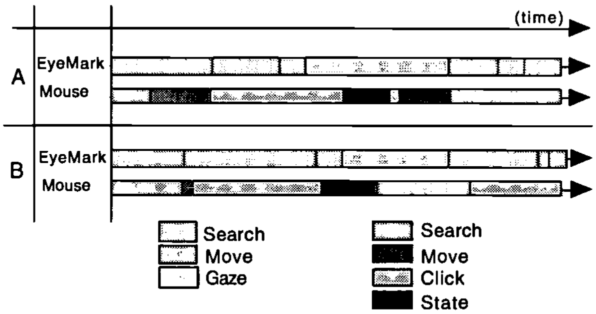

Fig.9 Realistic data vector of two testee

5. Two types of new Flipper Game

In the preceding paper , we analyzed the fundamental aspect of human visual cognition-act process communicating with CRT.In the present research , we use these results to understand human communication process using mutual eye movement. So , some typical experiment which cast the essential of this type of communication are necessary. So we have developed two types of new Flipper Games , Cooperative Flipper Game and Competitive Flipper Game.

5-A. Cooperative Flipper Game

In the preceding paper , we analyzed the behavior of our testee who was playing flipper game in detail.As it was essentially man-machine communication process , there was not the other person in the communication process. As there are two players in the present research , the situation are affected by the other's intention , so communication process becomes very complicated. There are important factors which affects the efficiency of cooperative work such as existence of common goal and allowance of communication between players. So , we have designed the following four Flipper Games which has different features.

A) Goal color is fixed beforehand and communication between players is not allowed.
B) Goal color is fixed beforehand and communication between players is allowed.
C) Goal color can be changed and communication between players is not allowed
D) Goal color can be changed and communication between players is allowed.

In case A), two players change color of divided subsquares into fixed color beforehand without communicating with each other with voice. So, one cannot assign a role of the other frequently and the used time to clear game becomes long. Two players can take strategy to share the role to clear games considering the situation on CRT in case B) , so the used time to clear game become shorter than in case A). It is not easy to guess the present goal color set by the other player from the CRT. So, a player sometimes feels as if the change caused by the other were the change caused by the system in case C).

In the case D), as the the species of present goal color can be heard from the other, he easily understand the situation , and so used time to clear game is reduced. If a player assigns the role of the other considering the real time situation of CRT, the cooperative work goes smoothly.

5-B. Competitive Flipper Game

At first , we designed the competitive flipper game in the following.

Our player must choose his goal color and he must change colors of all sub-square into chosen color. The other tetstee knows the goal color of the competitor , so he can easily disturb the action of the competitor by changing the color of subsquare.

If each player concentrates into his goal , the game ends is finished in some cases.

But, if they take strategy of preventing competitor's action , so , game does not end for case 4*4.

This type of game may be ill-setting as a game. But we can obtain several cognitive data by analyzing the behavior of players in this ill-setting game.

In the preceding paper , we reported the result of analysis of the communication of a learner putting on eye camera with a computer. We report in this paper the result of communication between two learners putting on eye camera individually via common CRT.[Fig.10] .

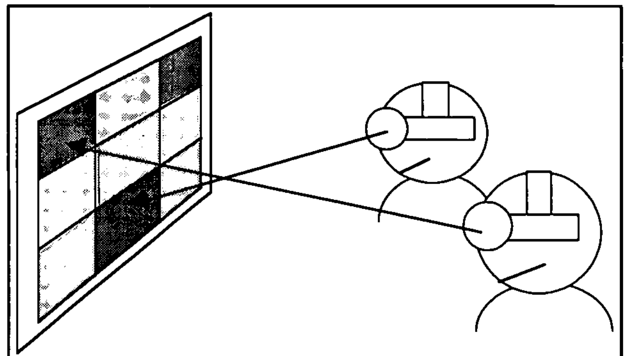

Fig.10:The new Flipper game for two players

6. conclusion

We have succeeded in constructing the frame which can identify understanding levels of learners who look at the modified BASIC programing text in Chap. 4.

And then we have developed experimental environment in which two testtees can communicate through eye movement with each other via CRT of computer in our laboratory. And we have reported some improvement to raise the efficiency of calibration system using new calibration function.We have developed new modified Flipper Game in such an environment as two players play co-operatively or competitively. These two communication process has several parameters and the behavior of player is very complicated . In this game , there are too many strategies which player takes in the game , so more simplified game is desirable to deduce critical results from experimental data.

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Instructional Design Principles for a Distributed Learning Environment

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Abstract: This paper describes the work of the Open School and Open Learning Agency in British Columbia, Canada, especially as it relates to the development of a distributed learning environment for the development and delivery of high-school level courses using technology to promote more interaction and access for students. It covers the application of instructional design principles to the development of such environments, and the special challenges these present.

The Open School—as part of the Open Learning Agency, in British Columbia, Canada—is in the business of supporting the development and delivery of learner-centred programs to approximately 48,000 learners. As a result of this mandate, Open School is in the process of creating a distributed learning environment for the development and delivery of high-school level courses (specifically Grade 11 & 12) using technology to promote more interaction and access for students.

Traditionally, the Open School has primarily developed print-based courses for distance learners—registered through one of the nine Distance Education Schools located throughout British Columbia. In recent years, there has been a move—within the Open Learning Agency and elsewhere—towards the integrated use of technology to enhance students' flexible access to content, resources, and people. This move has influenced the teaching and learning process, providing what we see as a *distributed learning environment*. This environment is made up of the following key features:

- learner-centered approach to design, development, and delivery of materials,
- electronic communications between learners and teachers,
- a modular course development process based on structured information,
- choice and flexibility of different delivery formats,
- a resource-rich environment for students, and
- synchronous and asynchronous interaction.

Open School's distributed learning environment makes use of technology and media to provide a student with choices beyond those normally available in a centralized environment like a classroom. This might look like a distance learner using print materials and watching scheduled television broadcasts in order to complete a course; it might also look like a classroom-based learner using the Internet to interact with experts in a particular field. The implementation of a distributed learning environment has helped Open School deal with issues facing the development and management of courses for a variety of learners—learning at different times and in different venues.

The following table outlines some of the issues and strategies the Open School is currently implementing.

Table 1: Issues and Strategies

Development and Delivery Issues (Drivers and Needs)	Distributed Learning Strategies (Developments and Characteristics)
Completion rates, student success and satisfaction	Teacher-mediated distance delivery model; Rich communications infrastructure; Development of a community of learners
Enhanced student engagement and greater depth of participation	Active learning encouraged through instructional design strategies; Course materials linked to communications infrastructure: conferencing discussions, collaborative forums
Reducing student isolation in "distance" model	Collaborative, communication-rich learning environ– ment; Development of a community of learners through the use of technology
Keeping course materials current and/or dynamic	Tightened revision cycles and content management processes through structured information (SGML); Database integration with document content
Customizing for differing market needs	Different versions of a course produced from a single, centrally managed source, based on specific criteria (mediated/non-mediated, print/online, skeletal/fully elaborated)
Flexibility for differing student needs or styles	Resource-based course construction model: parallel strategies to meet specific outcomes
Multiple modes of access	print and online courses; text, audio, video, and inter– active resources; ensuring integrity across versions by explicitly tying course materials and resources to outcomes

Although a distributed learning environment offers many varied and flexible learning opportunities for learner, it also presents challenges to those involved in the design and development of course materials. From an instructional design perspective the challenges include:

- a learning environment characterized by dynamic content,
- varied instructional support,
- resources and multiple media in varied delivery contexts,
- differing student needs.

To guide the instructional design of courses within this environment, key instructional principles need to be considered, as listed in the following table:

Table 2: Instructional Design Principles

Learning outcomes	Used to implement a learner-centered approach. Used as building blocks for content development. Provide guidelines for learners to be able to demonstrate what they *know* and are able to *do*.
Structure and presentation of content	Content structured to allow flexible and customized learning experiences. Use of multiple media and resources to provide a richer learning environment.

Table 2: Instructional Design Principles

Assessment	Application of authentic approaches to assessment (real-life and real meaning for students). Focus on students "demonstrating" their learning Based on criterion-referenced assessment strategies. Focus on the process of learning versus the end-product.
Feedback	Feedback as a mechanism for change for learners. Providing non-threatening and supportive feedback to assist in the development of learning.
Role of the instructor	Facilitator or guide. Facilitate the learning process through negotiation, stimulation, and monitoring discussion and project work
Technology	Help facilitate the learning process by allowing: – increased access – improved presentation of content, – increased learner interaction, – flexibility in selecting most relevant resources, - structured content management

These principles support an underlying constructivist approach to design and development while at the same time considering the multi-faceted nature of a distributed learning environment.

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Supporting Awareness for Augmenting Participation in Collaborative Learning

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Abstract: Knowledge awareness (KA) has been proposed for increasing collaboration opportunities in an open ended and collaborative learning environment. KA consists of information about up-to-minute activities of other learners. For instance, it indicates when someone is looking at the same knowledge that learners are looking at. Multiple collaboration is concurrently realized through KA. This paper describes a concurrent collaborative learning environment supported by awareness, toward augmenting participation in collaborative learning. We tested and verified the effectiveness of this system in an experimental training.

I. Introduction

Recently, a number of collaborative learning environments have been built advocated by educational theories[[O'Malley 94], e.g., CoVis [Edelson et al. 96], KIE [Linn 96], and CSILE [Scardamalia & Bereiter 96]. CoVis focus on making a collaboration process visible. KIE succeeds by helping students link, connect, distinguish, compare, and analyze their repertoire of ideas. Moreover, CSILE supports knowledge building for the creation of knowledge. In such environments, the learners actively provide their own knowledge into the system.

Knowledge acquisition and open ended CAI systems [Yano et al. 92] have been proposed to enhance and sustain learners' motivation. Especially, when learners acquire knowledge in the context of an open-ended activities, they are more likely to use that knowledge later. Similarly, in collaborative learning, distributed expertise and multiple perspectives enable learners to accomplish tasks and develop understandings beyond what anyone could achieve alone. Lave and Wenger [Lave & Wenger 91] suggested that the consideration of learning as legitimate peripheral participation (LPP) in communities of practice can be a valuable analytical perspective. Therefore, it is very important for learners to collaborate with each other. However, little attention has been given to the technical support for inducing and augmenting participation in collaboration.

In computer supported cooperative work (CSCW), a collaboration process has been described as a four processes model [Matsushita & Okada 95] which includes the elements of co-presence, awareness, communication, and collaboration. Co-presence gives the feeling that the user is in a shared work space with someone at the same time. Awareness is a process where users recognize each other's activities on the premise of co-presence. In the next process, the user collaborates on the specific task with other users and accomplishes the task and common goals. To increase communication opportunities, awareness is one of the most interesting topics. For example, awareness informs what other users are doing, and where they are working. These information facilitates informal communication between distributed users.

We have suggested that knowledge awareness (KA) is an important factor in collaborative process because not only it assists learners who are interested in the same knowledge but also it creates effective collaboration in an open ended learning environment [Ogata et al. 96a, Ogata & Yano]. KA gives the learner the information about other learners' activities in a shared knowledge space. KA encourages collaboration by exciting learner's curiosity and it fosters active learning.

Sharlok (Sharing, Linking and Looking-for Knowledge) [Ogata et al. 96b] has been developed as a testbed of KA. Sharlok is an open-ended and collaborative learning environment. It integrates a knowledge building tool with a collaborative interface tool. The result of the evaluation of Sharlok was that KA was very effective for inducing collaboration. However, KA has not yet been supported in the middle of collaboration. In this paper, we describe how KA during collaborative learning can be supported by Coconuts (Concurrent Collaborative Learning Environment Supported by Awareness).

We firsts describe the nature of collaborative learning in an open group in section 2. Section 3 presents overview of Sharlok and KA. In section 4, we presents the features and implementation of KA during collaborative learning. Moreover, we describe the experimental results of this system in section 5. Finally, the concluding remarks are given in section 6.

I. Collaborative Learning in an Open Group

A. An open-ended collaborative learning environment

Our research focuses on open-ended collaborative learning using computers and Internet. Table 1 shows several variables of collaborative learning in a closed group and in an open group. In a closed learning environment, like for instance, an ordinary classroom, a teacher organizes groups, gives the subject to the each group, and sets the time table for the discussion in advance. In this case, the learners can easily be very passive in group participation. Compared with this, learning in open groups is very active and learner-centered. The learner can join into discussions spontaneously and the participants of each discussion may be changing during time. Since, the students set the topic of the discussion based on their curiosity, so the beginning of the discussion is not previously defined. Moreover, in the open group, the participant can communicate both with other participants and with non-participants as well. It is very important for the participants to interact with non-participants for gathering information and understanding the topic of the discussion more deeply.

Table 1: Collaborative learning in a closed vs. open group.

Discussion	*Closed*	*Open*
Participants	Arranged	Random
Topic	Preset	Ad hoc
Time	Scheduled	Unscheduled
Communication	Inside group	Inside & outside group

A. Time dimension of open-ended collaborative learning

Figure 1 shows a time chart of open-ended collaboration. There are three parallel sessions in this situation. Learners can be classified into those who:

(1) participate since the beginning of the session;
(2) participate halfway through the session;
(3) leave halfway through the session; and
(4) leave at the end of the session.

From the chart, we can conclude between others, the following facts. Although the participants of discussion C did not change, participants changed during discussion A and B. The learner X did not understand which session to join neither how to participate in the discussion. Therefore, we propose that the system should support the learner to understand the discussions.

Figure 1: Diagram of open-ended collaboration.

A. Taxonomy of participation

In open-ended collaboration, there can be found some different kinds of participants except non-participants (see fig. 2):

(1) *Observational participant (OP)*: In this case, the learner only observes a discussion without utterances. Through observation, the OP can understand multiple discussions and eventually decide to join one of them.
(2) *Direct participant (DP)*: In this situation, the learner joins in a discussion and his/her opinions are shared and can be discussed by all of the DP of the same discussion team.
(3) *Indirect participant (IP)*: In this case, an OP interacts with DPs of any discussion team but without going any particular team. This situation can be motivated in two different ways, either a non-participant (NP) decides by himself/herself to give advice to a DP, or any DP asks a NP to give his/her opinions. The advises from the NP often makes the discussion active. Therefore, indirect participation is very significant to argument participation in collaboration. In this context, the communication may be informal because not all of the DP may know about the communication in which the NP is involved. An OP is a better collaborator than a NP because the OP knows the content of a discussion. Awareness of collaboration is needed to allow users such informal communication.

The learner may concurrently participate in multiple collaboration by combining different kinds of participation. To augmenting participation in collaboration, educational groupware systems should support observational, direct and indirect participation.

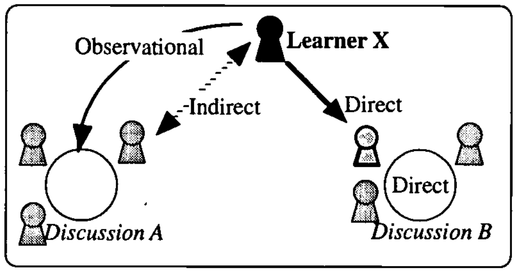

Figure 2: Participation form of concurrent collaboration.

I. Overview of Sharlok and Knowledge Awareness

A. Sharlok

Sharlok has an open ended and collaborative learning environment connected via Internet. The characteristics of Sharlok are the following:

(1) Sharlok allows learners to share their respective knowledge, consequently the learners can cover the lack of mutual knowledge each other.
(2) Learners can explore in a shared knowledge space according to their interests.
(3) Learners can link between relevant knowledge by hypertext link. Using such a shared knowledge space, they can learn covering multi-domain.
(4) By creating or joining collaboration during its use, learners can confirm or correct the knowledge. This process supports practical learning.

1. Personal learning environment

The personal learning environment of Sharlok has the following functions:
(1) the definition of a class;
(2) the creation of an instance object of a class;
(3) browsing search for objects;
(4) authoring of links between heterogeneous objects; and
(5) navigation of objects.
Sharlok enables learners to create and define new classes. Learners can create objects and input their knowledge by using pairs of attributes and values, texts and figures. They can start collaboration by asking a question. Sharlok invites learners to do collaboration. If the learner agrees, he/she becomes a participant of the collaboration.

1. Collaborative learning environment

Sharlok allows learners to communicate and collaborate in a collaboration window which consists of a text chat tool, and a group drawing tool. In the text tool, participants can write their respective ideas. Moreover, the drawing tool shows their mouse pointers and it allows them to draw figures at real time. Sharlok records the processes of the collaboration and it makes this information retrievable and accessible for all the learners.

A. Knowledge awareness

In CSCL, awareness is very important for effective collaborative learning and it plays a part in how the learning environment creates collaboration opportunities naturally and efficiently. Awareness may lead with informal interactions, spontaneous connections, and the development of shared knowledge. Although a large number of studies have been made on such awareness in single group collaborative learning, little is known about awareness for multiple and concurrent collaborative learning.

We assume that KA is the information for enhancing collaboration opportunities in a shared knowledge space (see [Ogata et al. 96a]). Its messages are about the other learners' real-time or past-time actions, that have something to do with knowledge on which a learner is doing or had already done. KA makes a learner be aware of someone who: (1) has the same problem or knowledge as the learner, (2) has the different view about the problem or knowledge, and (3) has potential to assist him/her in the problem solution.

There are two ways for providing KA: "passive awareness" and "active awareness". In the passive way, the system does not show awareness information until the learner requests it. In contrast, active awareness is autonomously informed to the learner. Sharlok induces spontaneous collaboration between learners using active awareness. For instance, User A may start to collaborate with User B by active KA which informs that User B has updated User A's knowledge. However, it is necessary to inform a learner only the important part of KA instead of all of KA. Therefore, we have proposed a new method for filtering KA [Ogata & Yano 97].

KA has a close relation with learner's curiosity. Hatano & Inagaki [Hatano & Inagaki 73] identified two types of curiosity; convergent curiosity (CC) and divergent curiosity (DC). DC occurs because the desire of learning which makes learner's stock of knowledge well-balanced by widening learner's interests. On the other hand, CC is generated for the lack of sufficient knowledge, it is very useful so that the leaner can acquire more detailed knowledge. KA induces collaboration by exciting learner's curiosity. In this way, KA assists creating real-time collaboration. However, awareness for concurrent collaboration is not proposed.

I. Coconuts

A. Overview

We propose Coconuts (Concurrent Collaborative Learning Environment Supported by Awareness) module in Sharlok in order to facilitate the participation into an open-ended collaborative group. Coconuts informs up-to-minute the participants' activities of concurrent collaboration. To augment the participation in collaboration, Coconuts has the following features:

(1) Awareness support for observational participants: In order that learners can be aware about what is discussed and who is participanting, Coconuts allows them to peep at multiple collaboration. After awareness of collaboration, the user can see the multiple discussion at the same time. Because direct participants do not know the existence of observational participants, the collaboration is not disturbed.

(2) Awareness support for indirect participants: Coconuts allows the user to communicate informally in the following ways: (a) from non-participants to participants; and (b) from participants to non-participants.

(3) Awareness support for direct participants: Coconuts allows learners to communicate and collaborate in real time. This environment provides workspace awareness for participants. Moreover, the system informs the participants who can help the discussion. Therefore, the participation of discussion increases;

(4) Awareness support for non-participants: Coconuts lets non-participants know which discussion to join into. Particular, the system actively shows the users the information about discussion only when users are not doing any operation.

A. System configuration

Sharlok consists of a client and a server program (see fig. 3). The server has four components: a shared database, a history database of learners' actions, an awareness server and a collaborative tools server. The shared database stores students ideas and collaboration processes. Awareness server manages the history database. On the other hand, a client has a student monitoring module, an awareness client, a collaboration tools client and a user interface module. Sharlok monitors the learners' activities in the shared knowledge space and it stores them into the history database. Awareness client provides awareness to the learner according to learner's actions.

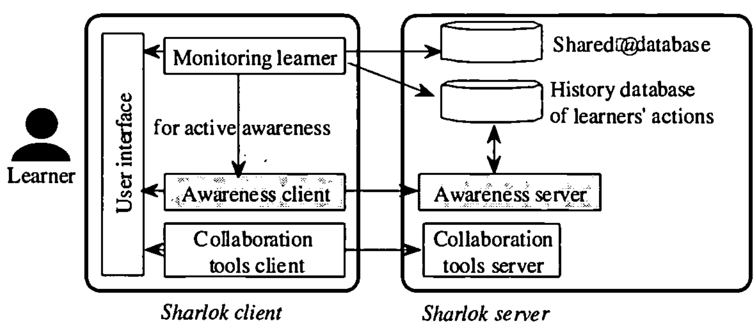

Figure 3: System configuration.

A. User interface

We have developed Coconuts using Sharlok. Figure 4 shows some screen snapshots of Coconuts in Sharlok which is used by two users: "sharlok" and "rinzu". "rinzu" collaborates about Japanese writers with "sharlok." Window (A) denotes the titles of current discussions and their respective participants. If the user selects a topic and pushes the peep button, coconuts shows the up-to-minute snapshot of the discussion as shown in window (B). The update button allows users to see the current collaboration state. The user can take part in the discussion with the join button. Coconuts allows users to observe multiple collaborative groups. The user can send a message by pushing the message button. In window (C), "takahasi" informally communicates with "rinzu". Moreover, a formal participant "rinzu" can ask some question about the discussion by selecting the help button. "To list" shows who can receive the message from the user. Coconuts provides the user with a message window like this shown on window (C) and "To list" shows who to send the user's message.

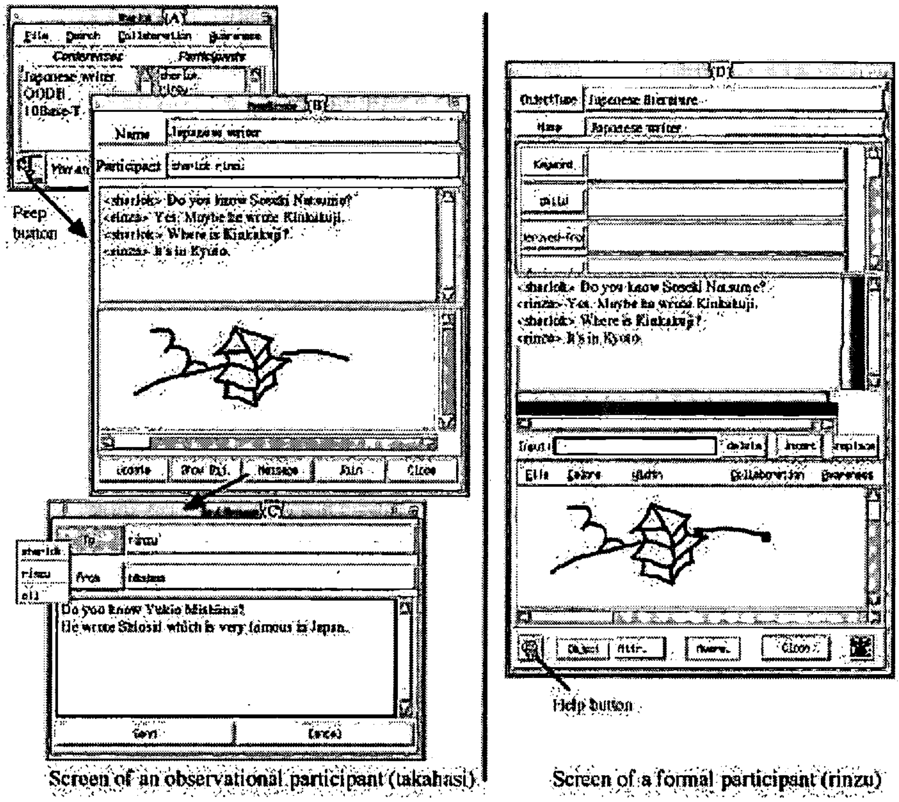

Figure 4: Screen of Coconuts in Sharlok.

I. Experimental Results

To evaluate Coconuts, we integrated a group of nine master course students. They had been using Sharlok during over 4 hours; two hours unsupported by Coconuts (group A), and another two hours supported by Coconuts (group B). Each user explored into the shared database and discussed sixty times about different topics, for example, SGML, OODB and 10Base-T.

Figure 5 shows the experimental result. The total frequency of participation of group B was higher than that of group A because Coconuts provides awareness and different kinds of participation. In particular, IP was very effective for increasing participation. In group B, the provision of awareness decreased wasteful formal participation. Some users mentioned that Coconuts helps to reduce the number of participants who left the discussion before it finishes. By OP, the users could understand the contents of multiple collaboration. The learners learned actively through real-time collaboration, and they felt satisfaction and attainment of learning after the test.

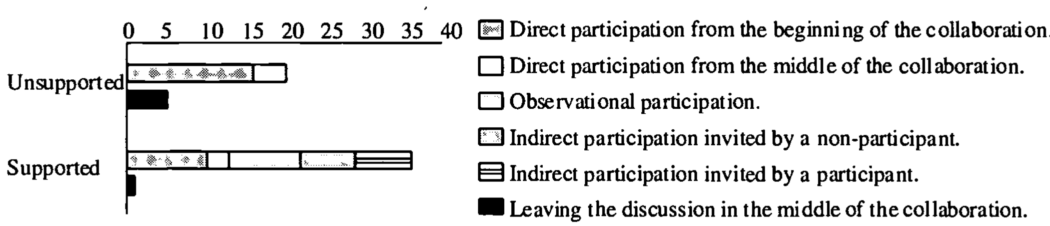

Figure 5: Frequency of participation.

I. Conclusions

In this paper, we proposed Coconuts for supporting awareness in a concurrent collaborative learning environment. We reached the following conclusion based on the experimental result of Coconuts:

(1) The provision of awareness facilitates the participation in multiple and concurrent collaboration and it reduces wasteful formal participation.
(2) Informal communication activates collaboration.

Although this paper describes a short term experiment, we will continue using and evaluating Coconuts in the future.

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A Case Base Reasoning System on the Internet for Reference of Information Technology Education for Teachers

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Abstract: While our society is becoming increasingly information-oriented, Information Technology Education (IT-Education) has just started from elementary schools to highschools, in nearly all Education sites. We are building a database which covers actual cases of such education, together with a management system based on CBR (cased based reasoning), accessible to the public through the Internet. Teachers can input their experience of IT-Education into this system using the CBR method, or just check among past cases, similar to their present application. By using this system, teachers from any Education environment, urban or local, can share a common knowledge of IT-Education practice.

Foreword

The modern society is more and more information oriented, thanks to the advances of scientific technology we witness in everyday life. We accept this as a fact. This phenomenon has brought about a new kind of teaching which not enough history to refer to and apply in actual class teaching. The existing cases are in reality not known to the public, and there seems to be no market to exchange the ideas and information about such experiments. They are hidden as teachers' private experiences. It is therefore required to create a place where private knowledge may be shared by a wider group of teachers through IT-Education and lead to a global refining of teaching methods, which would lead to quality improvement and to teachers' self improvement [Okamoto 1996, Nishinosono 1996]. Our aim with this research is to construct a Case-Based System for Information Technology being taught at high schools nationwide and put the developed system on the Internet. A great number of teachers could access this system, however far they are located from each other geographically, and use this system anytime in spite of hindrances such as time and location.

Study Purpose and Case-Based System

The users of our system will be teachers who are actually contributing to IT-Education, and also would-be participants. The system enables us to build a database for actual practices of IT-Education, and also accepts searching and registration of cases from anyone. For those who are actively involved in the Education process, reference to past similar cases will help to improve their teaching methods, when they find their teaching process not going as well as they've expected. For the would-be participants the system will offer past good and bad examples of the area, as guiding points for their future research. Our system sear the past history of the cases similar to a particular or possible class lesson, given some profile descriptors as IT-Education search criteria.

Registration of Cases

Registration of cases can be done by any teachers who have experience in teaching IT-Education. Data are input by several formats. Class, teaching method are input by choosing among a set of optional, ready-made items. At the same time, teachers can fill in the free area with their own work-out programs and students' reactions without following any specific format. Also, they can put levels of relative value between input cases and actual teaching contents by adjusting some tuning options. Thus the system learns by acquiring new knowledge with every registration of actual teaching contents and methods. Registered cases are to be included in the database and can be a target for future search.

Search of Cases

Case searching is designed for teachers who need to check past cases of IT-Education. They will input profile descriptors which define search patterns. The system actually sear past cases using these search patterns and a similarity measurement, and finally returns the case(s) which match the tea need best. If the result corresponds, in the system's conception, to the actual need of the teacher, the system will display it. The result contains information about the actual class procedure, about the topics and about an overall judgement of the teaching process. If the teacher wishes, he can ask for further detailed information about each item of these cases.

Adjustment of Cases

If the output is not what the user wants, the system tries to adjust the result by using the rule base of domain knowledge that is pre-installed, to fit the user's need approximately. When this adjusted result is considered to be appropriate, according to the similarity function computation, it is called a 'hit', and the adjusted result is added to the database as a new case.

Figure 1 : A typical example of CR

Figure 2 : The system architecture

CBR

To construct a system as above, CBR theory of knowledge processing and technology is used [Riesbeck 1989, Hammond 1990, Kobayashi 1992]. We give here the details of CBR and explain its efficiency for our system. Expert systems tools such as Rule Based Reasoning and Model Based Reasoning have been widely used to solve problems within certain intelligent systems. The former is efficient as it is based upon the expertise of domain specialists, but is vulnerable to knowledge acquiring. Similarly, Model Based Reasoning, which uses principles and laws of the structure of the target system, shows high reliability, but low efficiency. CBR consists of a set of problem solving architectures leading to a solution, wile using past cases of success and failure, similar to a given problem [Hammond 1989]. A typical example of CBR architecture is shown in fig.1. CBR eliminates the above problems and adds efficiency.

An exhaustive search through the case base takes a lot of time and a vast amount of calculation. CBR can reduce the tracking space by applying filtering criteria directly to an index file, which saves search time and volume. Therefore, our system can be implemented on middle range computers. When the picked-up result match the problem, the result is the desired solution. The result can be, however, rather far-fetched. Thus the need of adjustment using appropriate domain knowledge with the case repair module, which finally leads to the desired solution. This adjusted result is applied to the particular problem, and if it solves it, it is added to the database as a successful case [Kolodner 1993].

System Architecture

The Case Based System is being developed with the use of the WWW so that teachers and common users spread far from each other geographically may have access to the same system. The system doesn't require specific browsers, but can function on any desired one, and offers search and registration service at anytime and in anyplace. Users' information is processed and administrated systematically with the use of the CGI (Common Gateway System).

The WWW interface offers an interactive process between users and the system. cases are kept as HTML files. For efficiency's sake, an index file keeps profile descriptors of the cases. This file is used when the actual searching takes place. The system architecture is shown in Fig.2.

Case Base

The Case Base comprises two kinds of files. One is a set of case base files which describe actual class cases in the form of a frame, and the other one is an index file, which keeps specific descriptors of actual class cases. When a case is registered as a HTML file, registration/installation is done in the form of a frame. Three descriptors create each frame: the profile descriptor, the contents descriptor and the address descriptor.

Profile Descriptor

The profile descriptor contains the characteristic elements of actual class cases. The practice of IT-Education varies much, depending on the characteristics of each class and on the thematic genre of the specific informational area. The teaching procedure is selected by evaluating both class and specific thematic genre. Computers can be used in a class in a variety of ways. It is presumed that a class, where students actually write programs using computers, gives a different result from when they learn with the aid of ready-made applications such as CAI programs. If computers are used at an inappropriate time during class, we cannot expect good results. We also have to take into consideration that the number of computers available varies from school to school, so that the number of computers available to one student depends on the school the student belongs to. Therefore, the result from using computers is not simple. Also, the teaching/learning procedure is influenced by the different class aims, so that even if the same thematic genre of informational area would be studied, but in different classes with different subjects, the result cannot be the same. With all these circumstances in mind, we defined the profile descriptor slots as follows. Table 1 shows the profile descriptor slots and their possible values (range facets).

Table 1 : Profile Descriptors; some values

Slot names:		Range facets:
Pin-pointed	I) Teaching Subject	Simulation, Internet, Spread Sheet, Graphic Analysis, Programming, Chart Making, Problem Solving and its Algorithm, Measurement and Control of Information, Basic information in Technology, Information and Society
	II) Names of classes	English, Math., Language, Science, Social Study, Art, PE.
1) Lowest relation degree allowed between Teaching Subject and database case		Comparison and relativity value between teaching contents and related output (0-10)
Class working rate		2) Rate of Lectures, 3)Practice, 4)Experiment/lab. Work in terms of time (0-10 respectively)
Class formation rate		5) Individual learning, 6) Simultaneous learning, 7) Group learning. Their rate in terms of time(0-10 respectively)
8) Frequency of computer use		Use of computers during a class, in terms of time percentage (0-100%)
9) Use of computers		For word processing, for CAI, for communication as a notice board for students, for the Internet, for CAD, or no CAD at all
10) Number of students registered for a class		Actual number of students (no upper limit)
11) Number of computers		Number of available computers (no upper limit)

Contents Descriptor

The contents descriptor shows the details of the teaching contents and the teaching result of each case. The IT-Education knowledge of teachers who have actually participated in the teaching is to be assessed with a value in each slot. Teachers are expected to offer a teaching subject with an appropriate Education purpose and to add also the teaching contents. They have to study the essentials of a certain teaching content and use a variety of teaching materials and machinery devices, in order to create a lesson easily understood by the students. At the end of each class session, teachers grade students from the various points of view of the IT-Education. Moreover, teachers assess their own IT-Education ability themselves, as being either a good or a bad teaching job, and they compile the important points of the education process and add them to the IT-Education curriculum. With these in mind, we designed the slot column and value column of the contents descriptor. Table 2 shows examples of slot and value fields of this descriptor. For the value field, whole text files can be used to fill in the column, so that there is enough place for detailed information.

Address descriptor

This descriptor shows the detailed environmental information of each class teaching: school name, where the teaching has been carried out, teacher's name(s), class name(s) (non-specific, science, English, economy, engineering, agriculture, polytechnic, etc.), class tag and students' grade. At the same time, when the school's network topology and the detailed teaching information at that school can be reached through the Internet, the

Table 2 : Contents Descriptors; values

Slot names:	Range facets:
Aim of class	To know traditional local industory and ...
Characteristics of the class study	Referring to traditional local industory through a homepage .
The good points of the class	Using the Internet ...
Teaching suject	Traditional local products
Teaching device	Video tapes
Accumulated knowledge presentation	Putting the student papers on a homepage ...
Points to be amended; Proposals to curriculum	The number of computers per student are limited ....
General report on the result	More interest for the internet was achieved ...
Grade	Good job

Table 3 : Address Descriptors; some values

Slot names:	Range facets:
School	University of Electro-Communications, Tokyo
Teacher in charge	Toshio Okamoto
Genre	Engineering
Class Tag	Compulsory
Grade	Second year
Network topology	Has access to Internet
URL	http://www.ai.is.uec.ac.jp/

URL of the school is given. Table 3 shows an example of slots and values of the address descriptor.

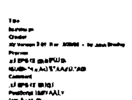
Interface

The system http://www.ai.is.uec.ac.jp/~chusen/CBR/SYS/ offers two interfaces, the one when users register, and the other one when users search for similar past cases. To make a registration, users have to fill in the above three descriptors, i.e., profile, contents and address descriptor. Input data will be transferred to the registration module of the system server through the Internet. Fig.3 shows the registration menu.

Searching for past cases, the users input characteristics of the data they need, as value columns of the previously shown profile descriptor. Users can input searching weights values by manipulating keywords (Fig.4). As users have three possible outcomes for their search: past successes, failures, and a mixture between the two, they can specify which of these results are to be shown to them Users can be interested in past failures as well as in past successes, depending on their interest in reiterating success cases or preventing mistakes that have been already made. .

Case Registration

The case registration module records values from the above stated three descriptors into one HTML file. At the same time, the system draws a numerical value from the key descriptors, and installs a numerical value in the index file. The index file is there to make case search more efficient. In the registration process, the inputs with no valid value are automatically rejected.



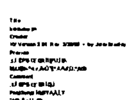


Figure 3 : Registration Page

Figure 4 : Searching Page

Case Search

The case search module draws search patterns from the information clients have given. These patterns include keywords from the key descriptors' value column and also search formats. Search formats, class genre and class contents determine the system values of the appropriate slot. The system has thus the possibility to choose suitable cases matching all these search conditions from the index file. The system then inputs these similar cases into a similarity function and draws as satisfactory cases as possible from among them. Thus, the output result cases drawn from the vast database are considered to satisfy the search condition best.

Approximate cases

The system starts searching for patterns similar to those input by the user. To apply the similarity function, which can be also seen as a search function, to all the cases in the database, means scanning a vast search space, which can be very inefficient and time-con Therefore, to minimise the search area, the system pinpoints approximate cases with the aid of input values from two kinds of slots here, for instance, slot 'teaching subject' and slot 'name of class' of the profile descriptor. Class names and teaching contents are indispensable search patterns to pinpoint cases. The system will then apply the similarity function to the pinpointed cases, and then will check the final output value of the similarity function. The case with the minimal distance between users input and registered data are considered to be the best result with the highest similarity degree to the user's needs. This pinpoint procedure enables the system to seek through as little case space as possible for the target and leads to an efficient case search.

Similarity Function

The system carries out pinpointing with a matching process referring to the two highly significant slots mentioned before and applies the similarity function to each of the pinpointed cases. This is how the similarity value is computed. The system checks the similarity value to measure the distance between each case and the search pattern input by the user. The shortest distance between them will be the best approximate case. We define the similarity function as:

Title:
/home/becky/kayama/doctor/Miz/Doc/ED_MEDIA/Final/Chu/equ.eps
Creator:
IslandDraw for kayama
Preview:
,±,Ì EPS Œ`®,Ìì§²Ù,Í¤A
ÌßÚÊÞ-°·ŧ«,Á·Ü¶¶,²,ê,Ä,¢,Ü,¹,ñ¤B

Here, U is the search pattern users input. T is a case already in the database. $D(U,T)$ is the distance between U and T. Su_i is the numerical value of the search pattern, St_i the numerical value of the registered case, with i the order of the numerical search pattern in the profile descriptor (Table 1).

Su_{key} is the percentage rate of the input keyword in the value slot corresponding to the slot 'General report on the result' in the contents descriptor (Table 2), with key the number of letters of the desired pattern, n the number of occurencies of the desired pattern in the text, and St_{result} the total number of letters in the database text. As for Su_{key}, an example of computation can be found in Fig.5.

Title:
/home/becky/kayama/doctor/Miz/Doc/ED_MEDIA/Final/Chu/keyword2.eps
Creator:
IslandDraw for kayama
Preview:
,±,Ì EPS Œ`®,Ìì§²Ù,Í¤A
ÌßÚÊÞ-°·ŧ«,Á·Ü¶¶,²,ê,Ä,¢,Ü,¹,ñ¤B
Comment:
,±,Ì EPS Œ`®,Íq,Ì
PostScript ÌßØÝÀ,Å,Ì,Ý
°ó¤,Å,«,Ü,·¤B

Figure 5 : Example of Su_{key}

The slots (1)-(11) in Table 1 are used for the computation of the similarity function used in the searching process. Each value of (1)-(7) is input by the user as values from 0 to 10. These inputs are converted into 0-1 values, and handed over to the similarity function. The evaluation of each slot (1)-(7) means the computation of the Euclidean distance between the searching conditions input by the user and the recorded values. In what concerns slots (8)-(11), they are evaluated from the point of view of *computer usage* and integrated into a single value, the *Comp* value in the similarity function definition equation. $d(u_l,v_l)$ computes the difference between the stored pattern and the user's input for the usage purpose of the computer (contents of slot (9), profile descriptor, Table 1). Here, $d(u_l,v_l)$ is computed as follows: it is 1, if u_l and v_l values coincide, or 0 if not. (10),(11) are used for the computer per student rate, and generate the value Com_{rate}. After computing this presented function, the system returns to the user the result which has the lowest $D(U,T)$ value.

Learning

In this chapter we explain in more detail the process of CBR learning. The main system's training consists in the usage of the case modification mechanism, the case diagnosis mechanism and the case repair mechanism.

Case Modification

In the case searching process, the most similar case, according to the user's search conditions, is gathered. The profile descriptor of the searched case and the user input search conditions are rarely in perfect concordance. Therefore, cases which don't coincide can be tuned by the modification mechanism, according to the user's conditions.
The user is tuning all slots for the case he is looking for. During tuning, the system presents pertinent choices for the slot, so the tuning can be done easily.

Case Diagnosis

The case diagnosis mechanism is testing the validity of the case which was tuned. The diagnosis mechanism is using the domain knowledge base of relations between the slots or the slots' value, a.s.o. If the result of this diagnosis is valid, the case is presented to the user. If it is not valid, the reason of invalidity is shown to the user, and a new tuning is repeated.

Case Repair

After the case diagnosis, the case diagnosed is attached features with the case repair mechanism, that are stored in the case data base. The repair mechanism adds some information and saves it as a case repair information frame. The stored information are 1) an information pointer to the modified case (the most similar case to the user's search conditions) and 2) the case modification frequency flag. This information is used for the case search. In the process of case selection, the system sear the case input by the user (we call this case the original case). If nothing matching is found, the system sear the modified case base, based on the original case and the case modification frequency flag. This flag expresses a class hierarchy number, that is created together with the modified case, and is equal to the number of modifications of the original case. Therefore, the functioning of the search mechanism reflects the modification experience.

Discussion

As the system requires from users to specify the desired relative value between input case and the actual teaching subjects stored in the database, a precise assessment. The fact that desired patterns that have to appear in the teaching contents allow a more flexible search than simple keyword matching systems.
The system has now been actually implemented and can accept case registration and provides the search function. Future improvement can be done to adjust the output result.
We are installing one case as one HTML file just to make the search procedure efficient, but it is presumed that the registration number will increase to a vast degree. It is impossible to control the whole database by only one domain frame. Therefore, we are planning to split the database into several different divisions, so that a distributed management system may be constructed. After all these adjustments, the system will be able to offer better results to the users.

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The Phedias Graphics System: A 3D Computer Graphics Project Environment

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Abstract: A common course in Computer Science curriculums is Computer Graphics. This course favors dynamic and interesting projects. The Phedias Graphics System (PGS) is a system for supporting projects in computer graphics courses. It has been designed specifically for instruction and provides for students a powerful tool for practicing new skills. The environment is transparent and allows students to examine the processes involved rather than treating a graphics system as a "black box". It has many unique features useful in pedagogical environment, including separation of modeling and rendering and support for both rendering and modeling projects. This paper describes PGS and its application in courseware. Particular attention is paid to the differences between an instructional system such as PGS and commercial systems such as OpenGL. A list of example student projects is included.

Introduction

Most computer science curriculums include a course in computer graphics. Students are fascinated by the application of computers in the motion picture and television industries and find such a course very attractive. It is a strong course because it teaches interesting and complex material and helps develop newly found programming skills in an environment that is highly visual and very dynamic. Indeed, it is a course that many students find quite entertaining.

This paper describes the Phedias Graphics System (PGS). PGS has been developed specifically for student projects in computer graphics courses. It provides an environment for student projects that is general and uses modern concepts in programming and graphics modeling, but can be installed with "holes" in the environment that can be filled by students. The idea of "holes" or an incomplete environment is similar to that of the NACHOS (Not another completely heuristic operating system) environment which is used to teach courses in operating system design [Christopher, Procter, and Anderson 1993]. The system has many additional features which are designed for maximum effectiveness in an educational project setting.

There are many approaches to teaching computer graphics. See Cunningham, 1987 for examples [Cunningham 1987]. Some instructors choose to emphasize underlying mechanisms and algorithms [Schaller 1993]. Projects in such an environment should necessarily provide more than just exercises in using a programming system, and may include rendering and fundamental algorithms work. The alternative approach is to treat the course as a tools course, teaching a common system, such as OpenGL or VRML, in detail. While this may appear to be attractive from the standpoint of "training for industry", it does limit student exposure to a single approach which may not closely relate to another system they may be required to use. Of course, an ideal structure probably lies between these two extremes. PGS provides such a stucture.

PGS provides project infrastructure. Many instructors believe students should be required to write systems from scratch [Schweitzer and Appolloni 1995]. While this may be effective in building new programming skills, it begs the obvious question of if programming of low level features such as matrix manipulations and object organization really adds to the understanding of the particular subject material. In a world progressing to component software, a toolkit of basic structure seems more ideal. Coding from scratch will limit the complexity of projects, effectively preventing loading file objects or dealing with complex formats such as TIFF and VRML. A toolkit allows students to reach that magic goal of a real image much quicker, thereby receiving instant feedback. Some approaches to toolkits for students do exist. Simple PHIGS (SPHIGS) is a companion to [Foley et al 1995], a popular text. TUGS uses a replaceable components approach to teaching computer graphics [Clevenger, Chaddock, and Bendig 1991].

Modeling vs. Rendering

A highly visible characteristic of PGS is the complete separation of modeling and rendering. Modeling is the description of a scene or virtual world. All elements of the world must be reduced to simple objects called *primitives*. The most common primitive is the polygon, a closed planer figure bounded by line segments connecting vertices. Additional primitives include more complex curve descriptions such as Bezier surfaces, spheres, cones, etc. The process of converting 3D objects into primitives can be confusing for students in that they must learn to think in three dimensions (3D).

Rendering is the conversion of a model to an image. While modeling is a relatively generic process, there are many drastically different approaches to rendering. The final location of primitives can be determined by projecting vertices or control points to two dimensional screen coordinates and directly rendering. A depth buffer can be used for visible surface determination. This approach will be referred to in this paper as *projection graphics*, in that it is based on simply projecting the primitives to their final locations. An alternative approach simulates the path of light through the environment in reverse. This technique is called *ray-tracing*. *Radiosity*, simulates the distribution of light throughout a scene using methods similar to finite element modeling. Each technique has advantages and disadvantages that must be made clear to students. Projection graphics is fast, but does not simulate effects such as shadows very will. Ray-tracing is slow, but produces more dynamic scenes. It is easily extended using recursion to simulate shadows, reflection, and transparency. Radiosity is an advanced topic typically not included as a project in computer graphics courses.

Students should gain experience with more than one rendering methodology. Projection graphics and ray tracing since are in common use and are very distinct in capabilities and performance. It is also desirable that student projects include implementation of rendering algorithms and methods as well.

The Modeling Environment

The modeling environment in PGS is based on polygonal modeling, though students can add additional primitives. Polygons need not be convex, as in OpenGL, but they must be planer. By default, PGS requires all polygon vertices to be entered in counter-clockwise order, though that behavior can be overridden. Students must develop an ability to visualize in 3D. A useful tool in that quest is the requirement that polygons be specified in a specific order. Given such a specification, a graphics system can perform *back-face culling*, the elimination of backwards facing polygons from consideration. Most systems support back-face culling since it is a significant performance improvement, but by default do not enable the feature. Students are often tempted to leave the feature disabled. PGS discourages that behavior and can be set by the instructor to always perform back-face culling.

The PGS modeling environment is a conventional hierarchical environment consisting of primitives and composite *objects*. Primitives are added to objects by reference, not copied into objects, so the true directed acyclic graph model of hierarchical modeling is supported. Vertices are unique to polygons, however. There are no shared vertices. This keeps the environment simple for students to work with. Primitives are defined by supplying vertex lists. In addition, primitives can include vertex normal lists, and texture mapping correspondence points. The structure for defining a primitive in code is quite simple:

```
PGSPOLYGON *poly = new PGSPOLYGON;     // Instantiate a new polygon
poly->Add(v1);                         // Add a vertex which already exists
poly->Add(VERTEX(1, 2, 1.75));         // Add a vertex directly
poly->Add3(v3, v4, v5);                // Add 3 vertices
```

Every effort is made to simplify primitive definition in code so the student can spend time creating complex and interesting models rather than copying boilerplate code. Students often prefer the Add3 and Add4 member functions since they allow triangles and quadrilateral to be defined in one step.

Objects are also simply defined:

```
PGSOBJECT *obj = new PGSOBJECT;          // Instantiate a new object
obj->Add(poly);                          // Add poly to the object
obj->Add(poly, trans);                   // Add poly with transform trans
obj->Add(poly, PgsTranslate(0.5, 2, 2)); // Add poly with a translation
```

In most modern graphics systems, transformations (changes in shape, size, or location of graphic elements) are modeled using a 4 by 4 transformation matrix which is multiplied by a 3D coordinate with an extended coordinate called a homogeneous coordinate. This extra coordinate allows many transformations to be modeled, including arbitrary rotation, translation, scaling, and skew. A common approach to creating models is to use transformations to place primitives into objects which can then, in turn, be transformed themselves and referenced in other objects. PGS makes this structure much more visible than systems such as OpenGL, which maintains a complicated, internal matrix stack. Students using PGS can create their own matrices, either by composing operations defined in PGS or by filling in values themselves. This structure can be used as a tool not only for creating models, but for computing vertices in textures, computing normals, etc.

Rendering

Many graphics systems are designed around a single approach to rendering and build this approach into their design. OpenGL uses conventional projection graphics, wherein graphics primitives are rendered immediately upon becoming available. Not only does this limit student exposure to a single rendering methodology, but is also blurs the distinction between modeling and rendering. Most texts, such as Foley, et al, a popular text, indicate this distinction, but it must be emphasized in projects. In PGS all modeling is performed first, then the scene is rendered.

PGS comes with three basic rendering systems (four if the wire-frame rendering in the previewer is counted). A conventional projection graphics renderer based on a polygon fill algorithm, a visible surface ray tracer, and a true recursive ray tracer. Students must have experience in each of these technologies. They are very different and yield different results. However, what is really important in PGS is that a student can implement their own rendering technology.

A common PGS project is to implement a recursive ray tracer. This technology already exists in the system, but can be disabled as described in a following section. Using the concept of *replaceable components*, a completely new ray tracer can be written using as much or as little help from the system software as is desired. In previous student projects the students have been supplied the polygon intersection components which are highly optimized in PGS and much faster than what students would normally wish to write, though polygon intersection algorithms would make an interesting project as well. The ray tracer implementation can be done in fewer than a hundred lines of code which is very similar to the algorithm presentation in textbooks.

This is an important feature of PGS. Students are typically confronted with either using a graphics system which only supports its own rendering methodology or attempting to write such a system from scratch. Neither approach offers the advantages that PGS can.

Lighting, Views, and Scenes

Lights must be placed in a scene for the scene to be visible (ambient light is also supported and will allow a scene to be viewed dimly without explicit lighting). Lights are defined either as points in space or directions to light sources. This is a very conventional approach. Lighting definition in PGS is simple:

```
PGSLIGHTS lights;                   // Lighting object
lights.Add(VERTEX(100, 100, 100), COLOR(.8, .8, .9));
```

This is contrasted with OpenGL which has multiple lighting modes, different defaults for each light type, and numerous options which must be enabled to use lighting. PGS lights are simple points in space. However, a new class can be derived from the PGSLIGHT class adding any light functionality the student may require. Lighting with exponential falloff or spotlight characteristics is easy to create.

A *view* is the definition of the camera placement in a scene. PGS uses the PHIGS model from Foley, et. al. for views [Foley et al 1995]. A user specifies a view by defining a view coordinate system. Note that students often have difficulty selecting views. There are many parameters to select and it is not obvious what window size or projection reference point setting will properly frame a scene. For this reason, PGS has a *previewer*. The previewer shows a wire-frame rendering of the scene with complete control over the view. The students selected view is used as a starting point and the student can then adjust the view.

A *scene* is the combination of lighting, a view, and something to look at. In PGS, that something is an object. Since objects are hierarchical, all items to be viewed in a scene can easily be combined into a single object. Transformations facilitate the placement of components in the object. This structure of lighting, a view, and an object in the form of a scene has been designed to simplify the representation of a model for a student. Systems such as OpenGL use large quantities of additional information to describe a scene and that information can be modified as the scene is constructed and rendered. There are numerous options which are routinely enabled and disabled. These options are confusing to students.

Object Oriented vs. Retained Mode

PGS is a highly object-oriented system. It is implemented as a C++ class library. Many common graphics systems, including OpenGL are referred to as *retained mode graphics systems*. A retained mode graphics system is a system that has global *state*. This state may include the model being created, features which can be enabled and disabled, and intermediate images. Most modern programming theory agrees that state should be localized, often to objects. There is no global state in PGS. This model is meant to better represent programming as it is often taught. Moving a student to a retained state system after exposure to PGS has proved to be simple. The opposite may not be so.

More and more computer science curriculums are emphasizing object oriented programming using C++ or Java. PGS is meant to be a good representation of that technology and is highly object oriented. It encapsulates much of its functionality in classes. The structure has been designed to make a transition to Java in the future very easy to do without an entire rewrite of the system.

Controlled Distribution and Replaceable Components

Students need to see many examples. These examples should include code which illustrates how algorithms or methods are implemented, how specific objects are defined, how routines are used, and, above all, good programming style. For this reason, PGS comes with many example programs including a fairly elaborate scene, texture mapping demonstrations, simple box examples, etc. In addition, the PGS code is an example for students of how algorithms are implemented. However, it is important that distributed code not give away the solution to assignments. A common element of a student project might be to create a tessellated sphere. Viewing the source code for PGSSPHERE will simplify that project greatly.

PGS prevents this problem using *controlled distribution*. Features in the system can be enabled or disabled when the library is built and installed. Features can be turned off and, therefore, made unavailable to the student. These features include texture mapping, smooth shading, advanced transformation modeling, etc. Often features should be unavailable in early projects and become available later. There are two levels of control: object and source. A feature which is disabled as an object will not be available for execution at all. An object which is disabled in source will be installed and available to use, but the source code will not be available. User components can be added to this system, making it easy to distribute project solutions.

PGS has a unique structure wherein many components of the system can be replaced or enhanced. As an example, the default color model is the Hall color model. A subset of the model is used for projection graphics. Students can replace the color computations with their own code which fully implements the model, a common project. The entire model can be replaced at will with another. This is true of many components of the system. New lighting with specific characteristics can be created, and an entirely new renderer can be installed.

Students require projects that will stress specific course material. Most systems treat rendering as a black box: model in, picture out. PGS allows for replacement of components in the supplied rendering algorithms or creation of an entirely new rendering module with as much or as little provided system functionality as required.

Loaded Content

It is important that projects in computer graphics not become bogged down in modeling. Students must go through the process of creating polygonal objects since this is an essential skill. However, it is rare that more than two projects would be devoted to all of the issues of modeling. But, students should be able to create complex and interesting scenes. For this reason, PGS allows *loaded contentt*, polygonal models or texture images which are loaded from files. PGS supports the VRML 1.0 and OFF file formats for loading graphical objects. It supports the TIFF format for loading images.

Students are more enthusiastic when the projects they produce are complex and of high quality. However, many are not artistic. Creating only simple geometric figures such as chairs, boxes, etc. will not motivate a student as much as creating a complex scene including textured surfaces and complex objects such as teapots, chess pieces, cows, etc. Loaded content allows students to move beyond "creating things" to "manipulating things" and is a much more realistic portrayal of what their future job function may be. Most computer scientists are not expected to be artists in their job at all.

Conventional Systems?

A common reason for choosing a conventional graphics system for instructional purposes is that these systems are widely used and the student is better prepared for employment than if trained on a proprietary or training system such as PGS. Indeed, it is important at this time that students be exposed to OpenGL. One approach that this author has used successfully is to include an OpenGL project in the course. A limited time is devoted to OpenGL feature description and a simple, usually highly animated, project is assigned. If this assignment follows PGS assignments, students quickly learn the difference in the two environments and pick up OpenGL with no difficulty. It is proposed that education in the basic concepts underlying systems provides students with the tools they need to adapt their thinking to a particular environment. Given that there are many graphics systems in common use, this seems to be a effective instructional technique.

It has been suggested that this question is similar to the question of what language to teach, a clean educational environment such as Pascal or Scheme, or a commercially successful system such as C or C++. However, moving from one language to another is a time consuming process. Learning how to map knowledge in one graphic system to another is not nearly as complicated. Both PGS and OpenGL require that you begin the process of defining a polygon, then add the vertices. OpenGL has an explicit end to that process as well. In nearly all cases, there are equivalent functions, though the many enable/disable features of OpenGL require definition.

Experience and Example Projects

It is useful to describe the experience of the last class to use PGS, the students in CS-43, Computer Graphics, Fall, 1997. The course instructor was Charles B. Owen and there were 21 students. In a ten week term the class participated in four projects.

Project 1: In this project students were asked to create three objects: a chair, a sphere, and one object of their own choice. The objects had to be positioned on a floor also added to the scene. The emphasized elements in the project were 3D visualization, polygonal modeling, vertex normals and smooth shading, and 3D positioning. During this project the texture mapping features and the PGSSPHERE object were specifically turned off and not available to the students. Student objects naturally included a spaceship, but also included a working clock, a spiral staircase, a hockey stick, and a recursively generated tree.

Project 2: This project expanded to all elements of modeling including texture mapping, using loaded elements (a set of OFF and VRML objects were made available), and creating a carefully composed scene consisting of a room with a window and texture mapped walls. In addition, students were required to map a world map texture onto the sphere they created in project 1. This project emphasized complex texture tiling, geometric transformations, and realism in scenes.

Project 3: As mentioned above, it is very useful to have a project in a commercial graphics system and this project fulfilled that perceived requirement using OpenGL. Students were required to create an maze which they could traverse. Note that this project did generate a large amount of grumbling about quirky OpenGL features, but moving from PGS to OpenGL did not present a large leap of methodology.

Project 4: The final project in the course is a larger project and moves the student entirely into rendering, specifically recursive ray-tracing. Since this is the final project in the course, it is divided into two parts: rendering and enhanced algorithms. There is a "checkpoint" when students must demonstrate only the ray-tracing component of the project. Note that all of the polygon intersection algorithms where enabled in PGS to simplify this project and allow the project solution to be faster than what a student would be expected to write in the short period of time allowed. The specific requirement for the first checkpoint was an anti-aliased recursive ray-tracer using the project 2 scene. It should be noted that this project is not nearly as complicated as expected and students have expressed their surprise that it took as little code as it did to get up and running. Another requirement of the project is a full implementation of the Hall color model.

The second half of project 4 is to implement some extension of this system. A long list was provided for the students to select from, including fish-eye lenses, stochastic ray tracing, depth-of-field, etc. This gives the student a chance to experiment with new technologies while gaining experience modifying an existing algorithm. The student opinions of the project as noted in the course evaluation were very good and students were quite proud of the resulting images.

Summary

The Phedias Graphics system provides an environment for student projects in computer graphics that emphasizes algorithm implementation and experimentation. Major components of the system can be enabled and disabled at will. Multiple rendering methodologies are available to students, and modeling and rendering are distinct entities. The system has been used successfully in student courses and has proved quite popular in that students are excited with they can produce complex and beautiful images using simple code.

The system is currently in final testing and will be made available to many users in the near future. It is C++ based and runs on most Unix workstations. It has been tested on DEC Alpha, HP-UX, and SGI Irix workstations. The software will be available at: http://devlab.dartmouth.edu/pgs/.

Acknowledgments

PGS is based loosely on the NGS graphics system. Though not much of the early history of NGS is known, it is believed to have originated at Harvard. It has been considerably modified over the years at Dartmouth College by Pete Sandon, Scot Drysdale, and the author. It was completely rewritten in the Summer of 1997 adding many of the features described herein. Many thanks to students in CS-43, who endured alpha and beta versions of the software. Thanks to Fillia Makedon for suggesting the name Phedias.

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Hypermedia and Learning: The Relationship of Cognitive Style and Knowledge Structure

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Abstract: Theoretical research claims that, in order to effectively apply hypermedia to enhance learning, instructional and software designers need to address two major issues: The level of structuring of the knowledge domain (as represented by the hypermedia software) and the cognitive abilities of the learner in navigating the knowledge-base. Over the past decade, a number of empirical studies have explored the effects and relationships of knowledge structure and cognitive style on learner performance when using hypermedia. The purpose of this article is to review the major research literature on this subject. The goal is to identify key and important findings, with the hope that these can better guide the appropriate applications of this technology.

INTRODUCTION

The use of interactive computers and hypermedia as knowledge exploration tools has been attracting much research in the field of computer-assisted learning, both in academia and industry. This fact is reflected by both the increasing number of interactive multimedia systems in schools as well as the number of conferences and publications on the subject [Becker 1993; Snider 1992]. However, the inherent flexibility that hypermedia software provides to students and teachers present a host of challenging questions and issues. At its most basic level, the crux of this research study is to better understand how hypermedia software can enhance the learning process and the transfer of knowledge.

In order to effectively apply hypermedia to enhance learning, there are two classes of issues that need to be addressed. These are authoring-related and learning-related [Locatis et al. 1992]. Authoring issues deal with the decisions that are presented to the hyperdocument's author (hyperdocuments are documents developed with the use of hypermedia authoring software). The more important one for this research study is the structuring of the knowledge domain. This issue deals with how the links of the hypermedia document should be structured (linked and organized) to represent the knowledge of the expert and, at the same time, guide the learning of the student. The learning issue of most concern to this research study is that of cognitive style. Hypermedia has been postulated to be most useful when discovery learning is warranted [Locatis et al. 1992]. Additionally, it has been shown that certain cognitive styles (active or exploratory styles) are more conducive to the effective use of educational hypermedia than others [Jonassen & Wang 1993; Larsen 1992; Yung-Bin 1992].

Finally, it has been widely claimed that the use of hypermedia learning systems promotes higher level cognitive skills, which require the association and linking of different ideas and information rather than the recall of facts and data [Ambrose 1991; Marchionini 1988; Tsai 1989]. It seems that the inherent web-like nature of hypermedia software is ideal for guiding the learner in forming these links.

HYPERMEDIA AND LEARNING

This study will examine the empirical studies associated with these issues. It will address the effects of the learner's characteristics (by specifically examining cognitive style) and the learner's level of self-direction (by addressing the structuring impact of the knowledge domain) on the performance of students when operating in a hypermedia learning environment. The research will be analyzed by examining the learner's overall performance, as well as higher level cognitive skills. The research which addresses the above two factors (cognitive style and knowledge structure) will be more fully described in the following sections.

Cognitive Style

When it comes to the use of educational hypermedia, what type of learner is most likely to effectively utilize a hypermedia environment? Locatis et al. (1992) claim that persons who have high general ability (e.g., cognitive style, Grade Point Average or GPA) should perform well in a hypermediated environment. Lower ability students might benefit if there is extra guidance. Although used interchangeably in the literature, there is a technical difference between the use of the terms cognitive style and learning style. Cognitive style deals with the "form" of cognitive activity (i.e., thinking, perceiving, problem solving, etc.), not its content. It is viewed to be "persuasive dimensions" of personality, bipolar in nature, and stable over time [Whyte et al. 1995]. Learning style, on the other hand, is seen as a broader construct, which includes cognitive along with affective and physiological styles [Keefe 1988].

The distinction being made, it should be clearly stated that this article, in reviewing the empirical research, will deal with cognitive style, even though at times the term learning style will be used (mostly in reference to previous research). A field experiment by Billings & Cobb (1992), with 63 undergraduate students using hypermedia, examined the major effects of learning style, GPA, and attitudes on achievement. No relationship between learning style and performance was observed. However, the study did show that GPA had a significant and positive correlation with achievement when included with the attitude scale into the regression analysis. Similarly, a field study of adult computer technicians located throughout the country examined the relationship between learning style and the effectiveness of a hypermedia instructional system [Larsen 1992]. The results failed to detect any significant correlation between learning style and achievement scores.

On the other hand, a study by Yung-Bin (1992) tested the effects of learning style and instructional advisement on undergraduate students' achievement when using a hypermedia instructional system. The results indicate that achievement test scores were affected by the interaction of learning style and advisement, with active-learning subjects tending to score higher on the achievement test than passive-learning subjects. Furthermore, passive-learning subjects who received the advisory version of the software scored significantly higher on their achievement test than passive-learning subjects who had the non-advisory version.

An experiment by Jonassen and Wang (1993) involving ninety-eight pre-service teachers in an open enrollment college showed that individual differences interacted with learning through the use of hypermedia. The research showed that the "field independent processors" cognitive style subjects generally preferred to impose their own structure on information rather than accommodate the structure that is implicit in the materials. The authors conclude that it is likely that field independent learners are better hypermedia processors, especially as the form of the hypermedia becomes more referential and less overtly structured [Jonassen & Wang 1993].

Knowledge Structure

It has been a commonly held view that discovery learning environments are ideal for stimulating higher-order thinking [Schank 1993]. These views have been discussed and documented at length by such noted cognitive theorists as Bloom (1956) and Gagne (1977). These observations raise interesting questions when applied to hypermediated learning environments: Will learners form better conceptual models using hypermedia or will the richness of the information overload learners and deteriorate effectiveness and efficiency of learning? Are some knowledge structure schema better than others in facilitating and promoting learning in general, and higher-order cognitive skills in particular? Is there a relationship between the hypermedia knowledge-base structure, cognitive style, and the promotion of higher-order cognitive skills?

In using hypermedia environments to teach higher level learning skills, Locatis et al. (1992) claim that hypermedia might best be used when discovery learning is warranted. However, according to Marchionini (1988), "Although self-directed and exploratory learning are worthy objectives to achieve in learning environments, freedom to learn does not seem to be a sufficient condition to assure effective learning." (p. 11). It seems that the rich learning environment may easily become a trip into "hyperspace" [Marchionini 1988]. In response, Tsai (1989) claims that this issue can be adequately addressed, "Even though users can freely choose their browsing paths, a hyperdocument has an intrinsic structure which is determined by how the nodes are linked together. This intrinsic structure should have some effects on users' browsing and commenting activities." (p. 11). This point is similarly noted by Conklin (1987), with his claim that there is no natural topology for an information space. Finally, Brooks, Simutis, and O'Neil (1985) claim that learners may actually be able to process information more effectively if it is presented in a manner that is closely matched by their learning style.

Although earlier reasearch yielded unclear results [Cordell 1991], recent empirical studies have been more conclusive. Jonassen and Wang (1993), in their study involving ninety-eight pre-service teachers in an open enrollment college, conclude that merely showing learners structural relationships is probably not sufficient to result in greater structural knowledge acquisition or performance.. The authors hypothesize that "what seem to matter most is the construction of personally relevant knowledge structures" (p. 7). It is claimed that such constructions can promote higher-order thinking in the form of logical reasoning. Stanton (1994) examined the comparison of a learning environment that presented the instruction knowledge in a linear format over which the student had no influence with another in which the student was able to determine the sequence of the instruction freely. The study, involving forty adult students, suggests that performance may be improved with a non-linear learning environment, but this is likely to be dependent upon the ability of the participants to organize the environment in a manner that suits their own learning style.

More recently, a study by Rasmussen and Davidson (1996) with pre-service teachers as subjects showed a significant interaction among hypermedia structure (hierarchical), learning styles (active-reflective), and performance. A more elaborate and extensive experiment by Paolucci (1997) analyzed the effects that knowledge structure (using three major schemas: hierarchical, branching, and networked or conventional hypermedia) and cognitive style (active vs. reflective) had on performance with a hypermedia learning system. Six fifth-grade classrooms from three different elementary schools within the same school district were chosen for the study (115 students). Although the study found no significant differences between the two types of cognitive styles, significant differences were found among the three knowledge structure schema groups, with the branching group performing significantly better than the hierarchical and conventional groups. Furthermore, a significant difference was found for the higher-order cognitive skills performance scores among the three knowledge structure schema groups, with the branching group performing significantly better than the conventional group but not significantly better than the hierarchical group.

DISCUSSION

In general, the empirical research shows that the use of hypermedia software as learning systems may not necessarily lead to improved performance, as is widely believed by educators. It seems that when "too much" freedom (as in the case of a conventional or network schemata) or "not enough" freedom (as in the case of a hierarchical schemata), is provided to the learner, performance may suffer. However, the results do indicate that hypermedia can lead to improved performance when the software is "appropriately" structured for the learner. Furthermore, it appears that hypermedia learning systems can provide (once again, when appropriately structured) an effective means for promoting and developing the learner's higher-order cognitive skills [Paolucci 1997].

Additionally, the research shows that learners with certain cognitive styles (labeled active, exploratory, or field-independent) may perform better in a hypermedia learning environment than those with others. This finding seems to be more conclusive when the cognitive style variable interacts with other factors, such as knowledge structure and advisement [Paolucci 1997, Paolucci & Wright 1996; Shin et al. 1994; Brooks et al. 1985].

The results imply that educators and designers need to be careful and pay close attention to how hypermedia software is used in the curriculum. Although the technology has tremendous flexibility in providing dynamic learning environments for all types of students and needs, this quality seems to be a double-edged sword. It seems that if the hypermedia learning environment is too structured, some students loose interest and the learning objectives may not be achieved. On the other hand, if this environment is too unstructured, some students may become confused and loose interest. Strategies for adding structure to hyperdocuments, such as those employed by the research reviewed in this article, are recommended to minimize this problem. This is probably more important for younger students (e.g., adolescents), who perhaps require more structure with their learning environments, and may need to be scaffolded throughout this early learning stage.

It seems that scaffolding students through the learning process is particularly useful when using hypermedia. It may be an appropriate learning strategy to decrease the level of structure of the hypermedia learning system as the students grow intellectually, culminating at the stage where they can actually develop their own hypermedia documents and construct knowledge (as many constructivists advocate). The important point to be made here is that this process will be highly dependent on the individual's skills and knowledge base, thus any strategy should be individualized. Teachers are encouraged to assess their students' cognitive abilities (e.g., cognitive styles) in order to design instructional strategies for optimal learning.

Moreover, it is important that hypermedia software developers use adaptive design strategies to address these issues. Research and development work on this class of hypermedia systems (i.e., adaptive hypermedia systems) is highly encouraged. Similarly, curriculum and instructional designers need to be keenly aware of the proper applications of multimedia information. It seems that, although multimedia information may attract the attention of the learner (especially the younger ones), and perhaps enhance the learning of new knowledge, textual information still remains the key component in the transfer of knowledge with hypermedia [Paolucci 1997]. Designers need to make sure that, if multimedia information is used in authoring hypermedia (as it should be), it is used to compel the learner to also read the text.

Currently, with the explosive growth and popularization of the Internet's World Wide Web, many teachers and educators (even at the elementary levels) are using highly hypermediated systems as learning environments. Additionally, the trend within many classrooms seems to be in letting students create their own hypermedia documents. Although these hypermedia projects may be deemed to be "cool" and fun by the students and teachers, very rarely is the question of whether knowledge of the domain has been acquired or learning has taken place. As this research study has shown, if the knowledge domain is too unstructured (as is definitely the case with the World Wide Web), learning becomes very difficult, especially for younger students. Therefore, structuring the World Wide Web or any other similarly hypermediated technology to meet the cognitive skills and knowledge base requirements of the learner is critical.

Finally, it is worthwhile to note that, in his experiment, Paolucci (1997) observed that quite a few subjects (adolescent students) had difficulty concentrating and focusing on the task at hand. Whether hypermedia can be effective for these students is questionable. On the contrary, unfortunately, it may even exacerbate this condition by providing an overly stimulating learning environment.

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A Methodology for Flexible Authoring of Structured Hypertext Applications

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Abstract In hypertext systems, structure is considered useful but "formality is considered harmful" [Shipman & Marshall 94]. This happens because hypertext authoring is a complicated cognitive process that consists of recursive activities, like emergence of ideas, representation and structuring of ideas, evaluation and update. Our aim is to provide a *hypertext model* and *authoring methodology* which combines structured documents, incremental document formalization and document evaluation techniques. A *constraint model* is used as the underlying foundation of the approach.

1. Introduction

Hypertext has been pointed out as a significant methodology for organizing and presenting course material, primary because it enables instructors to interconnect multimedia pieces of knowledge in a plethora of ways and to offer many access paths for exploration to their students. Incorporating structure in hypertext is considered as a solution to the cognitive overhead and disorientation problems. The objectives of a course presentation are better attained when the students are able to construct a cognitive model of the domain [Brok 97].

On the other hand, hypertext authoring is a complicated cognitive process that consists of recursive activities, like emergence of ideas, representation and structuring of ideas, evaluation and update [Nanard & Nanard 95]. Flexibility in definition of hypertext semantic schemas and authoring of specific documents, is an important prerequisite in order to support the authoring mental process and to avoid "premature organization" problems. Additionally, authors are unwilling to follow the formal schema of a hypertext application from the beginning of the authoring process [Shipman & Marshall 94]. On the contrary, they prefer to start with an informal document and gradually conform it to the schema. Furthermore, these authoring methodologies should be integrated into a document life cycle model, which includes a number of phases, e.g. design, implementation, testing, evaluation and maintenance [Nanard & Nanard 95] [David et al. 97].

A number of hypertext structuring and authoring methodologies and tools have been proposed recently [Marshall et al. 91] [Garzotto et al. 93] [Isakowitz et al. 95]. All these approaches focus mainly on the structural expressiveness of the hypertext model and/or the design of the presentation and navigation aspects of the application. Little or no attention is paid on the support of the mental authoring process. Another critical aspect in educational hypertext environments is the reuse of learning material. This includes not only the reusability of content, such as images or texts, but also the reusability of conceptual structures, such as node and link types. Reusability improves the cost-effectiveness during authoring and ensures the consistent expression of the same concept in different contexts.

The purpose of this paper is to propose a *hypertext model* and *authoring methodology* which combines semantic schema definition, incremental document formalization and document evaluation techniques. Our point of view is that a hypertext semantic schema consists of a set of typed nodes and links. Their composition and properties as well as the relationships among them, can be viewed as *constraints* that express the semantics of the domain and restrict author's actions. An informal document is one that does not satisfy some of these constraints. By handling the activation of the constraints, author can determine the level of formality during authoring. A prototype system that supports our model and methodology has been implemented and has been used in two educational scenarios as described later.

The rest of the paper is organized as follows: Sections [Hypertext Model] and [Authoring Methodology] present in detail our hypertext model and authoring methodology, respectively. In section [Implementation] we discuss the implementation of the system, while in section [Conclusions] we conclude and present further work.

2. Hypertext Model

The methodology is based on the use of *templates* which describe the structure of hypertext applications. Templates are used as patterns in order to construct real applications, i.e. networks of nodes and links, which we call *webs*. For example, a "Book" template can be devised to enable authoring of books. Obviously, many different webs can be constructed from a single template, thus achieving reusability at the *application type level*.

A template is constructed by smaller components, *node types*, which are interconnected by *link types*, collectively called the *schema* of the template. Node types and link types are used to model conceptual entities and their relationships. Each of these types may generate one or more nodes and links in the resulting web, interconnected in a similar way. Continuing the book example, a node type could represent a chapter or the table of contents of the book. Node and link types may exist independently of a template, enabling reusability at the *component type level*. Templates may also employ externally defined templates, a feature that permits modular application design.

The information contained into nodes and links is stored in *attributes*. Attributes may be defined on the basis of primitive data types or conceptual *attribute types*. Attribute types represent low level domain semantics, enabling reusability at the *data level*. Attribute types, node types and link types may be defined either locally in a template or inside a *repository* of types. In the second case, the same type can be used in many templates that share some low level semantics. Obviously, templates are reused as well and may be included in a repository.

Besides reusability of conceptual types and templates, another dimension is the reusability of real data of nodes. Generally, nodes cannot exist independently of a web, but as a special case, a repository may contain collections of node instances that can be reused in many webs.

The following figure [Fig. 1] depicts the parts of the hypertext model. In the following subsections we present in more detail the parts of the hypertext model.

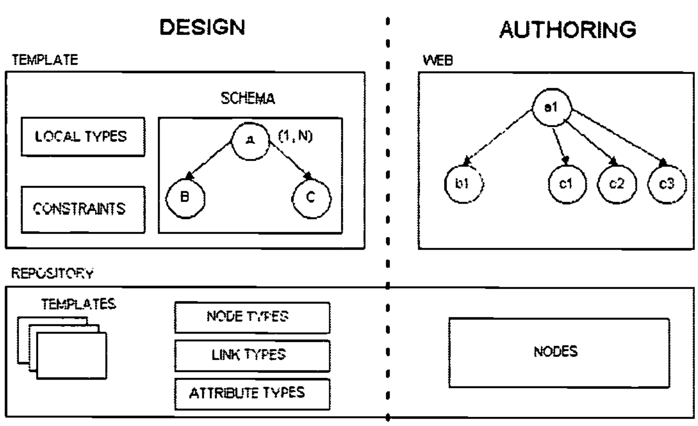

Figure 1: Hypertext model

2.1 Basic Objects and Object Types

Attributes and Attribute Types. An attribute is the smallest unit of information and is based on an attribute type or a primitive data type. Attribute types are based on a set of predefined data types (integer, real, string,

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enumeration, text, image, html etc.) and may be simple or composite. Composite attribute types contain a set of simple attribute types. Furthermore, an attribute type may have a default value. As an example, consider the concept *PersonName* that can be modeled as an attribute type based on the string data type. Attributes may be used only in the context of a node or link instance.

Nodes and Node Types. Nodes are the basic building blocks of applications and are based on node types. A node type is a named set of attribute types, each of which may be declared as optional or mandatory and may be constrained to have a bounded (min, max) number of values. Two abstraction mechanisms are supported for node types: *specialization* (or *subclassing*) and *aggregation*. In the case of specialization, a node type is introduced as a subtype of one or more node types and inherits all their attributes types. An aggregate node type is an abstract representation of a set of existing node types. Instances of an aggregate node type may origin from anyone of the aggregated node types. Node types may be assigned a special meaning and generate the following categories of nodes: *Index nodes* that contain links to other normal or index nodes, e*ntry nodes* that are candidates for starting points while navigating the web and c*ollection nodes* that contain a set of other nodes.

Links and Link Types. A link type is a named relationship between node types. Link types may have a set of attributes as well as two sets of allowable source and destination node types, respectively. Links can be anchored to a node as a whole, to an attribute of a node or to an anchor on an attribute's value. Each link type belongs to one of the following categories: *Structural link types* that denote the basic organization of the application and r*eference link types* that denote cross-references between node types.

2.2 Template Schema

A template schema is a collection of node types, link types and externally defined templates, interconnected in a graph-like structure. A vertex in the graph may be either a node type or another template, while the edges of the graph are link types. When a node type, link type or template is inserted in the schema, it is assigned a specific role and it is called *bound*. Apparently, a type or template may be bound more than once in a template, under different roles.

Generally speaking, the topology of the schema determines the structure of the resulting webs. In the simplest (default) case, each schema element generates an instance of the same type in the web. For example, a node type under a specific role corresponds to a node of the same type and role in the web. In the general case, one element of the schema may be used to generate multiple instances of the same type in a web. Specifically, bound node types can be constrained in the following ways: a) By the (min, max) number of nodes that can based on them, b) by the (min, max) number of links, possibly of a specific link type, that may depart/arrive from/to the generated nodes. Bound link types may be constrained by the (min, max) number of links of the same type that may exist between two nodes.

2.3 Constraints

As it is inferred from the previous subsection, the definition of a template produces a set of restrictions that directs and (at the same time) limits the author's actions. Examples of such restrictions are the source node type of a link type with a certain role in the schema, the number of nodes that can be generated by a bound node type, or the specification of an attribute type of a node type as mandatory, to outline a few of them. All these restrictions constitute first class objects, that we call *constraints* and are represented using a *constraint model*, as it is explained later. Constraints play a central role during the authoring process: by activating and inactivating certain constraints, different levels of formality may be achieved. In this manner, the author is able to create informal webs and evolve them gradually until they conform to all the template constraints.

Furthermore, the types of constraints that are produced from the template schema, does not include all the semantic restrictions that the designer may wish to incorporate in the template, e.g., the existence of a path between every pair of instances of two specific node types. For this reason, besides the template schema, the designer is able to express *additional constraints* such as path restrictions and distances between pairs of node types. The detailed description of all the schema-derived and additional constraints that are supported by our model, is out of the scope of this paper.

Every constraint has the following characteristics:

- The object(s) the constraint is imposed to. This may be a single component (such as a node type or an attribute type of a link type), a set of components of the same type (such as all the node instances of a bound node type), or the web as a whole.
- The strictness of the constraint. *Hard* constraints should never be violated. *Soft* constraints generate warnings but do not affect the corresponding operation.
- The stage of the authoring process that the constraint is active. Empirically, we divide the authoring process into four stages: *starting*, *draft*, *pre-release* and *final*. By declaring the stage, the author is actually determining the level of formality he wants to work with. During authoring, there are active the constraints of the declared stage, plus the constraints of all the previous stages.
- The event(s) that cause(s) evaluation of the constraint. For example, constraints for the node type instances may be defined on the following events: create, save, delete, add-link and delete-link.
- An optional pre-condition expression, a condition expression and an optional message. When an event assigned to a constraint occurs, the pre-condition expression is evaluated. If the result is "true", (or if there is no pre-condition at all), the condition expression (which represents the constraint itself) is evaluated. A "false" result means that the constraint is violated and the specified message informs the author for the problem. Also, if the constraint is defined as hard, then the event is canceled, as stated above.

More formally [Storey et al. 96], a constraint is defined using the following syntax:

> Constraint *<constraint name>* At *<formality level>* With *<certainty>*
> For *<object> [, <object> ...]*
> On *<event> [, <event> ...]*
> [If *<pre-condition>*] Assert *<condition>* [Else *<message>*]

For example, if there is a strong reason for a web to have at most 100 nodes of type *Person*, regardless of the formality level, the following constraint is created:

> Constraint *MaxPersons* At *starting* With *hard*
> For *Person*
> On *create*
> Assert *count(Person)>100*
> Else *"The web has already 100 Persons. You cannot create more."*

It should be noted that the designer is not required to express constraints using this syntax. All constraints are automatically derived either from the template schema or from a graphical user interface, dedicated for the definition of additional constraints. The author can only adjust the formality level and certainty of a constraint. The designer of the template defines all the other characteristics. In order to support the designer, certain default values are assigned to the formality level of a constraint, according to the object and event characteristics.

3. Authoring Methodology

The proposed authoring methodology consists of an iteration of the activities of *template definition, web authoring* and *web evaluation* [Fig. 2].

- *Template definition.* This action is carried out by the *designer* and is divided into three interwoven phases. At the first phase, the designer creates the new node and link types that are necessary for the application. He can create new attribute types or select from a repository. Also, he has the opportunity to add the new created types to a repository for later utilization. At the second phase, he defines the template schema by assigning roles to node and link types and interconnecting them. He can select node types from those previously defined in the template or from a repository. At the third phase, he specifies the various properties of the node types, link types, node-to-link connections and the schema as a whole. During the above phases, the set of constraints of the template is automatically created.
- *Web authoring.* This action is carried out by the *author* (who may be the same person as the designer) and involves the creation of a web. The author specifies the desired level of formality to work with. According to this, certain constraints are enabled to prevent invalid actions. The author can modify

certain properties of the objects in the template schema in order to influence the behavior of the constraints. This action is described in detail in subsection [Authoring Flexibility].

- *Web evaluation.* At any time during authoring, the *author* is able to evaluate the web. The set of constraints and the current formality level are taken into account and various results are produced: Elements of the web that violates active constraints and suggested modifications that are needed in order the web to conform to the next level of formality. After the evaluation, author may update the web, alter the activation of constraints and trigger a new evaluation.

In the following subsections, two important aspects of the authoring methodology are discussed. The first one is the impact of evolving elements at the repository or at a template, especially when webs are already based on them. The second one is the flexibility that is offered to the author in order to incrementally formalize the web while authoring.

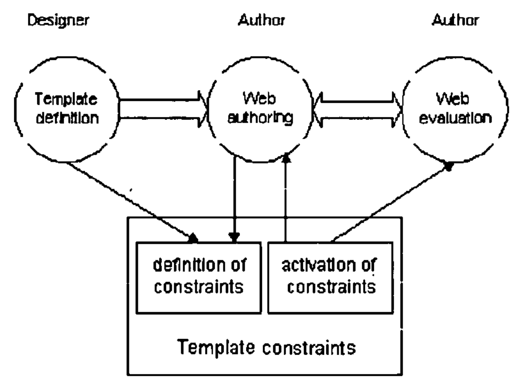

Figure 2: Authoring actions

3.1 Evolution

Evolution operations to the repository or to the templates are performed in a controlled and limited manner, because they may produce inconsistencies to already defined templates and webs, respectively.

Repository evolution should leave the repository as well as the templates based on it, in a consistent state. The basic rule is that an element of a repository cannot be updated if it is used on at least one template. Only the addition of new types is unconditionally permitted. All the other operations (renaming, removal, subclassing, property updating) are permitted only if there are no templates that use the elements that are directly or indirectly affected.

Template evolution is restricted in order to protect existing dependent webs. If no dependent webs exist, then the template may be freely updated. In the contrary, only addition operations may be performed unconditionally by the designer. An exception exists when the designer is also the author of all the depended webs. Then, any evolution operation is permitted to the template. The webs that are affected are marked as "invalid" and the evaluation action is forced to run the next time they will be edited, in order consistency to be achieved. Additionally, if a web is already in edit mode when a template evolution operation takes place, then the propagation of the operation is immediate. Authors can not modify the template. They have only the ability to update certain properties of the elements in the template schema, in order to influence the behavior of the constraints. This latter case is described in the next subsection.

To present the detailed semantics of every evolution operation and its effect when it is propagated to a template or web, is out of the scope of this paper.

3.2 Authoring Flexibility

The main contribution of the proposed authoring methodology is the flexibility it offers, inspired by two fundamental observations:

- Every creative activity (such as designing or authoring) is a mental process and not only a sequence of formal steps [Haake et al. 94] [Nanard & Nanard 95].
- Users are unwilling to provide formal information from the beginning of their interaction with a computer system [Shipman & Marshall 94]. They prefer to start with an informal version of their project and incrementally transform it to the desired level of formality.

As described in the previous subsection, our methodology permits evolution operations to repository, template and web level, although in a controlled manner. In case the designer of the template is also the author of the dependent webs, all evolution operations are permitted and the evaluation action will suggest the update operations needed in the web.

On the other hand, according to the level of formality, certain restrictions are relaxed while authoring. This is possible because each constraint in the template is assigned a formality level of activation. This assignment is made automatically while the designer defines the template. As the template evolves, so does the set of constraints. Additionally, the author of the web, although has not the ability to modify the template, he has access to certain properties of the template elements that influence certain constraints. In this way, the author has the ability to reach formality in his own pace.

4. Implementation

A working prototype of the proposed hypertext model has been implemented in the framework of the "*Buildings' Memory*" project and is currently being used for research and educational purposes at the Architecture Engineering Department of the National Technical University of Athens. Aim of the project was the development of a software system to support the analysis and study of traditional buildings. Buildings should be analyzed into various types of construction units, each unit should be described in detail (structured data, text, images, technical drawings, materials etc.) and be interconnected to other entities. The main requirement was to use templates that could exploit the common characteristics of buildings and additionally be able to express the complete structure of each building. Furthermore, during building analysis, domain knowledge is refined, leading to template and building evolution.

The system is successfully used for two educational scenarios. In the *first* one, the instructor creates a template for a set of traditional buildings. Template is used to analyze and document each building and students use the resulting webs. The *second* scenario is an exercise for the students. The instructor provides a template and each student is responsible to collect and organize the information needed to construct a valid web for the template. Students start with an informal web and, guided by the web evaluation procedure, evolve it to the required level of formality.

5. Conclusions

The contribution of our approach is that we integrate the concepts of structured hypertext, flexible authoring and evaluation in the same model, using an underlying constraint model. Future work includes three main directions. An important issue is to enhance the presentation features of the system. Right now, a simple WWW interface is used for the presentation of webs. Another issue is to further develop the type and number of template constraints supported by the system, without reducing ease of use [Osterbye 95]. The last issue is to support versioning of templates, in order more flexibility in repository and template evolution to be attained.

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Using Interactive Visualization For Teaching The Theory Of NP-completeness

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Abstract: In this paper we investigate the potential of interactive visualization for teaching the theory of NP-completeness to undergraduate students of computer science. Based on this analysis we developed some interactive Java applets which we use to present an NP-complete tiling problem PUZZLE in our lecture. This software is integrated into our hypertext lecture notes and our students also use it to find an NP-completeness proof for PUZZLE as an exercise.

1. Introduction

The notion of NP-completeness plays an important role in computer science. It is commonly agreed that once a problem is known to be NP-complete it is unlikely to find an efficient, i.e. polynomial time, algorithm to solve it. This has practical consequences: Many existent optimization problems are known to be NP-complete and, hence, it is usually a waste of time to try to develop algorithms for these problems with standard techniques like, for example, divide-and-conquer. Instead other techniques like simulated annealing are employed, that often lead to good and acceptable results in practice. Therefore it is important that students of computer sciences understand the concept of NP-completeness, and are able to check whether a problem is NP-complete or not.

Due to the rigorous mathematical treatment of complexity theory, many (if not most) undergraduate students have a serious problem mastering the concept of NP-completeness and, moreover, in developing their own NP-completeness proofs. We will report in this paper on our ongoing activities to use visualization in teaching theoretical computer science at the undergraduate level and show how the education of the theory of NP-completeness can benefit from multi-media techniques.

After recapitulating basic concepts of complexity theory we investigate the potential of interactive visualization to support the development and presentation of NP-completeness proofs. Then we illustrate our ideas using a certain NP-complete tiling problem as an example, which is presented in our lecture with the help of Java-applets. Furthermore the students use this software to develop an NP-completeness proof as an exercise. These applets and other interactive courseware is integrated into our HTML based hypertext lecture notes (*http://i12www.ira.uka.de/*`~info3/skript/companion/companion.html`). It can be used with every Java capable HTML browser.

2. Basic Definitions

To make sure that we are on common grounds we briefly rehash the definitions of Turing machines, the classes P and NP, and the notion of NP-completeness. We refer to [Kfoury et al. 1986] for a detailed description. Turing machines (TM) are the traditional way to formalize the notion of computable functions. They were invented in 1936 by Alan Turing [Turing 1936] and because of their simplicity they are still a very attractive and convincing concept. A *deterministic Turing machine* (DTM) consists of:

1. A two-way-infinite *tape* divided into cells. Each cell contains a *symbol* taken from a fixed set Σ. A special symbol B (*blank*) must occur in Σ.
2. A read/write head scanning exactly one cell at a time and being able to move along the tape.
3. A control unit which at any point in time is known to be in one internal state taken from a fixed set Γ of states.

The behavior of the TM is described as follows by a transition function $\delta : \Gamma \times \Sigma \rightarrow \Gamma \times \Sigma \times \{L, R, U\}$: If q is the current state of the TM, s is the symbol currently scanned, and $\delta(q, s) = \langle r, t, d\rangle$ holds, then the TM overwrites s with t, changes to the internal state r, and the read/write head, according to the value of d moves to the left if $d = L$, to the right if $d = R$ or remains at the current position if $d = U$. The Turing machine *stops* if $\delta(q, s)$ is undefined for the current state q and the current symbol s. A *configuration* of a TM T consists of the head position, the current tape, and state of T. A configuration is denoted by the relevant part of the tape written as a string with the current state before the symbol corresponding to the cell under the the head. For example $B00q_1 1B$ is a shorthand for a TM consisting of: the tape with symbols $0, 0, 1$ and blanks to the left and to the right; the current state q_1; and the read/write head over the cell with symbol 1. A DTM *computes* a function $f : \Sigma^* \rightarrow \Sigma^*$ starting with an initial state and a tape that contains in some way the arguments for f. Instructions are provided to read the function value from the final tape inscription when the TM stops.

Non-deterministic Turing machines (NTM) are defined similar to deterministic TM but with a transition function $\delta : \Gamma \times \Sigma \rightarrow 2^{\Gamma \times \Sigma \times \{L, R, U\}}$ mapping a state and symbol to a *set* of possible actions. The behavior of the NTM is defined as follows: If q is the current state of the NTM and s is the symbol currently scanned, then one triple $\langle r, t, d\rangle \in \delta(q, s)$ is chosen non-deterministically and the internal state of the NTM changes accordingly.

A (deterministic or non-deterministic) TM *decides* a language $L \subseteq \Sigma^*$ iff it stops on every input $w \in \Sigma^*$ and the final tape contains a 1 if $w \in L$ holds, and a 0 otherwise.

In complexity theory, problems are encoded into formal languages $L \subseteq \Sigma^*$ for a fixed signature Σ to abstract from their informal description. An instance of a problem is a word $w \in \Sigma^*$ and the question is whether w belongs to L or not. This makes it much easier to investigate them in a more general way. Therefore we assume that a decidability problem consists of a language $L \subseteq \Sigma^*$ such that $x \in L$ iff x is solvable. By definition L is decidable iff the question $x \in L$ can be decided for every $x \in \Sigma^*$ with a (deterministic or non-deterministic) TM. It is commonly agreed among computer scientists that all problems which can be solved by a DTM within a polynomial time bound are feasible, i.e. an efficient algorithm to decide it exists. All other problems are not feasible. This classification leads to the following definition: The class P and NP are the sets of all problems $L \subseteq \Sigma^*$ which can be decided by a deterministic resp. non-deterministic Turing machine T in at most $p(n)$ steps where p is a polynom and n the length of the input word $w \in L$. Because every problem in NP is bounded by a polynom the following can be proved:

Theorem 1 *For every language $L \subseteq \Sigma^*$ in NP there exists a non-deterministic TM that stops on every input with resulting output* 1 *iff $w \in L$ holds.*

First of all one might guess that NTM are more powerful, i.e. can decide more problems than deterministic ones. However, this impression is wrong and a proof is presented to undergraduates that both models are equally powerful. But one might expect that non-deterministic computations are less complex than deterministic ones. If this is really the case, i.e. P=NP holds or not, is one of the most important unsolved problems in computer science, because currently only exponential time algorithms are known to solve problems that are in NP but not in P. The technique of reduction and notion of NP-completeness can be employed to find such unfeasible problems: A problem L' is *polynomial reducible* on a problem L, denoted by $L' \leq_p L$, if there exists a DTM that computes a function $f : \Sigma^* \rightarrow \Sigma^*$ in polynomial time such that $w \in L'$ iff $f(w) \in L$. A problem $L \in$ NP is *NP-complete* if every problem $L' \in$ NP is polynomial reducible on L, i.e. $L' \leq_p L$.

If one could show $L \in$ P for an NP-complete problem L then P=NP holds. On the other hand, if P $\neq$ NP then all NP-complete problems are known to be infeasible. However, in either case it is of practical interest to know whether a problem is NP-complete or not.

3. Developing and Presenting NP-completeness Proofs

There are two general methods for proving the NP-completeness of a problem $P_1 \subseteq \Sigma^*$: First, by finding a polynomial reduction from another problem $P_2 \subseteq \Sigma^*$ which is known to be NP-complete, i.e. $P_2 \leq_p P_1$. Second, by an *elementary* proof, i.e. by giving a transformation, computable in polynomial time by a DTM, that maps every NTM with given input tape into an instance $I_1 \in \Sigma^*$ such that $I_1 \in P_1$ iff the corresponding NTM stops. The main part of both methods is the construction of a mapping from one domain (a NTM or an NP-complete problem) into another domain (a problem).

Interactive visualization can support the presentation and development of such an NP-completeness proof in several different manners: If the problem itself is presented in a lecture or textbook, then it is a useful and traditional approach to give a visualization of some examples of the problem. An electronic text, in addition, can visualize the problem in many other ways: Instead of presenting static pictures, it is possible to simulate an instance of the problem, for example, an instance of the traveling salesman problem can be represented as a graph (or map) and the students can search for a short round tour interactively. This may give them a better comprehension of the problem and its complexity Moreover, instead of choosing one instance of the problem, it is possible to provide an editor for typing in an instance of the problem and then investigating it interactively. If a reduction $L \leq_p L'$ is used in a proof, then both problems L and L' can be visualized as described. But what is more, we are able to map an instance of L' into an instance of L and investigate the effects and properties of the transformation visually.

If an NP-completeness proof is not given but has to be carried out by the student, e.g. as an exercise, then an interactive visualization can also help him understanding the problem better. However, the crucial and difficult part of any NP-completeness proof is the construction of the mapping between the two domains. It is likely that most students fail on the first attempt to find the correct transformation. Here an interactive software can help them to check their transformation on suitable problem instances. First of all, the student has to type in the transformation (which depends on the given problems). An appropriate implementation can focus on the relevant and interesting parts of the transformation such that nonsensical inputs are impossible. The student then has the opportunity to check his transformation for errors much easier than doing it by hand. As another advantage, the result can often be checked automatically (for example if only finitely many correct transformations exist). Thus the student get immediate feedback on the correctness of his solution. But even if the solution can not be checked automatically, it may be possible that the student can test his solution on certain instances of the problem interactively with the help of a simulation of the problem. In many situations it might also be possible to generate counterexamples for wrong solutions automatically. These counterexamples then can be inspected with the help of the software.

As an additional remark let us note that the technique of reduction is not restricted to the framework of NP-completeness. In computer science reductions are also used, for example, to prove lower time bounds or the undecidability of problems; thus most of the above techniques for visualizing reductions can be used in these areas as well.

4. NP-completeness Proof for a Tiling Problem

Every introduction into the theory of NP-completeness starts with the definition of the classes P, NP and the notion of NP-complete problems, and then presents the technique of reduction to prove the NP-completeness of one problem using the known NP-completeness of another problem. However, this leaves open the question of how to proof the NP-completeness of the latter problem. In our lecture we do this by presenting Cooks Theorem, which states that the problem of deciding the satisfiability of propositional formulas is NP-complete [Cook 1971], and we give an elementary proof based on a transformation of NTMs into propositional formulas.

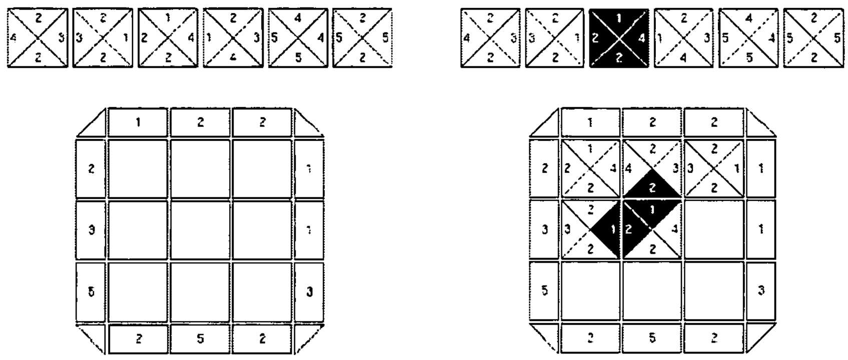
To understand this transformation one has to be familiar with propositional logic. Though first year students are teached basic parts of formal logic, many (if not most) of them have problems to understand the proof, in particular its general scheme and the validity of the transformation. To make sure that the students well understand this proof and the concept behind it, they have to carry out an elementary NP-completeness proof for another problem — a tiling problem — as an exercise. In our hypertext the presentation of this problem is supported by an interactive simulation of some of its instances; and we developed a Java-applet which makes it much easier for the students trying to solve the exercise.

4.1. The Tiling Problem

Consider the following tiling problem PUZZLE [Wagner 1994]:
INSTANCE: Given an alphabet Σ, a collection $T_1, \dots, T_n \in \Sigma^4, n \geq 1$ of "tiles" (where $\langle a, b, c, d\rangle$ denotes a type of tile with top side a, right side b, bottom side c, and left side d), and a quadratic frame $F \in \Sigma^{4t}, t \geq 1$.
QUESTION: Is it possible to fill the frame F with tiles of the type $T_1, \dots, T_n$ such the sides of the tiles match with the corresponding sides of the frame and their neighboring tiles?

In our lecture notes we exemplify this problem with visual representations of two small instances: one which is solvable and another one which has no solutions. Part (a) of [Fig. 1] shows the paper version of the solvable example, where $\Sigma = \{1, 2, 3, 4, 5\}, t = 3, F = \langle 1, 2, 3, 1, 1, 3, 2, 5, 2, 2, 3, 5\rangle, T_1 = \langle 2, 3, 2, 4\rangle, T_2 = \langle 2, 1, 2, 3\rangle, T_3 = \langle 1, 4, 2, 2\rangle, T_4 = \langle 4, 4, 5, 5\rangle, T_5 = \langle 2, 5, 2, 5\rangle$. The quadratic frame of an instance of PUZZLE is build from F starting from the top left edge in clockwise orientation.

In the hypertext this picture is omitted and replaced by a simulation of the instance (see part (b) of [Fig. 1]): Here, the students can pick the tiles with the mouse and try to fill the frame with them. If two tiles do not fit, i.e. the touching borders have different symbols, then these parts are highlited black. The advantage of this simulation over the paper version is the immediate response to a wrong or correct attempt to solve the instance, which makes it easier for the student to understand the problem in detail. After some experiments with the simulation most students should be familiar with PUZZLE, in particular because of its obvious relation to jigsaw puzzles.



(a) paper version (b) simulation in hypertext

Figure 1: Example of PUZZLE

For the proof of the NP-completeness of PUZZLE we consider one-way-infinite Turing machines, which differ from two-way-infinite Turing machines only in the restriction that the tape has a leftmost cell (and an infinite supply of cells to the right); in case the transition function attempts to move the head off the tape to the left the machine just stops. In our lecture we prove that the expressive power of one-way-infinite Turing machines does not differ from that of two-way-infinite ones. Its proof is based on a transformation of one type of Turing machine into the other. The proof is given in our hypertext lecture notes; its central parts are visualized with corresponding simulations of the original and the transformed Turing machine (see [Pape and Schmitt 1997] for details).

4.2. Supporting the Development of an NP-completeness Proof for PUZZLE

The central part of the NP-completeness proof of PUZZLE is to show that every problem $L \in \mathrm{NP}, L \subseteq \Sigma^*$ is polynomial reducible on PUZZLE. By definition of NP and Theorem 1 we conclude that a (one-way-infinite) NTM T exists that stops on input $w \in \Sigma^*$ with final output 1 after $p(|w|)$ steps (where p is a polynom) iff $w \in L$ holds. From the description of T and given input w we have to construct an instance of PUZZLE that is solvable iff T stops on input w with final output 1.

The main idea of the proof is to simulate T with the corresponding instance of PUZZLE by encoding a configuration of T and all possible transitions into a row of tiles. These tiles must be designed such that a row r of tiles fits under the preceding row iff r corresponds to a next possible configuration of T. The top side of a tile contains the symbol of the corresponding cell. If the read/write head is over this cell than the current state is added to the top side, too, and the left and right sides of the tiles are used to simulate the head movement over the tape. The bottom side of a tile contains the information for the resulting configuration. The frame of the puzzle has size $t = p(|w|)$ and is generated as follows: The top side of it is constructed from the given input tape and initial state of T; the bottom side is build from the given output 1 (the rest is filled with blanks); the left and right side is filled with special symbols (#) not occuring in Σ.

[Fig. 2] shows an example for a puzzle related to some TM (the details of the TM need not to concern us here): The top side corresponds to the initial configuration $q_1 01B$ and the bottom side corresponds to a (desired) final configuration $q_2 100B$. The first row of tiles corresponds to the initial configuration $q_1 01B$ (top side of tiles) and the resulting next configuration $1q_1 1B$ (bottom side of tiles); the tile in the top left corner of the puzzle simulates the transition $\langle q_1, 0\rangle \mapsto \langle q1, 1, R\rangle$.

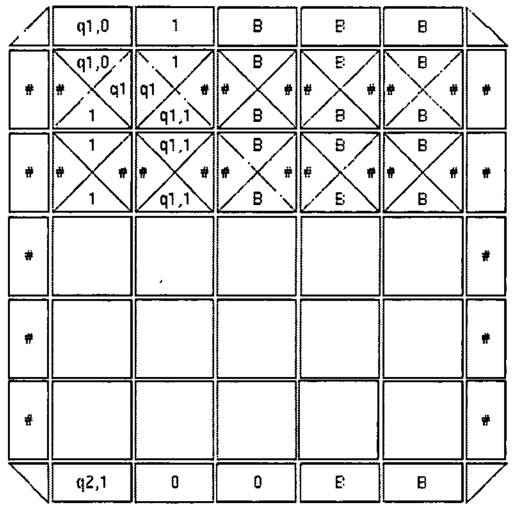


Figure 2: A partially filled PUZZLE related to some non-deterministic Turing machine

The difficult part of the proof is to find this transformation. For an introductional course on complexity theory this task is far to complex to solve without any hints. To make the search for a correct transformation easier, we developed a Java-applet with which it is possible to specify the transformation, to type in a Turing machine to which the transformation is automatically applied, and to try to solve the resulting puzzle. The frame is build automatically from the input tape and the output; therefore it is not necessary for the student to specify this part of the transformation. Furthermore, the graphical user interface for the input of the transformation is designed to forbid as much nonsensical inputs as possible without giving too much hints.

It is possible to classify the types of the tiles into six categories depending on the different actions and states of the NTM. Recall that a tile is directly related to a cell of the tape:

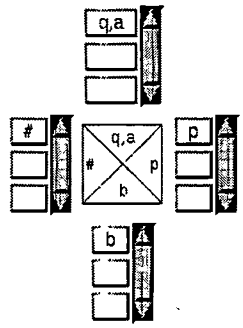
1. Neither before nor after the next step of the NTM the head is over this cell of the tape.
2. $(p, b, U) \in \delta(q, a)$, i.e. the head is above this cell, a new symbol is written to it, the head moves to the right, and the internal state of the NTM changes. In the applet the correct solution for this category is given as a hint.
3. $(p, b, R) \in \delta(q, a)$, analogous to 2.
4. $(p, b, L) \in \delta(q, a)$, analogous to 2.
5. The head moves into the cell from the left.
6. The head moves into the cell from the right.

In these categories a, b and q, p are placeholders for the corresponding symbols and states of the NTM. The input of the transformation for one category is done by a multiple-choice selection of symbols, states, or pairs of symbols and states (see [Fig. 3] for categories 2 and 5). This approach makes it a lot easier for the students to find the correct transformation and it inhibits too much nonsensical input.

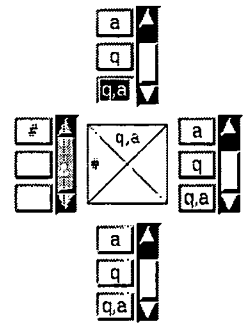
After the transformation is typed in, the students can feed in a NTM and have a closer look at the corresponding instance of PUZZLE, which is automatically generated applying the given transformation. They now can experiment with their solution and get confident about its correctness or they can try to falsify it by finding counterexamples, i.e. Turing machines which stop on a certain input but where the corresponding instance of PUZZLE has no solution or vice versa. If the latter happens then it is possible to modify the transformation and they can try to experiment with the new version again.

5. Conclusion and Further Work

We investigated the potential of interactive visualization for the development and presentation of NP-completeness proofs in computer science education and reported on our implementation of an example which incorporates most



(a) correct input for category 2



(b) partially filled out category 5

Figure 3: Input of the transformation

of our ideas. We believe that with this software students can learn certain parts of NP-completeness theory much better than with traditional teaching methods. The next step in our work will be a practical test during the lecture and tutorials. Based on this evaluation we are going to improve our software, e.g. by generating counterexamples for wrong solutions. Currently the students' solutions are still checked by human tutors, but we are also working on a fully automatic intelligent tutor for helping students with checking NP-completeness proofs based on the reduction technique for certain variants of 3SAT.

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A Modular Object Oriented MPEG-2 Postprocessor for Custom Bit-rate Reduction.

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Abstract: Modern computer science is dominated by multimedia and networking concepts. A great effort is world-wide applied to integrate these technologies in order to provide advanced multimedia services. Teleworking, distance learning, telemedicine and information kiosks are examples of interactive broadband services where the distribution of video information is assuming more and more importance.
In this paper we present a technology and a sample application for real-time or near real-time post-processing of MPEG-2 video streams. Reducing the bit-rate for network distribution and the dimension for storage purposes as well as implementing special effects, such as size reduction and picture in picture, are the results of the proposed application.

Introduction

Multimedia has been one of the most exciting technologies of the last decade: a number of applications have been developed taking advantage of the continuously growing computer power. The great diffusion of networking concepts and technologies, the still increasing number of Internet connections and network applications represent the background for a growing interest in the integration of multimedia tools, particularly broadcast video information, with networking.

Audio and video flows require a transport mechanism that intrinsically supports the concept of quality of service (QoS) in order to guarantee the correct information at the right time. Although fast Asynchronous Transfer Mode (ATM) network installations, natively implementing QoS concepts, are quickly spreading, the most diffused Local Area Networks (LANs) nowadays are Ethernet and its high speed variations, namely Fast Ethernet and 100VG-Anylan [Watson 95]. These network technologies use a best effort approach to data transmission, offering any or nearly any control over the quality of service.

On the other hand video services are heavily bandwidth sensitive and par excellence real time applications, consequently, badly fit to a best effort based transport, and an acceptable degree of reliability for video transport is seldom possible on Ethernet like networks [Stuttgen 95]. Starting from the analysis of video compression algorithms, we propose strategies that, acting at the level of the coding layers, can control and adapt the dimension and, consequently, the bit-rate to the availability of bandwidth. This approach will allow increasing the number of users that can be concurrently satisfied by a video server. As it has been experimented that video acceptability depends on the content [Apteker 95], the availability of a tool for selecting the reduced frame rate will allow minimising the leakage on the perceived quality of video sequences.

At present the most diffused video compression algorithm for broadcast and high quality digital video, is Motion Picture Experts Group 2 (MPEG-2) [LeGall 91], thanks to the extremely high quality and compression ratio obtainable, and its nature of asymmetric algorithm. While the coding process is highly resource consuming, real time decoding is obtainable on usual PCs with software or low cost hardware implementations. This article describes a set of tools to adapt a MPEG-2 compressed video stream to network transport requirements acting on its hierarchical coding structure.

The MPEG-2 standard

The MPEG-2 lossy compression scheme is based on the Joint Photographic Experts Group (JPEG) standard developed for continuous tone still image compression. It inherits from the JPEG standard the splitting of images into blocks, the Discrete Cosine Transform (DCT) and the zigzag order scanning of the transformed coefficients to remove spatial redundancy, and the Huffmann coding [Rabbani and Jones 91]. In order to further improve the compression ratio, it exploits the temporal redundancy between successive images by mean of a motion compensation algorithm [Bhaskaran and Konstantinides 95]. In an MPEG-2 compressed sequence three types of images are present in a fixed pattern.

Intra (I) frames are coded independently from the near neighbours, predicted (P) frames are coded referring to the preceding P or I frame and bidirectional (B) frames are coded referring to both the preceding and successive I or P frames. In this way B frames, the most frequent ones, are encoded using the smallest number of bits, while the I frames, the least frequent, are encoded as nearly plain JPEG, and P frames score a compression ratio halfway between Is and Bs. The 12, for PAL systems, or 15, for NTSC systems, picture set is called Group of Pictures (GOP).

The single picture, or frame, is then split into slices, that are 16 pixels high, and each slice is divided into macrobloks: 16 by 16 pixels areas. In each slice the first and the last macroblocks must be present in the coded bit-stream, while other macroblocks may be absent, in order to increase the compression ratio, if not significantly changed since the preceding frame. Finally macroblocks are further split into blocks, that are 8 by 8 pixels image areas, in particular one macroblock is composed of 4 blocks representing luminance information and 2 to 8 blocks for the down-sampled chrominance information; DCT coding is applied at block level.

The MPEG-2 stream can be scanned, without necessarily interpret its data, down to the slice level, because each entity (GOPs, pictures, slices and other extensions) is preceded by a 32 bit unique start code in order to recover from data errors and to allow pseudo-random access in the sequence. Start codes are not present from macroblock level down because their overhead would be comparable with pixels data amount. In order to analyse the single block or macroblock it is necessary to fully interpret the stream, including Huffmann decoding.

From the description of the algorithm [ITU-T 96] we can derive that a frame drop, more than the usual loss of smoothness of the sequence, may have disastrous consequences. If, for example, an I frame misses, all the GOP it belongs to is compromised, so if network workload conditions do not allow the transmission of all the frames, a mechanism to discard dependent frames (Bs and then, if necessary, Ps) is required in order to preserve independent ones. Furthermore it is possible to get continuous quality degradation, preserving smoothness or in addition to frame dropping, discarding some AC coded coefficients at the block level. This level of control over a compressed stream allows creating, on the fly or off-line, a new version of a given sequence drastically reduced in frame-rate and image quality. For example, by this process, an end-user can have an idea of the original movie stored in a server, minimising the impact on network load, and choose the quality of the movie according to specific needs.

A modular approach to MPEG processing

Thanks to the hierarchical MPEG-2 stream format, a lot of processing is possible on an already existing encoded sequence, provided to have a proper stream analyser working as a filter. Of course it is important that the output of the filter is still an MPEG-2 compliant stream in order to be transparent to both an MPEG standard player and to another eventual cascaded filter.This is the concept at the base of the described technology. As long as a number of different processing can be done operating at different levels of the MPEG hierarchy, a convenient tool to access the correct level in a simple and, at the same time, flexible way is needed. Furthermore the consideration that, in order to operate at a given level, all the higher ones must be processed, leads to the Object Oriented Programming as the most suitable technology for this purpose. Once developed a proper component to analyse the MPEG stream structure, more complex and powerful objects can be easily derived.

The stream analyser

The stream analyser object is the building block of the described work. It does not actively do anything on the input bit-stream more than following its semantics and presenting it at the output unchanged. The stream analyser component is developed as a Software Finite State Machine (SFSM) running as a separate thread and implementing the MPEG-2 stream format (see fig. 1).

The first SFSM simply finds a start code and then passes the control to the bigger one, that changes its state according to the last start code found and, at each level, extracts the available data from the stream. If the last start code is a wrong one, which means its not contemplated by the MPEG2 rules, the SFSM enters an unrecoverable error state.

Furthermore it defines the placeholders to properly handle the various data parts of the stream in the specific descending objects. In this approach, flexibility has been preferred to performance; in fact cascading several specialised objects duplicates the elaboration proper of the stream analyser itself, but allows the building of complex filters by simply combining proper blocks. Such approach could well fit a distributed processing among multiple machines.

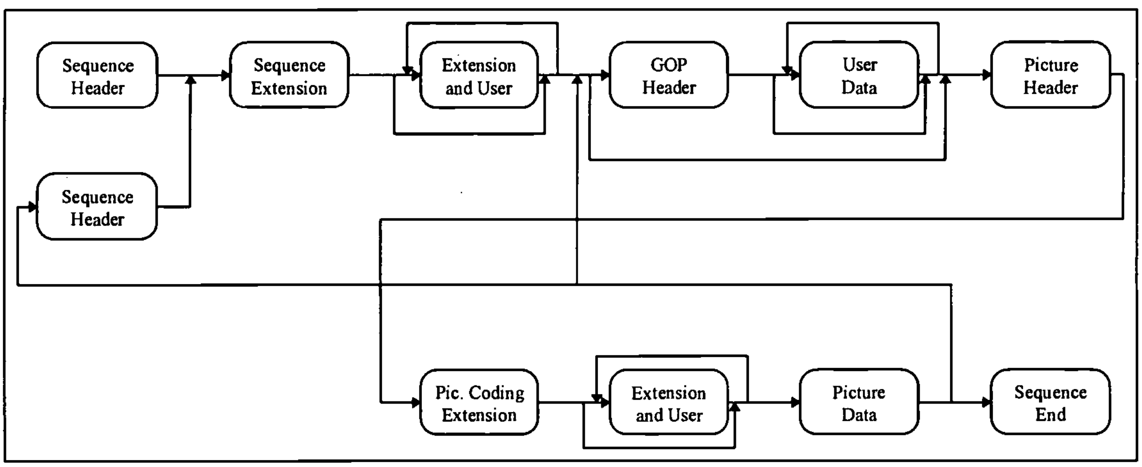

Figure 1 - The Software Finite State Machine

Frame skipping

There are two kinds of frame skipping objects, both directly derived from the stream analyser, that provide to selectively discard one out of N B or P frames according to the required bit-rate reduction. Of course before discarding a P image, discarding all the B frames is necessary, otherwise the residual B frames can not be properly decoded due to their reliance on P frames.

The generic frame-skipping module adds the handler for the "Start Of Picture" start code to the stream analyser object. It keeps an internal counter for the proper picture type and selects frames that need to be skipped.

Vertical size reduction

Vertical size reduction is achieved by discarding one slice out of n. Of course, being a slice 16 bits high, not all possible sequences lead to a good visual result, but this is the only way to reduce the vertical size without completely decode and re-encode the sequence. Similarly to the frame skipping component, this object adds a custom handler for the "Start Of Slice" set of start codes to the stream analyser. Slice start code, in fact, is not a unique number but any 8 bit integer between 01h and afh (175d) representing the vertical position of the slice in 16 pixels units.

Once again the vertical size reduction filter should not be used if dependent pictures are still present in the stream, because it destroys data that are in general necessary for the reconstruction of B and P frames.

Low level stream analyser

In order to process a stream at sub-slice level, that is macroblock and block level, full decoding of the Huffmann Variable Length Codes (VLCs) is required because, as stated before, no start code exists for macroblocks and blocks.

This is achieved deriving a new object, the stream low level analyser, from the stream analyser component. Conceptually the new component only adds low level processing by mean of linking proper handlers to the placeholders defined by its direct ancestor. Actually, for performance purposes, the SFSM has been partially rewritten to internally implement many of the needed functions, avoiding too many method calls.

VLC decoding is obtained by a set of tables, containing partially decoded Huffmann codes, based on the number of leading zeroes or ones of each code. This seems to be a good trade-off, in terms of efficiency and memory consumption, between using fully decoded tables and bitwise decoding by binary trees.

Horizontal size reduction

Horizontal size reduction is obtained in a very similar way to vertical size reduction: instead of discarding slices one macroblock out of n is discarded. The main difference is that the X size reduction module is derived from the low level stream analyser instead of the stream analyser object. The same considerations, true for the vertical size reduction module, are valid for what concerns frame dependencies and resolution: P and B frames should be removed before reducing the horizontal size of a sequence. Furthermore, being macroblocks sixteen pixels wide, not all the possible sequences lead to good results because various, eventually important, details of the original stream may be lost.

Performance summary

Figure 2 lists the results obtained with some test sequences encoded at different bit-rates. It is important to note that some performances are strongly dependent on the sequence characteristics and, in fact, only the horizontal and vertical size reduction behaviour is reliably predictable, but the presented data is definitively not a best case test and can therefore be representative of what can be obtained by the developed technology.

Original Bit Rate	Original Size	b0 Size	Compr Ratio	p0 Size	Compr Ratio	b0p0 Size	Compr Ratio	bps2 Size	Compr Ratio	bpsMb2 Size	Compr Ratio
2 Mbps	2094	1269	1,65	1340	1,56	515	4,07	257	8,15	128	16,36
4 Mbps	4441	2437	1,82	2830	1,57	826	5,38	412	10,78	210	21,15
6 Mbps	6763	3557	1,90	4352	1,55	1146	5,90	574	11,78	290	23,32
8 Mbps	9100	3970	2,29	6142	1,48	1012	8,99	509	17,88	257	35,41
10 Mbps	11444	4230	2,71	8316	1,38	1102	10,38	521	21,97	270	42,39

Figure 2 - Components performances

Each "Compr Ratio" column gives the compression ratio obtained applying the preceding module. File sizes are expressed in kilobytes.

- **b0 Size** is the file size after discarding all the B images
- **p0 Size** is the file size after discarding all the P images
- **b0p0 Size** is the file size after removing all the dependent (B and P) images
- **bps2 Size** is the file size after removing Ps and Bs and reducing the vertical size of the sequence to one half
- **bpsMb2 Size** is the file size after removing Ps and Bs and halving both horizontal and vertical size.

Continuous quality degradation

Down to block level very interesting results are obtainable also without completely decode and re-encode the stream data. Taking advantage of the structure of the coded transformed data, and in particular the zigzag order, it is possible to easily modify the amount of bits devoted to sequence details both in the luminance and chrominance components. Dropping a number of AC coefficients in a coded block allows reducing the stream bit-rate by a reasonably arbitrary amount. This process lowers the visual quality of the sequence, without introducing artefacts or affecting the overall smoothness of the video sequence.

In contrast with the previously described components, this means that it is possible to apply continuous quality degradation processing without discarding dependent frames, because no data is completely destroyed but only degenerated. Figure 3 gives an idea of the obtainable results in terms of compression ratio vs original bit-rate.

Original bit-rate	% lum. AC data	% chrom. AC data	Max compr. ratio
1 mb/s	10 - 15	0 - 5	1.2 : 1
2 mb/s	30 - 45	2 - 8	2 : 1
4 mb/s	50 - 60	3 - 10	3 : 1
8 mb/s	55 - 65	5 - 13	4 : 1
12 mb/s	60 - 70	7 - 15	5 : 1

Figure 3 - Further compression ratio vs original bit-rate

The StreamACCut component allows specifying the number of AC coefficients to be passed through, discarding all the subsequent coefficients, for both the luminance and chrominance components. The MPEG standard devotes an amount of data to colour representation far smaller than the one devoted to luminance coding, accordingly to the studies on the Human Visual System (HVS), far more sensible to luminance information than to colour. As a consequence dropping all the chrominance AC data leads only to small gain in terms of compression but with a similarly small loss in terms of visual quality.

Streams merging

Properly integrating two low-level analysers into a new component, it is possible to obtain a picture in picture (PIP) effect. Data from one stream is inserted into another one in an arbitrary position, specified by slice-macroblock co-ordinates.

This sort of processing, once again, requires that all dependent frames be previously removed in order not to generate artefacts in the transition zones from a sequence to the other.

The FilterBuilder application

In order to demonstrate, test and off-line exploit the described technology, a comprehensive application has been built incorporating all the presented components. FilterBuilder 1.0 (see fig. 4) allows to build an MPEG filter, compile it and run it on an existing stream with the help of a visual interface.

The tool bar in the upper side of the application window contains all the active objects available. They are, from left to right: stream reader, stream writer, B-frame skipper, P-frame skipper, H-size reducer, V-size reducer, streams merger, connection creator , connection eraser, component eraser and filter compiler.

After creating the filter placing the desired components on the grid and properly connecting them to one another by mean of the pipe creator, the filter can be saved to disk with the usual file/save menu selection. Then it must be compiled. In this phase it is checked for correctness and the user is prompted for the proper parameters of each component. In the end the filter is run by the apposite menu item. In the rightmost field of the status bar the user is informed of the number of running threads (components). When that number reaches zero the filter has finished its processing.

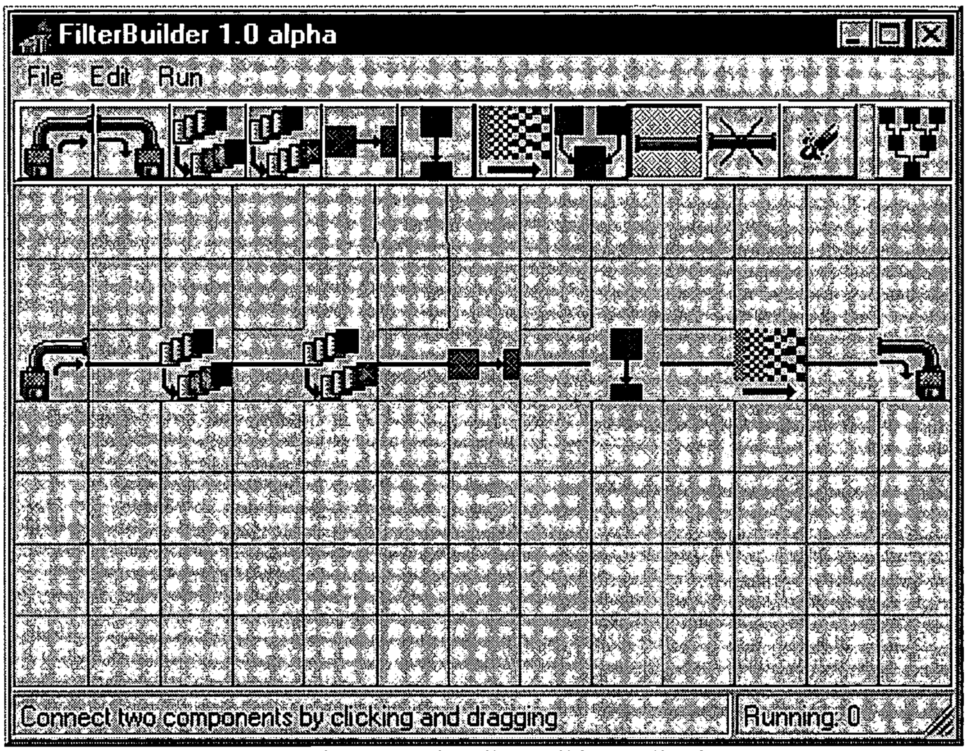

Figure 4 - The FilterBuilder application

Conclusions and future work

The described components are advanced building blocks of a potentially very useful and flexible technology. They will be the object of several enhancements in terms of performances, to target actual real-time sequence processing, and robustness, to recover in presence of particular or even faulty streams. On the other hand further development efforts will be devoted to network integration of the presented technology. This means, first of all, distribution of the processing power on multiple machines on a local area network, working at module connection level. A system for network load measurement and estimation will allow to dynamically and automatically modify the components parameters in order to adapt the stream to instantaneous network conditions. To be noted that, at present, component parameters are set at initialisation time and cannot be modified while the component thread is running. As a final task the system will be applied to World Wide Web technology to implement a high performance adaptive video server system.

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TIMÓN: NAVEGATION SYSTEM THROUGH WEB SERVER WITH EDUCATIVE INTEREST FOR THE THESE DIDACTIC EXPLOITATION OF THESE SOURCES OF RESOURCES

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ABSTRACT

This tool tries to serve as a guide to teachers who are beginning their navegation in this communication space consisting of the World Wide Web (WWW), in order to facilitate a faster access to these resources with educative interest and their later didactic exploitation.

KEYWORD: Navigation. WWW. Didactic resources. Teachers' training.

INTRODUCTION

The soaring growth of this new communication space has generated an important debate about the possibilities that new mass media can offer to learning in all the educative levels.

Currently there are many places where you can connect to explore questions related to education and joining resources to the educative development in new technologies. Some of these places or linkers, like the new and provocative Engines for Education, offer chances to interact in the training subject and the necessity to raise again the question of the current education structures (Del Moral, 1996).

First of all, let us try to provide teachers with the password to the Web servers so that the curricular integration of the net resources found there can become real, for that purpose it will be essential to have a navegation system that makes our objective possible.

Having access to our own Web servers is in itself an enriching educative experience. However, there are methods to access to the WWW with educative purposes in a structured way, where two approaches can be brought out: which should not be exclusive in any case.

- Conceiving it as a closed environment of educative material useful because of its hypermedia and distance learning capabilities.
- To access to a joint of materials that can be designed with educative or other sort of goals but which can be directed with guided educative explorations.

So then, the educative use of the Web sites is undoubted, besides having the features of a hypermedial system, can also have many applications in different fields such as distance learning or the elaboration of didactic materials with an interactive character from the resources available... However, it could be necessary to have some tools that could help us differentiate those useful resourses among the large amount of information available. Nowadays, brochures-applications, electronic magazines resource collections divided into themes and, in general, search tools are being developed as simple and immediate information means.

The compilation of all the educative resources interesting for teacher is not an easy task owing to the large amount of information available in the WWW, in spite of the existing educative, interest resources compilations made up by special groups of researchers or experts in specific themes, joined by other educative institutions creating their own connections and establishing a direct connection with those resources that they consider of interest.

Other initiatives provide a detailed guide of Web servers that can offer certain interest to different teacher groups, trying to introduce a brief synopsis of their contents with the intention of exploiting to the full the research efforts and time (Morlá, 1996). Also, some types of Web servers are pointed out, although superficially, that reflect a specific research to each subject related to the educative field, which is the case of the collection of Web addresses about the science field and the scientific knowledge realized by Lowy (1997).

Our proposal can be understood not only as a simple application but with the aim of qualifying, the teacher for developing certain tasks related to the knowledge of the Internet as a new resources generator.

TIMON: INTERACTIVE TECHNIQUE THROUGH NAVEGATION ORDERS

The application has a really attractive interface. You can access from the main screen to all the sections that make up the application. These sections widen the user's knowledge, specially those leaners who are familiar with Internet, and those who want to approach to the Net with a specific goal as in looking for new resources without dedicating too much time in order to carry out a didactic exploitation of them and to integrate them in any curricular area. Hundreds of hours of connection can be saved when looking for information or whatever we need and we can obtain material completely free and discover the most interesting new servers of the World Wide Web.

Thematic chapters or sections that have been included offer a big amount of information with which knowledge about the Net can be widened. The structure is so that accessing to the desired information is very easy. The presenting texts are of easy understanding, accessible to all users, but in a special way it is recommended to learners with educative interest to achieve the Web servers that make up the Internet. Other types of tools included are the hypertexts, that offer definitions of terms that could imply a conflict, comments, explanations, complementary information.

With the help of Web Site Menu you will find addresses of interesting web sites, both national and international, gathered together in subjects such as Sciences, Art, Literature, Music, Language, History..., and you can have access directly to them through the application linkers, direct access to the researches... Thus, curious sites such as the NASA one and many others can be known.

Through that application you can connect to other working application available in the Internet Web servers. It gives information about the different didactic resources, their identification formulas and ways of location and key to access to the information they contain with the purpose of being selected and debugged.

The application would try to facilitate the task of those teachers -of the different areas that make up the Primary and Secondary curriculum- in their determination to make effective the educative achievement of the information to the Web servers, helping them rescue those elements that can be useful to complement and illustrate their classes; or providing them with material that can be used to create their own didactic resources, such as multimedia presentations supported by; articles, unpublished videos about certain topics, computer animations, photographs and images of every type that, having been previously organized, can acquire a special meaning in the teaching-learning process.

We want to facilitate the management of the most interesting webs, allowing the complete organization of its storage. Information folders to define a structure of directories and subdirectories can be created. With this application we try to get a faster access to the Web sites, since it allows the texts to be displayed, and a screen scroll of graphics, sound etc...

Firstly access is offered to a thematic directory which contains a selection of classified addresses of diverse Web servers that leads directly, like a key, to the requested sections in Internet. The revision of the included webs could be changed when necessary and others could be added according to their discovery and educative values, but it does not mean that the teacher cannot research whatever and wherever he wants in the Net.

This tool while recognising the many posibilities the Net offers, only tries to facilitate and to speed up the access to those more common resources for teachers, especially those who are beginning their way in this new communication space and in this information hypermarket. That is to say, this application contains the key addresses that a learner interested in Internet must know at least, some of them of a general character because they are linked to educative institutions or organizations; others because they tackled topics directly related to Education; and others because they are closely bound to similar working areas presenting a large training value.

The pages of this application allow all the recuperated and saved information in a data base to be acceded to by the use of hyperlinkers. The main web site is able to present information organized in categories and indexed by URL addresses and in such a way that only the most recent addresses taken from the last process of research are shown. The application is made up of many pages exported from the Web, where you can view the text files and the access routes to other more consistent and bigger (sound, video..) files.

ADVANTAGES

The connection time to the Net is reduced to a great extent which means economic saving web sites could be explored whenever we want without the necessity to be connected, the data can be used like inclusions in presentations, the access to data will be fast and without waiting, researchs in recuperated webs can be realized and, moreover, you could program the bringing up to date of the sites contained in the data base with the frecuency that we want. To sum up, this tool will enable teachers to become independent of the Intenet connection, by locating all the information they need in their own personal computer.

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Evaluation of the EuroMET Web-Based Course in Meteorology

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Abstract: EuroMET has been created to address the education and training needs of professional meteorologists and students in tertiary education throughout Europe and more widely. Two courses, each modular in format, have been developed for the WWW. The courses have been evaluated at three key points during their development for their usability, scientific content and perceived pedagogical worth. By performing the evaluation in this way, recommendations for improvement could be made to the developers, these improvements incorporated, and all modifications fully tested before the course was considered ready for use. The final versions of the courses are currently undergoing a summative evaluation as they are used in real teaching and training environments. This paper describes the evaluation methods used during this project and the results obtained thus far.

Introduction

The EuroMET (European Meteorological Education and Training) project arose due to both the emerging interest within the meteorological community for Computer Aided Learning and the decision of the European Commission to foster telematic applications within the 4th programme for research and development. The education and training of meteorologists varies widely across Europe. Basic meteorology is taught in many universities, most often as part of other courses, for example geography or environmental science. In universities where it is offered as a comprehensive course, meteorology is generally taught in specialist departments at both undergraduate and postgraduate level. Due to the relatively small number of universities teaching meteorology at sufficiently advanced levels, National Meteorological Services (NMS) usually recruit employees at university degree level and then offer their own training as is necessary or possible. The NMS' education and training courses that exist at present differ greatly across Europe according to the size and organisation of each service. For example, some NMS run their own training courses, such as in France and the UK, and also offer these to other countries unable to offer their own, eg the Netherlands, while other NMS offer very little formal training, eg in Belgium. An important part of these training programmes is extension training, required because meteorological science and technology is continually developing so that new methods and theories need to be taught. At present no distance or open learning courses in meteorology exist within Europe.

Thus it can be seen that within the European meteorological community there is a need for computer-based learning resources not only to enable universities and NMS' training centres to share material, but also to offer an alternative to those NMS which either send staff on costly and time-consuming courses, or currently offer little or no training or education. EuroMET has therefore been created to meet this need. It aims to address the education and training requirements of professional meteorologists and students in tertiary education throughout Europe by establishing a multimedia, networked-based, open and distance learning service. Moreover, this service will be provided in such a way that it can be easily customised to fit local requirements.

The EuroMET consortium is comprised of 23 meteorological partners, i.e. universities and National Meteorological Services (NMS) from 15 European countries and the University of Quebec. The consortium is divided into two groups, the developers who are responsible for delivering the course, and the evaluators who are responsible for assessing the course. The developers are led by Météo France, where the project co-ordinator is also based, and the University of Edinburgh. The evaluation is lead by EUMETSAT (the European Organisation for the Exploitation of Meteorological Satellites) and the University of Reading. The 30 month project commenced in June 1996 and is split into three key stages. The first stage, lasting 6 months, was spent producing prototypes. The second stage lasted 12 months, during which time modules for the course were written by the developers, assessed by the evaluation team, and then returned to the developers for modification if necessary. The final stage, the demonstration phase, began in December 1997 and will run for a year, during which time the course will be used in universities and NMS on existing courses and as stand-alone education and training material.

The Course

It was decided that the course would be web-based, to make it easily accessible to everyone within the consortium, easy to include new developments and up-to-date material and also to make it possible to run powerful simulation models. The meteorological subjects for the course were selected in response to a European-wide needs analysis of National Meteorological Services. The two chosen were Numerical Weather Prediction (NWP) and Satellite Meteorology (SM). Both courses are comprised of nine chapters covering different sub-topics with each chapter containing a number of modules and totalling around 70 modules for each course. This modular approach allows teachers at different locations to choose only those modules which are directly relevant to the course they teach.

A common interface was chosen so that each module would look and feel the same. The interface was designed to be as simple as possible so that users could learn to use it as they went along. There is however an online help facility which explains all the navigation buttons and symbols and icons used throughout the course. It was also designed to be language independent, an important consideration for a multilingual project. Each module was constructed in the same way, opening with a motivation page to introduce the topic and engage the user's interest. The next page lists the learning objectives of the module, any pre-requisite modules the user should study first, any subsequent modules which follow on, and a list of module contents. The following pages then contain the teaching material, whilst the final page contains a summary of the material, which draws out the salient points of the topic. Users navigate through the modules by either clicking on arrows on a button bar at the bottom of the screen to progress page by page, either forwards or backwards, or they can click on the 'module structure' button, which enables the user to go directly to any page of their choice. A 'course structure' button similarly allows the user to select any module.

In support of this learning environment is a glossary to explain commonly-used meteorological terms and a keyword index which lists modules which contain material on important terms. Facilities for one-to-one and one-to-many communication are also included, such as email to subject experts, discussion groups and internet relay chat (IRC) areas. Tools to create adapted packages and extra material are also available from the EuroMET WWW site with full documentation, to allow teachers to create an online course from the EuroMET modules completely tailored for their needs.

Course Evaluation

The aim of the evaluation is to assess the course in terms of its ease of use, pedagogical effectiveness, including ensuring its scientific integrity, and utility in replacing conventional teaching, with emphasis on the multimedia aspects of the modules. The course is being evaluated in two main phases, one phase ran during the development work and the other after the development work was completed. The EuroMET evaluation scheme has been planned and executed by all the evaluation partners with occasional advice from staff at the Institute of Educational Technology, Open University, UK and from the EC-sponsored BASELINE and INUSE centres.

User Evaluation

The user, or formative, evaluation lasted for 8 months and ran concurrently with the development phase, in this way the developers could incorporate any changes that were considered necessary before the next evaluation phase began. The modules were released on to the WWW in three batches, after each module release the evaluators had 4 - 6 weeks in which to make their assessments and report their findings back to the developers. The modules were tested for their ease of use and pedagogical effectiveness with a view to modifying them, if necessary, so that they meet the learners' needs.

The user evaluation had two components. The first component was a quality check of every module, performed at least once by every partner, and was concerned primarily with the overall look and feel of each module and its ease of use. The second component was a more detailed look at the modules, with each partner being assigned a small number of modules to be assessed by several people within that institution, preferably covering a wide range in meteorological background and experience, such that each module was tested in at least four different institutions. This more detailed examination included checking the scientific integrity, determining users' impressions of different module characteristics, the level of interactivity, whether the module fulfilled its stated objectives, obtaining any suggestions of corrective action or possible improvements for the developers, and wherever possible testing the user's understanding before and after using the module. Two questionnaire forms were designed to fulfil these criteria, these forms were in spreadsheet format and were distributed and collected electronically.

Demonstration Phase

The second evaluation phase is the demonstration, or summative, phase. This phase runs for one year, commencing 1 December 1997. The aim of this part of the evaluation is to assess the modules in use on teaching and training courses in a variety of learning environments, and to assess their effectiveness in comparison to existing teaching methods. All partners, developers and evaluators, will participate in this phase. As the consortium includes partners from organisations of different sizes with different needs, as well as different facilities and resources available, the flexibility of the course can be fully tested.

Universities and some weather services can, for example, use the modules in conjunction with existing lecture courses. The modules can be incorporated in various ways ranging from the modules being used as complementary material which students are encouraged to look at in their own time, to full lecture replacement with dedicated classroom computer sessions. NMS which do not have their own training centres may well have to address the challenge of establishing how the modules can be used for 'on-the-job' training in an operational weather forecast environment. Potential use of the modules for these partners includes: giving individuals or groups dedicated time during their duty period for distance learning with the modules, supported by either a virtual tutor or a tutor group that meets at regular intervals; attempting to integrate the modules into the work schedule so that an individual could, for example, use a set of modules related to a weather-producing phenomenon and then look for real examples of the phenomenon while working, and using the modules as 'electronic job aids' that can be referred to as and when necessary during the course of the working day.

The pedagogical effectiveness of the EuroMET course will be assessed in various ways. For example, there is some scope during this project for the same course at an individual institution to be run in successive years with and without using the modules. Another option is to divide a student class into groups with perhaps one group using modules only, one having lectures and using modules, and a third group having lectures only. Examination or test marks could then be compared as a measure of the course's effectiveness. However, this is not always desirable when students' qualifications are at stake, particularly if some students feel they are at a disadvantage. Further evaluation of this sort can also be undertaken by higher degree students. Sometimes these students are required to take taught courses early on in their research programme, and so they could be used as assessors. Not all NMS examine their employees so evaluation of the modules' pedagogical effectiveness could take the form of users giving seminars to their colleagues. In some cases they may be given forecasting exercises to test their understanding of the material covered in the modules. These assessment methods could also be used in universities.

It is also important to gather information on the users' and teachers' opinions and feelings about the course.

This information will come from a range of questionnaires available online. The main questionnaires are the 'user' and 'teacher' questionnaires which will be completed by everyone using the course, either for learning or teaching. They address such issues as how the modules were used, if users received enough support or feedback whilst using the modules, how easy they were to incorporate into their studies/workload, as well as gathering general views on the comparative value of the modules and whether users felt they had learnt from them. The teacher questionnaire asks for views on the comparative value of the modules also, and about the impact it had on them, and provides areas to describe any student assessments, observations or interviews conducted. Both questionnaires also pose questions regarding the usage and usefulness of the communication facilities available with the course.

Evaluation Results

Initial results from the user evaluation phase have been collected and analysed. An independent usability study has also been carried out with the EC-supported project INUSE (Information Engineering Usability Support Centres), a network of centres specialising in usability issues.

User Evaluation Results

The first user evaluation phase found a disparity in the modules, with some placing the emphasis on using interactive and graphic elements to explain meteorological concepts, while others stuck to a more traditional, text-based approach. Users generally did not like the very heavy use of text, but preferred the use of animation and interactive exercises, as they offer a unique way of visualising concepts. It was felt therefore that the developers should have made more use of the WWW's potential. The navigation tools also caused problems, with users often unsure if they had accessed the whole of the module or feeling that they were 'lost' in the module as occasionally there appeared to be no clear route through it. A further problem was the definition of the objectives of each module. These were sometimes poorly defined in terms of learning goals and very often just resembled the table of contents, making it very hard for a user to decide whether they had successfully completed a module.

There were also some very good features present in some modules and which were recommended to be included in all modules. These features included the 'sensitive' equations and the conclusion pages at the end of a module. Sensitive equations were particularly useful when a module contained complex mathematical expressions with many terms which made it difficult to comprehend. Making each term sensitive, so that when the cursor was positioned over a term a pop-up explanation appeared on the screen, meant users found expressions far easier to understand. The conclusion page was also useful as it summarized the material and concepts covered and reaffirmed the important points. These features were incorporated into the Phase II modules. Further improvements included the use of more interactivity, though the evaluators felt that some modules were still too dry and formal, and the introduction of a timer bar which showed not only the time the user had been in a particular module, but also the fraction of it accessed. Navigation was also improved to guide the user through the module in a more linear manner to avoid being or feeling lost.

The Phase III evaluation showed that there was an overall improvement in quality of the modules since the Phase II evaluation. The amount of interactivity in the modules improved with most considered to have sufficient interactivity. There was also a more imaginative use of interactivity with a wider variety of exercises for the user to perform. The objectives were much better defined, and the navigation had further improved with the introduction of 'course structure' and 'module structure' windows which close automatically once a module or page has been selected. This is a big improvement when navigating round the course. The only potential problem identified is that of variation in material between modules, that is the amount of material in a module and its relative difficulty. Users might become frustrated if, after long exploration of a module, they find it does not meet their expectations because it is either too difficult or too easy. However, this problem has not been tackled and, as the majority of modules have been evaluated out of sequence in this phase, so that sometimes it has been necessary to test advanced modules without first studying its preceding modules, it remains to be seen whether this is a real problem or is simply an artefact of the evaluation procedure thus far.

Usability Study Results

A usability study was conducted at Reading University in collaboration with INUSE, with representative users using the modules to perform typical tasks in a realistic environment. A representative from an INUSE centre, NPLUS (National Physical Laboratory Usability Services) in Teddington, UK, supervised the study.

The usability study concluded that the course modules were well-designed and meet the needs of the users. Module presentation was good, with the right amount of information on each screen, the graphics and interactive elements were well liked, and the download times were acceptable. Furthermore, the results showed that it was likely that teaching staff will be able to successfully integrate modules into their courses and that the EuroMET course will provide a useful and usable study aid. Minor technical problems occurred during the study, such as graphics not loading correctly and windows that did not close when they should, but these have since been corrected by the developers. A recommendation for the quizzes within the modules was that users expressed a desire for some to be designed where they were required to submit answers of their own rather than merely selecting from a list of possible answers in order to fully test their understanding, this was also addressed in the Phase III modules.

Pre- and Post-test Results

Pre- and post-tests have been carried out only on a small scale during the user evaluation due to a number of reasons. One difficulty was with short time-scales, particularly for the first and third phases. Modules were delivered onto the WWW at the beginning of each evaluation phase, so in order to design pre- and post-tests, the evaluation partners had to read through each module and devise questions before the users could access the modules. This was a lengthy process and with only a few weeks for each evaluation period it simply was not possible for every institute to do this. A further problem was finding representative users to do the tests. As part of the user evaluation both subject experts and novices tested the modules. Subject experts are essential to check that the material in each module is scientifically correct, while novices can test the pedagogical effectiveness. However, due to the tight project timetable, the first two user evaluations occurred out of term time for most universities which have by far the largest proportion of learners. Added to this is the fact that the modules were not delivered in sequence. Some of the more complex modules require users to have covered others in the course first therefore a newcomer may have problems understanding material in a particular module, not because the module is poor, but because they do not have sufficient background knowledge.

SM module	number tested	average improvement (%)	NWP module	number tested	average improvement (%)
s1.1	2	0	n1.1	3	22
s2.1	3	42	n1.2	3	33
s2.2	3	38	n3.8	3	25
s2.3	3	33	n3.11	3	0
s2.6	4	40	n4.5	3	55
s7.2.1	3	45	n4.8	3	11
s6.2	4	13	n3.1	2	10
s6.3	3	17	n3.3	3	8
s6.4	3	42	n3.5	2	38
s6.5.2	4	0	n6.3	5	30
s6.5.3	2	75	n5.4.1	4	30
s9.3.2	2	63	n7.2	5	0

Table 1: Improvement in test scores before and after users complete a module.

Despite these problems, the results from the modules for which pre- and post-tests have been undertaken are encouraging as they suggest that users are able to understand and retain information which helps them improve their level of knowledge (Table 1). They also provided the evaluation team with valuable experience for the demonstration phase when much more extensive tests will be possible as many representative users will be using the modules as part of a structured education or training course.

The Future of EuroMET

The demonstration phase provides an excellent opportunity to fully test the pedagogical effectiveness of the course and its utility in replacing and complementing existing education and training methods. A meeting to be held part-way through this phase, at the end of March 1998, will ensure that the evaluation tools are well-defined and appropriate for all partners, and may hopefully yield some preliminary results on the course's use and effectiveness.

It is hoped that after the demonstration phase institutions will continue to use the EuroMET course. Maintenance of the course servers for a minimum period of 2 years is guaranteed. Interest in the course has also been expressed by individuals and organisations who are not in the consortium but who have joined the EuroMET user group. It is expected that these members will be allowed access to the course at the end of the project in return for some level of commitment to the consortium, either financial or in terms of developing or evaluating new material.

If this whole exercise is seen to be successful by the Informal Conference of Western European Directors (ICWED) of Weather Services it is hoped that further development of similar modules will be funded through their collaborative 'EUMETNET' venture.

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Hypermedia as a Cognitive Tool

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Abstract: Hypertext and Hypermedia systems can be used in many different ways, among others as "cognitive tools". Such hypermedia systems are supposed to help learners structure their thought processes and gain a deeper understanding of the subject material. The following text describes the way how students at the University of Technology Vienna used a concept mapping tool based on a hypermedia system. The results show that most of the students use such tools in a rather conservative manner. Nevertheless, there is a minority which tries out innovative features in a very creative way.

1. Introduction

Hypertext and hypermedia systems can be used in educational environments in a number of different ways. One possibility how such systems can be employed is the support of students creating externalized versions of their own knowledge structures, especially in the form of graphs. The technique of motivating students to use elaborate learning strategies by drawing spatial representations of their knowledge structures is an old one and has been developed for paper and pencil. Several different names have been used for such techniques, e.g. concept maps, cognitive maps or semantic maps. In the following paper, the term concept maps [Novak & Gowin 1984] will be used. Because of its flexibility and the possibility to re-edit existing concept maps, the computer in general and hypertext systems specifically seem to be especially appropriate media for this methodology.

So far, the majority of investigations of the usage of computer based concept mapping systems have concentrated on the question whether concept mapping is a superior form of learning compared to more traditional methods. Generally, the results of these investigations have been promising although some specific problems can be observed. The aim of the study described in the following paper is different although it is based on the notion that computer based concept mapping tools can be used successfully in an educational context. Initial motivation for the study was our observation that students who develop hypertext documents seldom use novel or innovative structural features of hypertext systems, and if they use them they do it in an unpredictable manner. It was, therefore, the aim of our project to investigate how students develop hypertext documents and especially how they try to structure the information in their documents and which structure-generating features of the system are more attractive than others.

2. The System DarkStar

The topic of our study is based on the experience gained during a project concerning hypermedia and learning which was carried out at our department between 1992 and 1994. Inspired by George Landow [Landow 1992] we asked students to write their own hypertext documents as assignments in seminars. We soon realized that students had serious conceptual problems with this task. The most important of these problems was that they had difficulties to translate the linear texts which they were supposed to read during the seminars into non-linear hypertext. This circumstantial evidence motivated us to develop the system DarkStar which is based on HyperCard and which was supposed to help students create more innovative hypertext documents. Innovative in this context means that students were to a certain extent constrained to use novel features of the hypertext concept like non-linear links between pieces of text, pop-up fields with examples or explanations, or graphics and animation. All these features are novel in the sense that it is either not possible at all to use them in books or at least very difficult. We assume that hypertext enables students to get insights into the material they study which they cannot get by reading and writing linear text. In this sense, hypertext systems can serve as cognitive tools [see Kommers, Jonassen & Mayes 1992]. As the students seemed to have the most difficulties with the concept of hypertextual structure, the system DarkStar contained many elements to make structuring easier. One of the most popular of these features was the so-called Overview Editor [Fig. 1], a tool which resembles other electronic concept mapping tools to a large extent. The Overview Editor allowed students to create, delete and name links and nodes and to position links and nodes in the two-dimensional space offered by the computer screen.

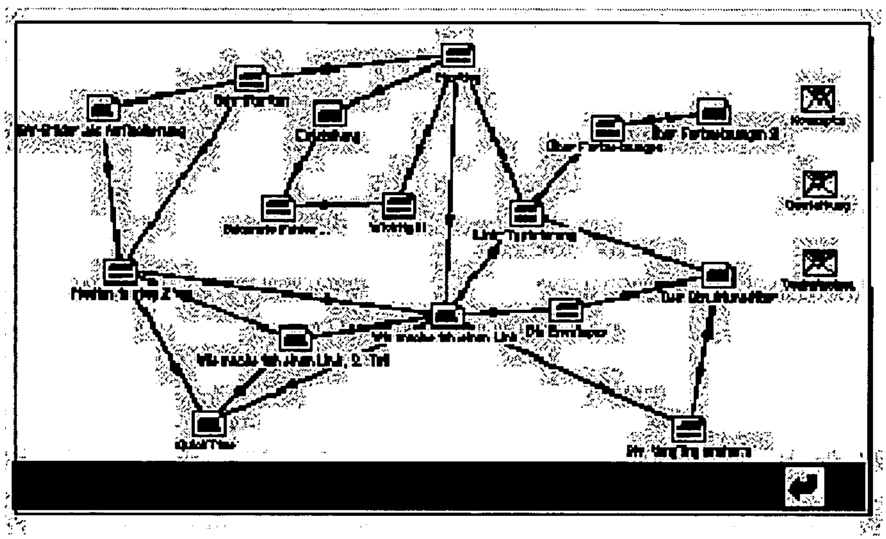

Figure 1: The Overview Editor

DarkStar was developed iteratively. It was evaluated continually to assess whether it really supported students to fulfill their task. There is some promising evidence that it is possible to improve the quality of the students' documents by offering them a hypertext authoring tool which is specifically adapted to their needs [Pohl, Purgathofer & Prenner 1995].

3. Concept Mapping, Structural Information and Hypertext

According to [Novak & Gowin 1984] concept maps are graphical representations of concepts and their relationships. The concepts represent a small number of key ideas. The formulation of such key ideas are crucial for every learning task. Based on their practical experience, Novak and Gowin suggest several different ways of applying concept maps, among them: exploration of what the learners already know, extracting meaning from textbooks, planning a paper or exposition, etc. Our approach to concept maps is slightly different to the one of Novak & Gowin. On the one hand, we use concept maps in our teaching practice only in combination with "normal" hypertext systems. Structural information is not only conveyed through the concept map but also through the topological organisation of text on the screen and the use of graphical material, and it can be assumed that there is an interaction between these two components. On the other hand, we try to motivate students to organise information in novel ways, among others as non-hierarchical structures. This contradicts Novak and Gowin's ideas to a certain extent as they demand that concept maps have to be hierarchical.

There is some evidence that the use of concept maps in learning environments can have beneficial effects. [Kozma 1992], [Kommers & de de Vries 1992] and [Fisher 1992] who used computer based concept mapping tools report positive results. [Reader and Hammond 1994] argue that concept mapping is a more time consuming method than traditional forms of learning. Thus, students are motivated to spend more time going through the material and analysing it. This leads to a better performance of those students developing concept maps. [Jonassen and Reeves 1996] also give an overview over research supporting the use of concept maps. They point out that concept maps are a powerful tool to analyse the learning process and students' changing knowledge representations. The studies quoted above also discuss important factors which influence the usage and design of computer based concept mapping tools. Concept mapping is more beneficial with advanced students than with beginners [Kozma 1992]. The introduction of concept mapping tools or more generally hypertext necessitates a modified curriculum and a change of the criteria for testing students' achievements [Kommers & de Vries 1992], [Jonassen & Reeves 1996]. Students have problems with several novel features of concept mapping tools [Fisher 1992].

In general, it can be said that the efficiency of concept mapping as a methodology of learning is to a certain extent supported by empirical evidence. Concept mapping and hypertext as a theoretical concept apparently share a number of traits. Therefore, computer based concept mapping tools are often either integrated into hypertext systems or used in combination with hypertext.

4. The Study - Aims and Methodology

The aim of the study described below is to observe how students using a hypertext system develop their own documents, and especially how they try to convey structural information. We think that structural information can be expressed in at least two ways: in a concept map or content overview and through the use of topological cues on the other pages of the hypertext document. In the tradition of [Novak & Gowin 1984] our students were encouraged to develop documents with little text and much structural information. The task of developing hypertext documents is part of the normal work routine of students at our department. This implies that task and setting were realistic and relevant as far as students' experiences are concerned.

The practical aim of our investigation is, first, to formulate tentative guidelines or principles for the design of concept mapping tools or hypertext systems with an emphasis on the representation of structural knowledge. In this context, it is necessary to find out which features are not accepted by the users and to formulate ideas how to enhance the usabiltiy and affordance (Norman 1988) of those features which are accepted. Second, we want to formulate tentative guidelines or principles for the educational practice. We posit that knowledge about how students use hypertext systems can help teachers to advise students more systematically.

For our investigation, we used a sample of 143 documents which are a representative cross-section of all the documents created by students at our departments. All the documents were developed with the system DarkStar. To analyse the documents we used a collection of categories which were partly derived from the relevant literature and partly from our practical experience. These categories sometimes ask for subjective judgements. By defining the categories carefully, we tried to minimize any possible subjective bias. The method of analysis is descriptive. It can be argued that such methods form a valuable contribution to educational research [Knupfer & McLellan 1996].

We used two different sets of categories. One set was mainly concerned with the structure of the whole document as it appeared on the Overview Map. The other set dealt with layout and screen design. The most important question the first set of categories tried to answer was whether students adopted traditional hierarchical forms of structuring information or not. Link types are treated insofar as they can clarify this issue.

The second set of categories examined the question whether students used layout, screen design or graphical elements to convey a sense of structure. Typographic and layout features which play an important role in this context are highlighting [Mayhew 1992], grouping [Mayhew 1992], [Tullis 1991], and the distribution of white and black space on the screen [Watzmann 1993]. Highlighting is a possibility to point out important concepts in the text to the reader. Nevertheless, it should be used sparingly. Grouping is to a certain extent based on the Gestalt laws of proximity. It is a powerful tool to show which elements belong together and which do not. Factors which influence grouping are proximity, colour, graphical boundaries and highlighting. All these factors should make semantic relationships between the objects on the screen visible [Tullis 1991]. The distribution of white and black space on the screen, which is to a certain extent related to grouping, provides a clear path through the material and gives a conceptual framework of the text [Watzmann 1993]. In more sophisticated forms of page design, information is presented in chunks. These chunks are organised according to the semantic meaning of the text. This results in a complex pattern of black and white on the screen which differs from the traditional "grey" page of a book.

5. Results

5.1. Hierarchical vs. Non-hierarchical Structure

As already mentioned, students predominantly used a hierarchical form of structuring information [Tab 1].

	absolute numbe	%
hierarchical links	4240	85,20%
non-hierarchical links	584	11,70%
links to other document	153	3,10%
•	4977	100,00%

Table 1: Distribution of hierarchical vs. non-hierarchical links

As we can see, hierarchical links are by far the most frequent form of link type. The category "links to other documents" represents links which students made to other students' hypertext documents. As students who attended the same seminar worked in parallel at their documents this was apparently a problem. Only very few students used this possibility.

There are only three documents with no hierarchical links at all. In contrast to that, there are 83 documents with no non-hierarchical links at all. The document with the maximum number of hierarchical links contains 130 links of that type. The document with the maximum number of non-hierarchical links contains 37 links of that type. There are also several other documents with a considerable amount of non-hierarchical links. This indicates that many students did not realize the possibilities offered by non-hierarchical links. On the other hand, there are several students who realized these possibilities and used this feature extensively.

5.2. Link Types

The term link type in this context is perhaps misleading as it is used in the literature to characterize link types belonging to a complete system of link classification. In contrast to that, the term link type here refers to a few characteristic linking methods which students used to express their ideas about structure. This concept of link types was not developed theoretically but rather deducted from our practical experience with students' hypertext documents.

Link between the same term on two nodes: Students very often use this method of linking two nodes. They happen to notice that one and the same term occurs on two nodes in their document. Therefore, they create a link between those two nodes. The interpretation of this process is ambiguous. On the one hand, it can be argued that this form of linking does not require elaborate thought process and is rather mechanical. We found several examples for fairly useless or even confusing links of that type in students' documents. On the other hand, it sounds plausible that for the reader of a hypertext document it is easier to grasp the structure when the same terms are used on both nodes he has visited. For us it is, therefore an open question whether to advise students to use this kind of link.

3804 (76,4%) out of 4977 links are links between the same term on two nodes.

Examples: Students fairly often use links to refer to examples which illustrate an idea brought up in the text. 1324 (26,6%) out of 4977 links are of that type. Only 26 out of 143 documents do not contain any examples. Students differ considerably in the amount of examples they include in their documents. One document even contained 46 examples.

Explanations: Students also fairly often use links to refer to explanations of terms used in their document. 1890 (37,9%) out of 4977 links are of that type. Only 9 out of 143 documents do not contain any explanatory links. The maximum of explanatory links in a document is 71.

Example links and explanatory links are rather similar in at least two respects. They were categorized as hierarchical links in the category system we used. In contrast to that, examples and explanations are usually seen as a form of digression in a linear text. In this sense, examples and explanations can be seen as a feature which transcends the distinction between hierarchical and non-hierarchical structure. The second similarity is the fact that in both cases some students use this feature quite heavily whereas others do not use it at all. This probably indicates that some students did not realize that they had this possibility whereas others who were aware of it used it quite intensively.

5.3. Typography

126 out of 143 documents use an acceptable font size for text (12 point). 114 documents use bold for highlighting and only 18 italics. All documents either used indentation or empty lines as methods of structuring their text. In general, this shows that students are acquainted with basic principles of screen design and use them to structure their documents.

5.4. Grid

The term "grid" refers to the categories introduced by [Watzmann 1993]. She tries to formulate criteria for the quality of screen design. Good screen design, according to her opinion, is highly structured and uses a range of different topological or graphical cues. [Tab. 2] shows to what extent the students at our department used methods of structuring text and pictures on the screen.

	yes (no of documents)	no (no of documents)	partly (no of documents)
gray page	25	118	0
chunking	120	2	21
queuing	100	43	0
mixing modes	38	105	0

Table 2: Organisation of information on the screen

The term "gray page" describes a screen which resembles a traditional book with no organisation of the information at all. Chunking means that information is divided into small, meaningful pieces of text. Queuing leads to an even more structured screen. Information is arranged topologically, so that the position of pieces of text conveys meaning. Mixing modes refers to a screen design which includes different modes of expression (text, graphics, pictures, formulas etc.).

Chunking and queuing seem to be very popular with our students. This shows that they have realized that a computer screen offers possibilites which do not exist in a book. Nevertheless, the students we observed in our study did not use pictures, graphics or other modes very often [see 5.5.].

5.5. Use of Pictures and Graphics

Only 41 (29%) documents out of 143 use graphics or pictures. Whereas the students we observed showed a certain ability to develop a satisfying layout they are still not very creative as far as use of other modes of representation are concerned.

6. Conclusion

The aim of the study described in this paper was the observation of students creating structured hypertext documents. The students, in general, had difficulties with novel ways of structuring information, especially with non-hierarchical structure. New possibilities which are offered by electronic text are more easily accepted if they resemble traditional linear text to a certain extent as, for example, links to explanations and examples. Features of structured hypertext which are attractive or at least potentially attractive seem to be characterized by the fact that many students who use them do that quite intensively. This indicates that those students who did realize the advantage of novel structuring possibilities try to apply them fairly often. The study described above still does not give a very comprehensive picture of the activities students are engaged in when they structure their hypertext documents. It would be interesting to assess whether the contents of the material the students have to learn has any influence on their documents or whether there are texts which can be converted to highly structured hypertext only with difficulties. We will investigate these questions in the future.

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Significant Use of the Internet by Faculty, But Not for Teaching

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Abstract: The study found that there is significant use of the Internet by faculty thus confirming for those at Western Michigan University who were responsible for building the wide-area campus network that access to the Internet and other local computer resources was available. Ninety percent of faculty report using the Internet at least several times a year while sixty percent report doing so on a daily basis. A variety of Internet applications were reportedly used by faculty with e-mail being the most frequently used. A disappointing finding suggests that faculty are not widely using the Internet for direct teaching activities. One-half of faculty require students to use email and only one-third require them to explore the world wide web as part of course activities. Use of these activities were requested of students by faculty on average of less than once a month.

1. Introduction

There has been an exponential growth in the use of the Internet by large numbers of people. Computer techies, for the most part, have been the pioneers in Internet use, but other groups, including college and university faculty, have also adapted the new communication technology to their professional and personal use (Adams & Bonk 1995, Halman 1995) In an effort to discover more about the use of the Internet by faculty, a study was undertaken at Western Michigan University, a large midwest regional university serving the State of Michigan, to determine the level of Internet awareness, access, and use by faculty. The study was undertaken, in part, to generate information for a special taskforce charged by the President of the University with reviewing instructional technologies and technology support. The committee, Ad Hoc Taskforce on Educational Technology, was co-chaired by the Dean of Libraries and Director of University Computing Services

The survey attempted to explore the following areas:

1. faculty awareness of, access to, and frequency of use of the Internet
2. faculty knowledge of, frequency of use, and self-reported expertise of commonly available Internet tools
3. faculty use of the Internet for teaching activities

In recent years (1993-95), there had been significant financial expenditures and manpower comitments made by Western Michigan University (as well as many other institutions) to create a wide-area networks that would allow faculty, students, and university staff access to local computing resources, University online library services, and external resources via the Internet. This study, taken at the end of that period (January 1996), attempted to confirm that faculty were aware of the new computer resources and services available to them, that they had access to the services, and that they were making use of them.

Another common issue at the University was the level of awareness by faculty for using computers and internet related software tools, and faculty expertise in the use of the internet tools and services such as email, web browsing, and searching data bases. Several agencies (University Computing Services, University Libraries, and Office of Faculty Development) at the University were already invested in offering workshops, consulting services, and technical support to faculty to assist them in the use of computers, the library online services, newly available internet services and resources, and use of computers for teaching activities. Questions at the University focused on the need for additional faculty training, level of training (i.e. introductory, advanced, etc.), and level of technical consulting services that were still needed by faculty.

Of special interest to the Ad Hoc Committee was the need for larger numbers of faculty to make use of the Internet resources and services in direct teaching activities at the University. Previous studies at the University had found that only a small percentage (25% or less) of the faculty were actively using computers in instruction and/or requiring students to use computers as part of their classwork (Poole, Van Valey, & Vakalis 1994, Poole & Van Valey 1994). Was the rapid growth in the use of the internet and the expanded campus computer network generating changes in the way faculty were using computers as part of their teaching activities? This is a critical question for the University to answer to justify, in part, the recent investment in technology.

2. Survey Procedures

The authors have been surveying the faculty and students at Western Michigan University for more than ten years and have developed a reliable survey procedure that includes mailing a multiple choice, fill-in the blank survey to faculty at their offices. A pre-survey postcard was sent to all faculty making them aware of the survey. The survey was mailed in late January after the start of Winter semester. Those faculty filling out and returning the survey were promised a 3.5 inch diskette of University-related internet graphics as a token for completing the survey. Fourty percent, or 376 faculty members, returned the survey. The distribution of faculty in the research sample closely follows the distribution of all faculty surveyed. This was true for the sex of respondents, for distribution by age, for professorial rank, for mean year employed, and for employment by college. Based on these findings, the research sample was deemed representative of the University population of faculty. For this survey the Internet was described as the use of e-mail for off-campus communications, use of gopher and world wide web servers, use of telnet applications, and use of other related Internet applications.

3. Faculty Use of the Internet

Faculty were asked to identify the first year that they used the Internet. Nearly twenty-percent of faculty report using the Internet before 1990. Since 1990 there has been a steady yearly increase in faculty using the Internet with an especially rapid increase (twenty percent) taking place during 1995. More than fifty percent of the faculty report using the Internet before or during 1993. Fewer than ten percent of faculty report that they have never used the Internet. Less than two percent of faculty expect never to use the Internet. Faculty were also

Table 1 - Total Hours Per Week Faculty Use the Computer

Weekly Use of the Computer For All Things

Range = 0 hours to 70 hours   Average Use = 19.98 hours

Weekly Use of the Computer for Only the Internet

Range = 0 hours to 30 hours   Average Use = 6.0 hours

0 hrs. = 10.3%, 1-6 hrs. = 54.2%, 7-10 hrs. = 24.1%, >10 hrs. = 11.4%

asked to estimate their frequency for using the Internet. On average faculty reported using the Internet several times per week with more than sixty percent using it on a daily or more often basis. Those faculty who report using the Internet do so on average of six hours per week with thirty-five percent of faculty reporting they use it more than six hours per week, see (Tab. 1). The majority of faculty (fifty-four percent) use the Internet between one and six hours per week. Ten percent of faculty reported zero hours of internet use per week. By contrast, faculty report using the computer for all activities an average of twenty hours per week. Use of the Internet (six hours per week) would represent approximately thirty percent of the total time spent each week by faculty using a computer.

4. Faculty Access to the Internet

Having access to the Internet is an important first step in using it. Ninety percent of faculty reported they had access to the Internet, another five percent were not sure, but thought they had access, two percent did not have access but expected to have it within a year, and another two percent did not have access and did not expect it, see (Tab. 2). Faculty were also asked if they had access to personal computers at work and at home. A similar percentage of faculty (ninety-one percent) reported access to personal computers at home and at work. Internet access would seem to closely parallel personal computer access at both work and home.

Table 2 - Faculty Access to Personal Computers and/or the Internet

Access To Personal Computer at Home = 91.4%
Access To Personal Computer at the Office = 91.6%

Do You Have Access to the Internet?

Yes = 90.9%, Maybe = 4.8%, No, But Expect to = 2.7%, No and Don't Expect To = 1.6%

Faculty were provided nine possible options of access to the Internet, including access from their offices, from their homes, and from other University locations. They were asked to identify all options that were available to them, see (Tab. 3). The two most widely identified access points were a direct (ethernet/campus network) connection in their office (by eighty percent) and a telephone connection from their home (by seventy percent). Forty percent of faculty reported an ethernet/campus network connection from a department location. Twenty percent, or less, of faculty reported Internet access via University or department computer labs, or from an office telephone. Only ten percent reported access via a department telephone while less than one percent reported a direct network (ISDN or other) connection from home.

Table 3 - Faculty Opinions on Where Faculty Get Access to the Internet

Internet Access Connections	Percentage
- Direct Network (Ethernet) Connection in Office	81.1%
- Direct Network Connection in Department	41.9%
- Network Connection in Un. Computer Labs	22.5%
- Network Connection in Dept. Computer Labs	20.0%
- Phone/Modem Connection in Office	16.7%
- Phone/Modem Connection in Department	9.6%

- Direct Network (ISDN) in Home	.4%

Faculty were asked to rank locations on campus were access should be made available to the Internet. The top four locations included faculty offices, University and department computer labs, and the University libraries. Also consider important locations were student housing, classrooms and lecture halls. Not as important for campus locations were public kiosks.

5. Faculty Use of Internet Applications

What do faculty use the Internet for? Faculty who reported using the Internet were asked to report the frequency of use of sixteen commonly found Internet applications. The number one rank applications was use of electronic mail (e-mail) by nine-seven percent of faculty, see (Tab. 4). Faculty reported using e-mail on average of once per day with two-thirds of faculty reporting using it daily or more often. The next most frequently used Internet applications were searching for reference materials, searching on average of once per week. More than eighty-five percent of faculty report using these second rank applications. Ten percent of faculty report using the second ranked applications on a daily or more often basis.

Searching databases, using online library catalogs, searching for personal information, and use of discussion lists were the third most frequently used Internet applications used on average of once a month, see (Tab. 4). More than seventy percent of faculty reported using these Internet applications. The exception was use of discussion lists where only one-half the faculty report using it. Internet applications used on a less than monthly basis include gathering research summaries, searching for government documents, receiving electronic newsletters and journals, and gathering images and pictures. Two thirds or less of faculty report using this last group of Internet applications. Internet applications used infrequently by faculty include participation in chat rooms, and buying products. Internet applications that are rarely used by faculty include video and audio conferencing.

Table 4 - Rank Order of Frequency of Faculty Use the Internet for Various Applications

Application	Mean	Daily Use	Weekly or Less	No Use
- Send/Receive E-mail	5.86	67.0%	30.6%	2.4%
- Search for Reference Information	4.01	11.7%	80.8%	7.5%
- Search for Files	4.02	15.6%	73.3%	11.1%
- Search for Scholarly Information	3.76	11.3%	76.8%	11.9%
- Search Databases	3.43	10.5%	73.1%	16.4%
- Search Online Catalogs	3.42	6.0%	83.6%	10.4%
- Search for Items of Personal Interest	2.98	3.9%	69.6%	26.5%
- Use Discussion Lists	2.76	16.9%	36.4%	46.7%
- Gather Research Summaries	2.49	3.0%	62.2%	34.8%
- Search for Government Documents	2.43	2.7%	64.1%	33.2%
- Receive Newsletters	2.40	6.3%	47.2%	46.5%
- Gather Images, Pictures	1.91	2.1%	28.6%	59.3%
- Use Chat Rooms	1.40	1.5%	19.5%	79.0%
- Buy Products/Services	1.24	.6%	16.0%	83.4%
- Video Conferences	1.14	---	9.8%	90.2%
- Audio/Phone Conferences	1.10	---	8.0%	92.0%

Scale: 1 = Not At All, 2 = Less Than Once A Month, 3 = Once A Month. 4 = Once A Week, 5 = A Few Times A Week, 6 = Once A Day, 7 = Several Times A Day

6. Faculty Use of the Internet for Teaching

Two questions were asked that related to the use of the Internet in teaching activities. One question asked the frequency of requiring students to use the computer for various tasks. Seventy-eight percent of faculty require students to use the computer to prepare papers and reports. The average frequency was once a month. Nearly seventy percent of faculty require students to search databases for reference materials. The frequency of use was less than once a month. "Other" uses of the computer required by faculty averaged less than once a month. A minority of faculty required students to use the computer do e-mail, explore the World Wide Web, and to use graphics and draw programs, see (Tab. 5).

Table 5 - Rank of Frequency That Faculty Require Students to Use Computer Applications

Computer Applications	Mean	Frequency of Use	% of Faculty
- Prepare Papers/Reports	2.75	Once Month	78%
- Other Applications	2.39	Less Than Once Month	50%
- Search Databases	2.29	Less Than Once Month	68%
- Use e-mail	2.10	Less than Once Month	46%
- Explore World Wide Web	1.77	Less Than Once Month	36%
- Use Graphics/Drawing	1.63	Less Than Once Month	28%

Scale: 1 = Not At All, 2 = Less Than Once A Month, 3 = Once A Month, 4 = Once A Week, 5 = A Few Times A Week, 6 = Once A Day, 7 = Several Times A Day

Faculty were also asked if they used the computer for various teaching tasks. Using the computer for "other" teaching tasks (other than those asked) averaged once a month and was used by nearly one-half of the faculty, see (Tab. 6). Used by less than a third of the faculty and use less than once a month on average were projecting images/data, demonstrations of e-mail, demonstrations of experiments, and demonstrations of the Internet. Faculty were also asked about requiring students to have computer accounts. Twenty-four percent of faculty require course computer accounts. Another seven percent encourage computer accounts, but do not require it and another six percent require a personal computer account. More than sixty percent of faculty do not require a computer account of any type.

Table 6 - Rank of Frequency of Faculty Use of Computers In Classroom Activities

Computer Application	Mean	Frequency of Use	% of Faculty
- Other Teaching Tasks	2.44	Once a Month	55%
- Project Data/Images	1.85	Less Than Once Month	37%
- Demonstrate Internet	1.57	Less Than Once Month	27%
- Demonstrate Experiments	1.55	Less Than Once Month	28%
- Demonstrate E-mail	1.51	Less Than Once Month	30%

Scale: 1 = Not At All, 2 = Less Than Once A Month, 3 = Once A Month, 4 = Once A Week, 5 = A Few Times A Week, 6 = Once A Day, 7 = Several Times A Day

7. Conclusions

A number of conclusions can be drawn from the findings of the Internet survey of faculty at Western Michigan University. Some of the conclusions answer the concerns of the Ad Hoc Taskforce on Educational Technology that was studying technology related resources and services to faculty at the University. Some of the conclusions suggest that additional effort is needed to support faculty in the use of the computers and the Internet.

The study found that there is significant use of the Internet by faculty thus confirming for those at the University who were responsible for building the wide-area campus network that access to the Internet and other local computer resources is available. While nearly thirty percent of the faculty reported using the Internet before the recent University expenditures for expanding the computer network on campus, a majority of faculty reported they started using the Internet during the development period with twenty percent using the Internet for the first time in the year immediately preceding the study. Ninety percent of faculty report using the Internet at least several times a year while sixty percent report doing so on a daily basis. Based on these findings, the authors concluded that the Internet is now a commonly used computer resource and service on Western's campus. Access to the Internet by faculty was also not a significant problem with ninety percent of faculty reporting access from their offices via network connections and from their homes via telephones and modems. Access also exists, but is not widely used by faculty in campus computer labs. The authors conclude that faculty at Western have extensive access to the Internet from both on and off-campus which was, in part, made possible by recent network development efforts.

A variety of Internet applications were reportedly used by faculty with e-mail being the most frequently used application. Other Internet applications used by a majority of faculty include searching for reference information, searching for files, searching for scholarly information, and searching online catalogs. These findings demonstrate that the email services provided by the University and the University Libraries online catalogs and database resources are being used by faculty via the Internet. Some applications over the Internet not frequently used include discussion lists, gathering research summaries, searching for government documents, receiving newsletters, gathering images, using chat rooms and conducting audio and video conferences. These infrequently used applications represent, in the opinion of the authors, possible target areas for additional faculty training.

A disappointing finding suggests that faculty are not widely using the Internet for direct teaching activities. Approximately one-half of faculty require students to use email and only one-third require them to explore the world wide web as part of course activities. Use of these activities were requested of students on average of less than once a month. The authors concluded that faculty are not yet requiring students to use the Internet on a regular basis. On a more positive note, a majority of faculty report requiring students to use a computer to prepare papers and reports, to search databases, and to do other computer applications. Other disappointing finding was that less than one-third of faculty use the Internet and email for demonstration purposes during classroom activities The average use of these two Internet related items was less than once a month. On a more positive note, one-half of faculty reported using the computer during classroom teaching activities. The authors conclude that requiring students to explore and use the Internet and demonstrating the Internet or email in class were not frequent teaching activities by faculty.

The authors conclude that recent campus computer network development activities have been successful in providing faculty access to the Internet and other computer resources at the University and that there use has been significant. Many Internet related applications are being used by faculty, but especially email. However, faculty are not yet widely using the Internet and email for teaching related activities.

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Visual Support of Multithreaded Conversation for Collaborative Learning

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Abstract: This paper describes a prototype software tool for support of peer-to-peer conversation on distance education courses in text-based asynchronous mode. This goal is accomplished by visualizing multiple threads of conversation. The theoretical basis for this design is a comparative analysis of oral, written and electronic communication which enables the identification of properties of the conversation structure relevant to software design: fragment length and fragment linking mode. Combination of these properties gives rise to linear or multithreaded conversation structures.

1. Introduction

Asynchronous text-based communication, having been available since the earliest days of the Internet, continues to play an important role in almost all electronic communities and, in spite of the development of new multimedia technologies enabling sound and video communication, seems likely to persist for some time. This medium possesses some traits that are very useful for educational purposes. Experience of distance educators shows that this medium is best suited for group discussions and seminar-type studies, rather than for delivery of basic lecture material [Hiltz 1992], [Harasim 1990], [Garrison 1993]. Students interact with each other and with the instructor, discussing, debating and elaborating their growing knowledge.

In a traditional setting interaction between students takes place largely through natural language. It implies intensive message exchange and conversations between participants. [Kaye 1992] stresses the importance of social and linguistic aspects of communication: its active character. Knowledge results from active interaction between students and instructor, or even only among students, as opposed to the understanding of learning as knowledge acquisition from some external source.

Introduction of a new medium changes the structure and character of communication, and these changes can be for better or for worse [Adrianson & Hjelmquist 1991], [Fulk at al. 1992], [Kiesler et al. 1985], [Er & Ng 1995], [Dubrovsky et al. 1991], [Grote & Baitsh 1991]. It has been found that users evaluate a medium largely on the basis of its ability to support different types of conversation [Lea 1991], [O'Connail et al. 1993], [Kraut et al. 1992]. Problems in conversation caused by the introduction of a new medium may drastically decrease the quality of learning, so our ultimate aim in the research is to provide software that provides beneficial support for users' conversational activities.

2. Conversation

Having chosen a conversation as an object of the inquiry, we have to work out an approach we will take for analysing it. Conversation is a subject of many disciplines: philosophy, psychology, linguistics, media studies, etc. Each possesses a particular approach, aim and methodology, often incompatible and incomparable to other disciplines. So it should be explicitly stated how we define the object of the research, and how we observe, measure and evaluate it.

2.1 Conversation Structure

In this work a surface structure of conversation as an indicator of communication processes was chosen. There are several advantages of dealing with conversation structure only. First, it is very easy to observe, since in text conditions transcripts are generated automatically. It is also easier to conjure the problems encountered by users from conversation breakdowns. Application of this method can give new data when analysing conversation [Seller 1995].

2.2 Oral, Written and Electronic Conversation

To gain an insight into the structural aspects of conversation, three forms of verbal communication are compared: oral conversation, writing and conversations that take place in email and computer conferencing. Writing (or, to be more specific, printed text) here is also considered as a form of silent conversation of an author with a reader, or with herself. With most media: writing, TV, special codes, etc. we ultimately end up with messages in the some language. So here the term 'conversation' will be used in a broad sense to denote any activity in natural language taking place between interlocutors.

2.2.1 Linearity

Written and oral communication were compared along the linear vs. non-linear lines [McLuhan 1964]. The first was considered linear, the second – non-linear, simultaneous.

It is easily understood that writing (print) is a linear medium. In a book, word is followed by word, sentence by sentence, chapter by chapter, etc. Writing something down allows conceptualisation of the sentence as a spatial object with a linear structure [Lakoff & Johnson 1980].

But oral conversation is to a large extent linear too. Words are pronounced in a linear order, one after another, at one moment only one interlocutor can talk. Consider, for example, a 'conversation is a thread' metaphor existing in the language: *lost the thread (chain, connection) of his argument; resume or take up the thread of; gather up the threads.*

2.2.2 Conversation Fragment Linking

The difference between oral and written conversation structures is in the way the 'links' are connected. Due to the ephemeral nature of speech, interlocutors can only refer to something said relatively recently. Topics are changed often; there exist many incomplete, abbreviated sentences. This creates a linear structure with short links.

The persistent nature of text, on the other hand, allows people to refer accurately to something created a long time before. Something can be referred several pages back or forward and looked up when necessary. This in theory allows the building of complex non-linear structures. But the tradition of print downplayed this trait of text. The attempts to break this linearity (e.g. footnotes, cross-references) were marginal (in both the literal and metaphoric sense).

New electronic media inherit the persistent nature of text, but are less hindered by printing tradition. The recent explosive growth of popularity of hypertext shows the huge potential of non-linear structures.

Text-based asynchronous communication allows the weaving of complex webs of argument, where in the same 'conversation space' several topics can exist simultaneously. One outcome of this new trait is the multithreaded structures of on-line discussion. Over 80% of messages in computer conferences reference one another [Harasim 1989]; also one message may contain more than one topic [Riedl 1989]. How this new trait can be used for computer tools design will be described later in this paper.

2.2.3 Stylistic Aspects

[McLuhan 1964] stressed the importance of visual versus audio sensory channels in media evaluation, the opposition of ear and eye and consequent differences in style and usage.

Text-based electronic conversation is visible, like text. It is essentially a written form of communication and is usually approached as such. But it has been suggested that electronic media in some aspects are similar to oral communication [Ong 1982], [Bolter 1991]: spontaneity, rapid exchange of messages providing almost immediate feedback, and fluid structure of information are all traits indicative of an oral style. From oral conversation it also borrows the way of referencing other pieces of text. When quoting parts of others' messages in their own, people refer to them as to something said rather than written.

	Exchange rate	*Message Lifetime*	*Linearity*	*Link length*	*Sensory channel*
Oral	Fast	Short	Linear	Short	Audio
Electronic	Fast	Short or long	Non-linear	Short	Visual
Written	Slow	Long	Linear	Long	Visual

Table 1: Media comparison

[Tab. 1] provides an illustration rather than the precise taxonomy of medium traits. Electronic medium is a very broad term and allows for a wide range of values for any of the traits. Messages can be kept long time or erased immediately. Message exchange speed can vary from almost synchronous, to delays of days, weeks and months. The purpose for including this table is to emphasise the point that electronic medium allows for a special kind of communication that shares some properties with both oral and written communication, being nonetheless unique. That is why it is impossible to directly apply existing theories for oral and text communication to its analysis.

3. Existing Systems

This section will review existing systems that support text-based conversation. It is important to remember that a communication system is always situated in a social context. When users exploit the system, they augment and modify its technical properties with social procedures. This is especially true for conversation, which is very flexible. Conversation patterns change depending on particular media and contexts [Ackerman et. al. 1997]. It seems that users feel that for a particular medium a particular style of communication should be used, so when they had to send their messages with another medium, they often wanted to recompose their messages [Whittaker et al. 1997]. Being aware of this process, we will pay attention to both the technology itself and its usage, because the usage can give us insights into the real needs of users.

3.1 Email and Conferences

Email systems disrupt conversation by putting incoming and outgoing messages into inbox and sent items folders. It is equivalent to taking a dialogue from a book and sorting all the utterances by the interlocutors. The information remains the same, but it is not a dialogue anymore. So users have to rely on their memory and imagination to reconstruct the conversation as it really is. To bypass this restriction, users found a way to transmit a conversation context by quoting the original message in the reply. [Fig. 1] shows an example.

Original message:
I propose to invite Jane on Friday. She will be able to have a good weekend's rest before starting her work.
The University will benefit from her contributions.
Reply:
>I propose to invite Jane on Friday.
I have only been able to make a reservation since Saturday, but I guess it's still OK.
>The University will benefit from her contributions.
I agree completely. We just have to make sure her lectures fit nicely into our overall programme.

Figure 1: Email transcript

The lines marked with '>' in the reply are quotations from the original message. In this fragment we can notice the informal style of the message, similar to oral exchange. Two threads of conversation can be easily identified, but they are 'crammed' into one linear mail message.

Some conferencing systems do provide the threading facility, allowing people to post replies to existing messages, creating thus tree-like multithreaded structures. Among such systems are Lotus Notes™, Collabra included into Netscape Communicator™, and other commercial software. All messages are put into one folder, so conversation is traced easier. Still, such systems design is centred on the message exchange metaphor, e.g. comments are possible to the whole messages only. Very often people also quote the original message in their reply, like in email systems. This reflects the need for finer granularity of a reference unit.

3.2 Coordinator™

A notable attempt was undertaken by Winograd and Flores [Winograd & Flores 1986]. Drawing on Speech Acts theory they developed a tool called Coordinator™. Conversation was conceptualised as a set of building blocks representing particular speech acts that were followed one by another. Users could construct conversation from these blocks. The main drawback in the Coordinator's design was that the authors drew on *Speech* Acts theory, but, as was shown above, conversation is different in electronic medium. At any one moment the conversation supported by the Coordinator could only be in one state, not accounting for the multithreaded structure of on-line conversation.

3.3 Hypertext Systems

Usually hypertext systems lay stress on the written nature of interaction. With them people *write* hypertext. Even group systems are conceptualised as a collaborative writing systems, rather than communication systems.

Only some of them support spatial representation, e.g. Aquanet and VIKI [Marshall et al. 1994]. These are hypertext-based tools that exploit free spatial layout to support the task of information structuring. As such, they are aimed at a different mode of structuring ‘conversation’ than the current work. However their work is a good source of evidence of the power of spatial organisation of text, and the consequent interface and usability challenges.

3.4 Electronic Whiteboards

There exist a number of ‘whiteboard’ tools supporting a shared drawing space. For example, NetMeeting [Microsoft, 1998] is a suite of conferencing tools supporting synchronous multimedia communication between users connected over any kind of computer network, including the Internet. One of the NetMeeting tools is the Whiteboard, which provides a drawing space on which participants can type text and draw lines and other shapes. Whiteboards do not usually have any clear data model underlying the whiteboard display and the focus is on synchronous communication. There exists a subclass - Conversational Props Software. Its main idea is that people would often use some artefacts as conversation props and build their conversation around them [Hill et al. 1994]. Usually such systems are complex multimedia ones. They support several communication channels. For example, on video there can be transmitted an image of some artefact or drawing, and conversation would be in audio mode. The emphasis in such software is more towards the support for different media types, rather than richer support for text communication itself, and so this software is not considered further in the current work.

3.5 Conclusions

The main area where the potential of electronic media is not adequately realised is its ability to support non-linear, multithreaded conversations. Existing software tools do not support effective creation, presentation and navigation of such structure. Some are too restrictive (email, conferences) others (whiteboards) have almost no underlying data model. There is a need to design a data structure that is flexible “in the right direction” and firm enough in others *to support* conversational activities. All this leads to formulating prototype specifications.

4. The Prototype

In the current research an attempt is made to support a specific property of electronic communication, namely multithreadedness, at the same time preserving the informal, spontaneous style of oral conversation and enhancing the support for the visual nature that it shares with text. This is accomplished by visualising threads and message references spatially.

To illustrate the main idea, let us return to the excerpt of an email message [Fig. 1]. The most obvious improvement is to allow users to comment on items and arrange them spatially [Fig. 2].

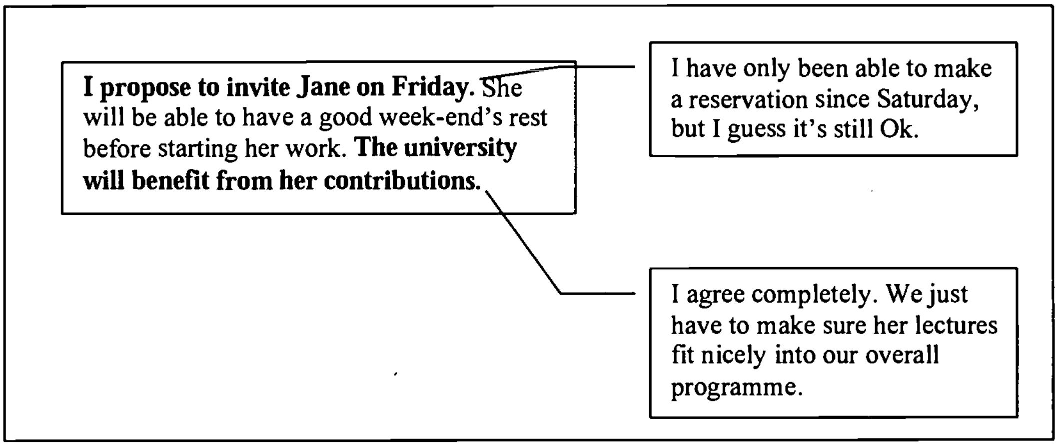

Figure 2. Threads represented spatially

This will allow the construction and presentation of complex hypertext-like structures. Here we will make use of the fast oral way of the connecting remarks. At the same time the textual and visible nature of the communication brings the potential for deeper reflection and continuation of such conversation over longer periods of time. Here are the main properties of the prototype:

- spatial presentation of conversation threads
- granularity of reference unit – any continuous part of text
- oral way of connecting remarks

4.1 Implementation

The most promising platform for the delivery of distance education courses is WWW, so the one technical requirement is that the prototype is integrated into it. So we are implementing it in Java with a client-server architecture. The client is implemented as a Java applet. The server is a Java application that performs queries and stores info in a relational database. Currently, since the system is designed as asynchronous, only one user can be active in a space at any one time. This makes it much simpler from the engineering viewpoint, but enables the basic visual design options to be explored.

Given the limitations on space, here we concentrate on the theoretical aspects of the work. More technical details on the system implementation are available from authors.

5. Conclusions and Further Research

The research showed the possibility of creating software on the basis of conversation surface structure. Further research will concentrate on gathering evaluation data from user trials with the prototype. This will give rise to the second iteration of the prototype, and its evaluation in a more realistic setting. Generally, besides the methodological aspects this research raises major HCI challenges. Supporting speech interaction in such a complex cognitive activity as learning, using a highly spatial style, will require exploration of the need for optimizing the display, using scaling and perhaps text colouring and shading, and enabling multiple configurable views of the conversation "graph". All of this would need to be done in such a way as to provide a smooth and more or less "transparent" interaction style, to minimize inhibition of the free, spontaneous nature of such conversations.

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NetDay: A Model for Collaboration Among University, School, and Industry

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Abstract NetDay is a nationwide volunteer grassroots movement to wire every classroom across the United States for Internet access. On NetDay teachers, parents, administrators, community members, industry personnel, and other volunteers meet to pull and terminate CAT 5 cables or wires that provide the infrastructure necessary for connecting our children and their teachers to the vast educational resources available on the World Wide Web. In the fall of 1996, the Ole Miss NetDay Team was formed to help school districts within northern Mississippi hold these "high-tech barn raisings." To date, the team has assisted seventeen schools with the planning and implementation of their NetDay projects and has helped save the districts over $1,000,000 in labor and materials costs. It is through such cooperative efforts that great achievements in access to technologies can occur.

NetDay is a nationwide volunteer grassroots movement to wire every classroom across the United States for Internet access. On NetDay teachers, parents, administrators, community members, industry personnel, and other volunteers meet to pull and terminate CAT 5 cables or wires that provide the infrastructure necessary for connecting our children and their teachers to the vast educational resources available on the World Wide Web.

In the fall of 1996, a group of faculty, staff, and administration members from the University of Mississippi formed a the Ole Miss NetDay Team in order to support the national NetDay initiative. This group's goal was to provide the technical and organizational expertise necessary to assist school districts in conducting their NetDays throughout northern Mississippi.

The Ole Miss NetDay Team's first task was to gather all information possible about the national NetDay initiative, including the equipment and materials required for wiring the schools, the volunteers and technical expertise necessary for completing each project, the financial and time costs involved, the variety of resources available to support NetDay, etc. Most of this information was available at the National NetDay web site at http://www.netday.org. Gathered information was presented and discussed at a series of initial organizational meetings.

Based upon the team's understanding of the NetDay process, lists were made of the equipment, materials, volunteers, community resources, industry resources, etc., required for the wiring project. A local school, Lafayette Middle/High School, in Oxford, Mississippi, was selected as the first NetDay site. Telecommunications experts from the Ole Miss NetDay Team worked closely with the school district superintendent, school site's principal, and technology coordinator in conducting a series of technical walk throughs to determine the location and quantity of drops, hubs, servers, etc. Based upon this information, the number of volunteers and the amount of equipment and materials necessary to complete the first NetDay project were calculated.

With these details at hand, a local town meeting was called to kick-off the NetDay initiative in northern Mississippi. Invitations were sent out to local school administrators, PTA officers, community leaders, heads of area business and industry, etc.

The NetDay Town Meeting was held in the late fall of 1996. Participants were informed of the NetDay initiative, how a NetDay was conducted, and the parts they could play in its success. They were called upon to support the NetDay effort either physically (in the form of volunteers and manual expertise), materially (in the form of donated materials and equipment), or financially (in the form of money that could be used for materials and equipment).

The following NetDay subcommittees were formed: volunteer, food, technical, public relations, materials, funding, and wiring equipment and tools. Subcommittees made a commitment to work together until every school in the area was 100 percent wired.

In addition, the first NetDay school site and date were announced, along with a detailed itemization of what the Ole Miss NetDay Team had determined to be necessary for the successful wiring of the school. Subsequent meetings of the subcommittees were scheduled, as well as "sanity check" meetings with all subcommittee heads to assure steady progress of NetDay plans.

Local businesses and industry demonstrated tremendous support for the project. Grocery stores provided food for both the kick-off meeting and NetDay. The Chamber of Commerce provided t-shirts for all NetDay volunteers. The County Board of Supervisors covered the cost of conduit. BellSouth provided a wiring kit and the services of two fully-equipped trucks, as well as a team of trained workers. The Telephone Pioneers provided additional manpower. The Ole Miss Volunteer Services provided individuals to help with food, registration, etc. The local radio and newspaper provided public service announcements. The electric company provided the materials necessary for wiring between the high school and the superintendent's office, as well as trained personnel. A local hardware stayed open beyond normal business hours and set up an account for the school, just in case there were last minute tools and materials needed. The list of support could go on and on.

Although 70 volunteers had signed up for NetDay, over 100 appeared at the start time of 8:00 a.m. Participants were divided into eight wiring and three conduit teams. Each team was assigned a specific segment of the school building and was provided with color-coded maps and instructions for wiring from the classrooms to the nearest hub.

By 4:30 in the afternoon, the entire school was wired. The infrastructure necessary for Internet connectivity was complete. Our first NetDay was a tremendous success!

Since that time, the university, schools, and local industry have wired every school in our two local districts—Oxford City School District and Lafayette County School District. Now we are branching out to schools in outlying, rural areas. The Ole Miss NetDay Team sends members to help school districts organize their NetDay projects, helps solicit volunteers, and brings students and faculty members to help with every NetDay.

Within the past year, through these collaborative efforts, we have help wire seventeen schools with well over 2,000 Internet connections. Since the estimated cost for Internet wiring is from $500.00 to $1,000.00 per connection (depending upon local prices), we have helped save our local school districts at least $1,000,000 to $2,000,000 so far.

The Ole Miss NetDay Team, in conjunction with the Mississippi Department of Education, recently sponsored a NetDay Workshop for other school districts that were interested in conducting NetDays. Representatives from 22 school districts in northern Mississippi attended the day-long workshop that focused on the organizational and technical skills necessary to make each NetDay a success. Experienced NetDay volunteers from the local schools, the university, and industry presented their roles in the wiring project.

We realize that we have only begun to scratch the surface of helping our school districts in northern Mississippi with their NetDays. In 1997, we saw a doubling of the districts asking for our help in planning and implementing their wiring projects. So far in 1998, there has been a tripling of scheduled NetDays.

We hope that our model of how the collaboration among the university, schools, and industry is helping the students—our children—connect to the future inspires others to conduct their own "high-tech barn raising" or NetDay project. It is through such cooperative efforts that great achievements in access to technologies can occur.

In-Class Use of Course Webs

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Abstract: As increasing numbers of course webs are built, it is increasingly important to evaluate the effects of those webs on student learning. Web usage may depend on student expertise, classroom setting, and available computing resources. In past studies [Rebelsky 1996b] [Rebelsky 1996a] I examined student reactions to a wide variety of web resources, from assignments to transcriptions of individual class sessions. In this present study, I examine student usage of course webs in classroom situations in which computers are readily available and students are comfortable using hypertext systems. For these students, there is significant, but not uniform, use of web-based course supplements during class periods. More importantly, these students report benefits from their self-directed in-class use of those online materials.

1. Introduction

The World-Wide Web [Berners-Lee et al. 1994] continues to change the ways in which we teach and are expected to teach. Many instructors are putting part or all of their courses on the web (for distance learning or as course supplements), and students are expecting to find course resources on the web. In spite of this growth, there is little formal or informal evaluation of usage or impact of these *course webs*. For example, of the 182 full papers presented at the 1997 World Conference on Educational Multimedia, Hypermedia, and Telecommunications [Muldner & Reeves 1997], only six provided any form of evaluation of student usage of course webs, and many of those included only rough notes on observations. (However, a number of others evaluated student use of particular hypertext learning tools.) This lack of evaluation is surprising, given that "most researchers agree that insufficient evidence exists to determine whether outcomes match the proclaimed promises of hypermedia" [Fitzgerald & Semrau 1997].

As developers of course webs, we must ask ourselves how students use, react to, benefit from, and are otherwise affected by our course webs. The questions developers of course webs might ask themselves and their students include: (1) When do students access the materials? Before, during, or after each class period? (2) Which materials do students regularly use? Outlines? Syllabus? Assignments? Answer Keys? (3) Where do students access the materials? In the classroom? In their dorm rooms? In public laboratories? (4) In what form do students use the materials? Printed? Electronic? Both? Neither?

In previous studies [Rebelsky 1996a] [Rebelsky 1996b] I reported on student usage of resource-intensive course webs that included outlines of the topics to be covered in class period, copies of anything written on the blackboards during class periods, assignments, selected questions and answers, traditional course handouts, and, in one course, transcriptions of each class period. Students reacted positively towards the online availability of the resources, and indicated that they appreciated effort required to produce these webs. At the same time, they felt overwhelmed by the materials, with many deciding that they needed to print and read everything. In an in-depth analysis of the effects of web usage on computing anxiety [King et al. 1997], King, Henderson, and Putt reported that use of course webs does not appreciably affect computing anxiety (either positively or negatively).

The present study approaches the problem from a different perspective: *If students have ready access to computers and the web during class time, how does that affect their perception and usage of the web?* In particular, what types of pages do they use most frequently, when do they use them, and what do they say about their usage? The study is based on two courses: a second course in computer science, and a mid-level course in software design.

2. Background

In the fall of 1997, I prepared extensive course webs for two courses at Grinnell College, Computer Science 152 and Computer Science 223. The design of these webs was based on previous research on student use and preferences [Rebelsky 1996a]. Each web contained (1) a front door with links to the remainder of the web and appropriate external resources; (2) standard handouts, such as syllabus, rules and regulations, and assignments; (3) moderate-sized outlines for each class period, developed on or before the day of each class; (4) a short news document documenting updates to the web; (5) online quizzes; and (6) appropriate reference materials, including readings and external links. The class outlines had three parts: (1) a short summary of the topics to be covered; (2) a list of administrative information with links to appropriate pages; (3) my notes on the day's topics. A typical outline is four pages long. Students were told about the course web the first day of the course, and were rarely, if ever, given paper handouts. These course webs can be found at www.math.grin.edu/~rebelsky/Courses/CS223/97F and www.math.grin.edu/~rebelsky/Courses/CS152/97F.

Grinnell College's Computer Science 152 is a standard second course in Computer Science, with emphasis on data structures and algorithm analysis. CS152 meets four days per week. We teach the course in Java so that we may emphasize both object-oriented and imperative design. Grinnell has recently adopted a two language/three paradigm strategy in keeping with the new standards for introductory sequences [Walker & Schneider 1996]. In the fall term, there were seven students enrolled in CS 152, three of whom had taken a previous course based on functional programming, and four of whom had other exposure to programming. All students were familiar with the World-Wide Web and were unfamiliar with Java. The text for the course, a preprint of Bailey's *Java Structures* [Bailey 1997] included an online software library and reference manuals for the library that were included with the course web.

Grinnell College's Computer Science 223 is a mid-level (sophomore to senior) course on issues in software design. CS223 meets three days per week and covers a wide variety of topics, from forming a programming team and building large projects to issues in user interface design. As such, it draws upon a wide variety of texts, from general treatises on software design [Winograd 1996] to collections of articles on programming [Bentley 1986] [Bentley 1988]. This makes students more inclined to rely on instructor-generated resources, such as the course web. Like CS152, CS223 uses Java as the main language so as to better illustrate object-oriented design. In the fall term, there were twenty-four students enrolled. Of these, nineteen were majors and five were nonmajors. Students were generally unfamiliar with Java, but were uniformly familiar with the World-Wide Web. About half were able to write HTML.

Both courses were taught in the department's MathLAN classroom. This room includes sixteen HP 712/60 Unix workstations. In CS223, students were forced to pair up on workstations, but they were accustomed to this pairing from experiences in other courses. There were some in-class exercises given in both courses, as well as some electronic quizzes (in CS223, students could collaborate on a quiz). Students were permitted to use the computers as they deemed fit during class periods. The MathLAN classroom is adjacent to the MathLAN laboratory, where students often look at course pages before and after each class period. The MathLAN laboratory contains an additional sixteen HP 712/60 Unix workstations and is used as an open laboratory for student use and as a classroom for selected classes.

During the term, I observed a number of students loading the course web pages during class periods, doing "research" on in-class questions by looking elsewhere on the web, and using the computer as a notebook. To ground these observations, I gathered data on how they were using computers and the web during and outside of class periods.

3. Methodology

Data on student web usage were gathered in two ways: students took two surveys on their web usage, and web server logs were analyzed using custom tools. The survey focused on students perceived use of the web, particularly of the class outlines. The logs permitted more general analysis.

Before mid-semester break, students were given an electronic survey on the course webs and were told that the intent of the survey was to determine if and how the class web should be changed for the remainder of the term. In CS152, all seven students answered the survey. In CS223, twenty-one of the twenty-four students answered the survey. The survey asked students (1) how often they referred to the class outlines during, before, and after class sessions (using a scale of 1 to 5 with 1 representing "never" and 5 representing "always"); (2) whether the outlines were a help or a hindrance or both; (3) whether they printed the outlines; (4) whether they took notes on the computer; (5) a number of free-form questions about the course web; and (6) some questions not pertinent to the study at hand.

Because of a problem with the tool used to build the surveys, not all responses to the first survey were recorded accurately. The tool was repaired and the students were again surveyed about web usage at the end of the term as part of an end-of semester course evaluation. For this survey, all seven students in CS152 answered the survey and twenty-three of twenty-four in CS223 answered the survey. In the final survey, the numeric rankings were described only as "1-never and 5-always." The numeric results in this paper are based only on the second survey. The textual responses are taken from both surveys.

The access logs generated by our httpd daemon were analyzed with a custom Perl script. Cumulative data for the first seven weeks of the course were used for overall analyses. For each course, this script selected pages according to appropriate criteria. For accuracy, the pages counted were limited to those that were (1) part of the course web (i.e., contain the site root as part of their path); (2) accessed from inside the college (i.e., contain grin.edu as part of the requesting machine); (3) accessed from machines the instructor does not regularly use (the instructor's machines are never used by students, and the instructor does not view the web from student machines); and (4) valid requests (i.e., requests for which a page exists).

For counts of usage of the current day's outline "during class", time of access was restricted to the 15 minutes before and 10 minutes after the class period (if a class that met from 1:15 to 2:05, the times were 1:00 to 2:15).

4. Results and Discussion

Because there are few studies on student use of course webs, this study focused on student reactions and the types of pages they used. Most students report making at least occasional use of the course outlines, with the majority (five of seven in CS152, twenty of twenty-three in CS223) reporting that they always or almost always used the outlines at some point (before, during, or after each class period). Many students seem to pick a particular time to use the outlines, and stick to that time. Some students appear to use the outlines before and during class as a guide to what will happen and others use them later for review.

Student comments described a wide variety of uses of the webs during and near class time. As one might hope, some used them to prepare themselves for the topics in a given class.

> I read the outlines before class so I know what to expect and to be in a proper mindset. [CS223 student]

> Before class, it's a great way to get in the mindset of what's going on in class that day. [CS152 student]

Others used them as aids to recall, to answer questions they had during class, or to find other perspectives.

> Sometimes they give enough information beyond what is getting written on the whiteboard. That way, I can piece it together for myself without having to slow down the rest of the lecture for a silly question. [CS223 student]

> I really like being able to jump back to any point in the lecture if I find that there is something I didn't quite catch and need repeated. [CS223 student]

One danger of online resources like these is that they adversely affect student note-taking. Since note-taking has a clear role in learning [Carrier 1983], it is worrisome that some students use class notes as a replacement for their own. I attempt to combat this problem, in part, by using my outlines as only a rough guide for what I teach each day. I often develop new or modified examples, and rarely look at the outlines during class. Students reported that they perceived positive effects on their note-taking. For some, this is because they have not yet learned to take good notes:

> I have only mediocre note-taking skills so the outlines that you provide are superior to any notes I would take myself. [CS152 student]

> It's nice to have a record of what happened in class (since I'm a poor note taker). [CS223 student]

After class, it's really beneficial to be able to compare your notes to the class notes and see if you got distracted/whatever or if you didn't emphasize the same things as the outlines did. [CS152 student]

It is, however, worrisome that these students do not yet understand the implicit benefits of notetaking.

More importantly, many reported that the in-class availability of outlines permitted them to concentrate more on understanding than on "mindlessly" copying what I write or say.

Since I do not have to take many notes I am able to concentrate more on understanding what you say instead of writing down. [CS152 student]

Instead of taking the time to write down everything and missing stuff, I can watch and listen more closely. [CS152 student]

I can spend more time listening to what you and other people say than take notes. [CS223 student]

Some of those who were confident in their note-taking abilities reported that they used the outlines to supplement their note-taking.

I like to organize notes when I take them and if I know what general subjects you cover, I'm happier. [CS223 student]

One of the perceived benefits of hypertext is that it supports a variety of learning styles. Student answers suggested that this is, indeed, the case.

I have much better comprehension of things that I read instead of hear. Since you do not follow the outline exactly, reading it can be a way of getting things rephrased or put differently. [CS152 student]

Seeing something on the screen, however, makes me much more likely to remember something. [CS223 student]

It has been reported (e.g., in [Rebelsky 1996a] [Windley 1994]) that students tend to print "everything available" in their course webs Surprisingly, most students n these two courses reported that they did not regularly print the class outlines. In CS152, only one of seven students reported printing the class outlines. In CS223, only three of twenty-three students reported that they printed the class outlines. It is not clear whether or not this is because of the in-class availability of the resources, but it seems more likely that as computers become more available, students feel less needed for printed copies.

A summary of student self-reports of usage of course outlines appears in [Tab. 1]. The first part of the table summarizes their reported usage before, during, and after class. The second part of the table summarizes the computed maximum and minimum for each student across the three categories. That is, if a student reports a value of 1 for before, 3 for during, and 5 for after, that student's maximum and minimum will be recorded as 5 and 1. These categories are used to accommodate different strategies for using the course web.

Course	When	1	2	3	4	5	Median	Mean
CS152	Before	2	2	1	0	2	2	2.71
	During	0	2	1	3	1	4	3.42
	After	0	2	1	3	1	4	3.42
	Max/student	0	1	1	1	4		4.14
	Min/student	2	3	1	1	0		2.14
CS223	Before	1	0	8	5	9	4	3.91
	During	1	4	2	6	10	4	3.86
	After	0	2	13	8	0	3	3.26
	Max/student	0	0	3	10	10		4.30
	Min/student	2	5	12	4	0		2.78

Table 1: Student's self-reported use of class outlines. A rating of 1 indicates that the student reports never uses the resource during that time. A rating of 5 indicates that the student reports always using the resource during that time. The maximum and minimum categories reflect the greatest and least values students reported across each of the time periods.

Clearly, different students find different times to use the web and place different emphases on web use. In CS152 there was one student who reported making very little use of the course web (a maximum across all three categories of 2). On the final survey, the student indicated a desire to use the web more but did not explain the limited use. In CS223 there were four students who made significant use of the course web before, during, and after class (a minimum of 4 across all three categories).

One unexpected result was that self-reported usage of course webs in CS223 seems to decrease slightly during class. It may be that many students quickly refer to the outline at the beginning of class to get a better perspective on what will be covered and then do not refer back to them during class. This is clearly an area that should be examined further.

Analysis of web log files shows that reported in-class usage of outlines is fairly close to actual usage. In CS152, the outline of the current class was accessed during class 5.9 times on average. These accesses came from an average of 5.0 machines. This is in keeping with the reported numbers. In CS223, the current class outline was accessed during class 15.0 times on average, from an average of 12.5 machines. A small number of in-class (or, presumably, shortly pre- and post-class) access came from machines outside the classroom, but this number was less than one document per day.

Data from the web server log files was used to generate the reports on overall student web usage in [Tab. 2]. A short analysis of the files accessed suggested that certain sets of documents biased the results. In CS152, documentation that accompanied the book was included in the counts, so a separate analysis without that documentation was done. In CS223, some documents generated by javadoc included images that were counted towards the totals. In addition, a directory loop in the examples section resulted in their being multiple paths to the same document, which greatly increased the number of different documents loaded. Again, separate analyses were done to handle those differences.

The number of accesses per document per student is relatively uniform across classes, with each document being accessed approximately twice by each student. While there are clear variation in access patterns (e.g., the root of the web accounts for nearly one-fifth of the accesses, the two classes have different types of pages, different students use the web differently), it is comforting to see that students do, in fact, regularly use the course materials.

Course	Accesses	Machines	Docs	Students	A/D	A/D/S	A/S/Week
CS152	1720	64	96	7	17.9	2.6	35
w/o book	1225	63	70	7	17.5	2.5	25
w/o root	925	60	68	7	13.6	1.9	19
CS223	5794	94	195	24	29.7	1.23	34.5
w/o images	5378	94	144	24	37.3	1.55	32
w/o examples	5027	94	83	24	60.6	2.5	30
w/o root	3914	91	81	24	48.3	2	23

Table 2: Overall web usage in first seven weeks. Restrictions are cumulative. A/D is accesses per day. A/D/S is accesses per day per student. A/S/Week is accesses per student per week.

As [Tab. 3] suggests, students look at a wide variety of materials, but most visits are confined to the course root (presumably as a starting point for explorations) and outlines (which, in the webs used in this study, contain most of the information).

Course	Total	Root	News	Syll.	Outlines	Assign.	Examp.	Book	Other
CS152	1720	300	17	67	497	225	23	495	96
	100%	*17%*	*1%*	*4%*	*29%*	*13%*	*1%*	*29%*	*6%*
in class	747	170	5	34	287	100	5	109	37
	100%	*22%*	*1%*	*5%*	*38%*	*13%*	*1%*	*15%*	*5%*
CS223	5794	1113	135	424	1297	1215	353	0	851
	100%	*21%*	*30%*	*8%*	*24%*	*22%*	*6%*	*0%*	*16%*
in class	1836	323	51	151	619	258	75	0	359
	100%	*18%*	*3%*	*8%*	*34%*	*14%*	*4%*	*0%*	*20%*

Table 3: Page access by category in the first seven weeks of each course. Percentages may not total 100% due to rounding.

As one might expect, the types of documents used varies depending on whether students are inside or outside of class. In particular, use of class outlines increases significantly during class sessions. Presumably, this is due to a number of factors. First, students are less likely to look at "extraneous" material (such as assignments or syllabus) during class sessions. In addition, students who use the web during class time are likely to follow along in the current outline, or sometimes refer back to previous outlines for further information.

5. Summary

For many of the students in these courses, the in-class use of course webs has had an impact on how they learn in class, or at least on how they perceive their in-class learning. During each class period, over half the students load web pages (in CS223, the sharing of workstations makes presumed usage even higher). Students who use the pages in class report that the web helps them learn better in class, and both poor and good note-takers report benefits for their note taking.

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Computer-Mediated Communication in Continuing Professional Education: A Guarded Appraisal

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Abstract: Deakin Australia, the commercial arm of Deakin University, has included computer-mediated communication as an element of the professional development program produced in conjunction with the Australian Society of Certified Practising Accountants (ASCPA). The CPA Program is delivered by distance education to candidates seeking professional accreditation as Certified Practising Accountants. For a number of reasons the use of CMC to date has been disappointing. The role of CMC in the CPA Program is being reviewed in light of this experience. This paper discusses the history of, and future plans for, CMC in the CPA Program.

Introduction

Computer-mediated communication (CMC) represents a potentially rich enhancement to education and training programs, particularly those offered through distance education. The opportunity for asynchronous (and synchronous) interaction using textual communication enables participation in group dialogue and collaborative project work which is quite distinct from equivalent face-to-face communication. These and other strengths of CMC have been documented widely. See, for instance, [Harasim 1989] or [Kaye 1989].

Deakin Australia has introduced CMC into continuing professional educational programs with mixed results. This paper briefly outlines Deakin Australia's experience to date using CMC and explores possible strategies for future application of online education techniques.

The Provision of Continuing Professional Education

Deakin Australia, the commercial arm of Deakin University, provides education and training programs in collaboration with clients from professional associations, government agencies and the corporate sector. Continuing professional development programs are offered, by distance education, in conjunction with a range of professional associations including the Australian Society of Certified Practising Accountants (ASCPA). Candidates in these programs are typically young graduates in full-time employment who are seeking accreditation as full members of their respective professional associations.

The Accounting Society's CPA Program has the following main features:

- Two core and three elective semester units of study ('segments') are to be completed.
- Assessment occurs via invigilated, end-of-semester, multiple-choice-question examinations.
- Distance learning is the mode of delivery.
- A combination of study media and support mechanisms is used, including:
  - printed study manual (the main learning resource)
  - audio cassettes

- CBE via floppy disk
- face-to-face workshops in the larger urban locations
- WWW-page information service and study forum
- academic and administrative support from ASCPA education staff via telephone/fax/email links.

- 22 300 people enrolled in the Program for 1997, generating approximately 16 000 segment enrolments per semester - a much larger enrolment than many university faculties.

- The enrolment pattern is approximately 70% from within Australia and 30% from South East Asia (Hong Kong, Malaysia and Singapore) with a sprinkling of candidates from Europe and other locations.

- Formal evaluation of materials occurs as part of an annual development cycle.

Deakin Australia's education and training programs have used computers extensively for many years: computer-managed learning has underpinned the Technology Management course undertaken by students from corporate and government clients, and computer-aided learning on computer disk has formed part of the distance learning materials distributed to candidates undertaking the ASCPA's CPA Program.

In 1995, Deakin Australia introduced 'Deakinet' into the CPA Program. Deakinet gave candidates access to the Deakin University electronic network which provided email access to and from candidates, tutors and other education staff of the ASCPA, as well as access between candidates. Candidates were also invited to subscribe to discussion groups based on their subject enrolments.

Candidates were required to provide their own personal computer and a suitable modem. Deakin Australia provided the necessary software and documentation on connecting the modem, installing the software and logging into Deakinet.

The Deakinet Experience

The rationale behind the introduction of Deakinet was to reinforce the motivation of candidates to participate fully in the study programs and, importantly, to facilitate candidates' maintaining a regular study pattern through the semester program.

The ASCPA Deakinet service included a schedule of weekly study questions for consideration and subsequent discussion. Each subject area was moderated by a member of the ASCPA's education staff.

It was hoped that adding email to the existing ASCPA candidate support network (telephone and fax contact, and face-to-face workshops conducted in the main urban centres in Australia and South East Asia) would produce the positive outcomes reported in case studies of other distance education online study groups. For example, see [Blantern 1992], [McConnell 1991], [Paulsen 1991] and [Steeples et al. 1996].

The Deakinet experience was disappointing. ASCPA study group numbers were abysmally low (less than 3% of enrolments in the CPA Program itself) and there was virtually no discussion traffic in response to the set question topics and no discussion topics generated by the candidates themselves.

The low participation rate was due to a combination of limited access to a personal computer and/or modem (modem access was 26% in 1995, 28% in 1996 and 49% in 1997) and a serious shortage of discretionary time available to candidates contending with full-time employment, part-time study and the usual range of family and related commitments. Of those who did register to participate in Deakinet, many reported technical problems connecting modems and in logging into the network.

The pattern of enrolment in Deakinet and the level of participation by ASCPA candidates did not improve after the initial semester program and Deakinet was withdrawn during 1996 and replaced by a limited information service provided on a WWW page, to which candidates must arrange their own access. Use of the CPA Program information service continues to be low.

CMC: The Hype and the Reality

The professional literature discusses the educational functions able to be fulfilled by CMC. For instance, [Chacon 1992] extends Kaye's essential characteristics of CMC into a table of pedagogical functions of the Communication Mode (CM).

From written medium
- learning verbal information
- development of expression
- developing skills for analysis and syntheses of text

From group interaction and co-operation
- motivational support of distance students
- development of critical judgement
- participative problem-solving
- opportunity for incidental learning

From audiovisual medium (developing feature of CM)
- added motivational strength
- substitutive of direct experience
- presentation of abstract knowledge

It appears that CMC is able to offer teaching options across the spectrum of strategies employed in face-to-face and resource-based distance education program settings. Chacon observes that 'the quality of service delivered by computers does not depend as much on their technological sophistication as on their relations to users and other media. Within a given user mode, the corresponding pedagogical functions may be accomplished as well by the "low end" of "cheap" media as by the more sophisticated ... This conclusion has enormous importance for distance education programs, concerned as they are with equal opportunity of access.'

Not surprisingly, educational providers are 'going online' at a great rate of knots. Many institutions appear to be making productive use of CMC. Numerous 'virtual universities' are offering educational programs via the Internet. The bandwagon of online education is gathering momentum.

The Deakin Australia experience with Deakinet has led to a more restrained view of the potential role of CMC in continuing professional education. There is no doubt that CMC does add to the armoury of distance (and face-to-face) education instructional strategies. However, the practicality of these strategies needs to be assessed in relation to the particular instructional circumstances. In the case of the CPA Program, the 1995 cohort of candidates with access to modem links was too small to permit development of a vigorous online discourse. While the 1998 cohort is certainly much larger, the problem of a shortage of study time remains. CPA Program candidates make pragmatic judgements about how their scarce study time is best allocated. Program evaluations suggest that the printed study manual is regarded as the primary resource and that other support resources must be demonstrated to add value as effective means of examination preparation before they will be embraced.

The Future of CMC in Deakin Australia Programs

Considering the range of services that is potentially available through CMC in relation to the needs of CPA Program candidates, the following observations may be made:

- An opportunity for dialogue with education staff of the ASCPA and other CPA Program candidates would be valuable.

- Such dialogue would be likely to be oriented to supporting segment study manuals and other segment study resources.

- CMC dialogue may be preferred by some candidates (over present phone and fax services) because of costs involved and for the reasons explored by [Mason 1989], that is, CMC is not seen as being as intrusive on tutors and fellow students as telephone queries and enables students to ask questions at the time an issue arises rather than during office or other specified hours of contact.

- Activities which proposed collaboration between candidates to build knowledge and explore academic points of interest within study programs would be bound to fail because of the shortage of study time available to candidates.

- Any move to introduce techniques and services which involved CMC becoming a primary teaching medium would raise serious problems of access and equity.

- Widespread use of discussion groups and other techniques which involved close moderation of small groups by tutors would impose huge administrative and logistical problems and would be untenable.

- Applications which relied on candidates storing and reviewing copious text files would not be popular. Candidates maintain that there is already too much to read in segment programs.

- Applications which reinforced a regular reference to the segment study program and encouraged candidates to pace their study evenly through the semester would be a useful timetabling and planning aid.

- In addition to enrolled CPA Program candidates, it would be desirable to make Program information available to potential candidates.

- Applications which promote 'examination readiness' are likely to be popular.

- An update service which provided succinct details of legislative and regulatory changes etc. and other current developments in the segment study discipline would promote candidate interest in the use of CMC within the study program.

Deakin Australia is continuing to explore uses of online communication in continuing professional education. A range of options is being considered to build on the present restricted use of CMC within the CPA Program based on the above observations, the theoretical considerations of CMC discussed earlier in the paper and Deakin Australia's experience with Deakinet. These options, to be offered via WWW pages and associated email links, fall broadly into three categories of CMC activity - an information service, an update service and a tutorial service.

Information service
Information to intending enrollees (and the world at large). Components of the service are presently in place and include:
- CPA Program handbook (pre-requisites for enrolment in CPA Program, CPA Program objectives, segment outlines and objectives etc.)
- Weekly study schedule
- Examiners' reports
- CPA Program enrolment form

Update service
CPA Program updates
- Administrative notices, reminders
- Errata sheets
- Legislative changes, information on new standards and other accounting document releases

Stop press
- Informal information exchange (eg. job vacancies, other items of general interest)
- Notice of topical information (eg. newspaper and journal articles, visiting speakers, seminars etc.)

Tutorial service
Weekly study commentary
- Brief comment or elucidation of some aspect of the segment study program (eg. review question, case study, diagram, reading, CBE program feature, audio cassette discussion etc.) to reinforce the sense of a timetable for regular progress through the segment study guide and to help to integrate the various resources making up the study program. Candidates could be invited to submit questions or make comments on the tutorial entries.

- Examination review (to include practice questions and commentary, candidate queries and other responses to be invited)

Symposium series

- Two or three sessions of dialogue (over the 12- to 14-week semester) involving exchanges between subject experts on some important or difficult segment topic, each could run over one or two weeks.
- Candidate questions/comments would be invited.

Seminar series

- Simulation of face-to-face workshops or seminars in which presenters outline given topic areas within segment study programs.
- Topics to be selected such that scope of presentation, while broader than the planned weekly study commentaries, is confined to discrete, logistically manageable study units.
- Presentation to consist of audio commentary and accompanying graphics and a limited use of text to reinforce and summarise key issues.
- Candidates to be invited to submit email queries and comments.

Segment knowledge base

- Database containing additional information on segment study program (eg. points arising from segment workshops, questions and information arising from phone contact with candidates, links to relevant pages on WWW and any other sundry segment intelligence).

Chat service

- Invitation at nominated times for online chat with tutor and/or other segment specialists.
- This service would be run on a limited trial basis to assess the likely resource implications if offered as a standard feature throughout the CPA Program.

Conclusion

Having entered the domain of CMC and been disappointed with the initial outcome, Deakin Australia is reviewing its experience and devising an alternative online strategy.

The use of CMC in continuing professional education must recognise that significant barriers constrain the intended users. Access to basic equipment will be a problem for a sizeable minority of users for some time yet. Adoption of specific conferencing software in addition to use of the WWW will exclude other potential users. To be of benefit to those users possessing the required hardware and software, services provided through CMC must be perceived to add value within a narrowly focussed study framework. Accordingly, online techniques need to focus on simple applications which facilitate examination readiness (or promote mastery of specified skills outcomes) and economise on study time.

A further complicating factor for Deakin Australia is the large numbers to be catered for within client programs, particularly the CPA Program. Information and update services do not present a problem in this respect, and some of the tutorial activities may be designed to economise on co-ordinating/moderating input. However, trials of the proposed seminar and chat services will need to be closely scrutinised to assess the resource requirements of a wider application of these techniques.

CMC has the potential to powerfully enrich continuing professional education and other forms of distance education. [Carvin 1997] points out that CMC (through the WWW) is able to extend the scope of an education/training organisation in the roles of tutor, publishing house, forum and navigator. It remains to be seen whether this potential is realised across all of these roles or in a less balanced development.

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Answering Critics of Media and Technology in Education

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Abstract: Serious critics of media and technology in education must be answered. The response provided in this paper concludes that: 1) media and technology are best used as cognitive tools to learn with rather than as surrogate teachers, 2) media and technology are only vehicles for the content and pedagogy that educators design into them, and 3) future efforts to integrate media and technology into education must be guided by stronger research and evaluation.

Introduction

In the United States of America, the degree of federal government support for the development and use of media and technology in education has never been stronger than it is today. For example, in his 1997 State of the Union address, President Clinton said:

> Now, looking ahead, the greatest step of all - the high threshold of the future we now must cross - and my number one priority for the next four years is to ensure that all Americans have the best education in the world. Let's work together to meet these three goals: Every 8-year-old must be able to read; every 12-year-old must be able to log on to the Internet; every 18-year-old must be able to go to college; and every adult American must be able to keep on learning for a lifetime.

Overlooking the fact that the quote above actually contains four goals, not three, all of President Clinton's priorities for his second term of office have direct relevance to media and technology in education. First, the ability to read in the 21st Century demands the development of new forms of media literacy. Negroponte describes the Internet as a place where "children are heard and not seen" [Negroponte, 1995, p. 202]. He predicts that the reading and writing skills of Internet savvy students will improve because "Children will read and write on the Internet to communicate, not just to complete some abstract and artificial exercise" (p. 202). The importance of media and technology in the development of the "new literacy" is obvious.

The second goal regarding Internet access for 12-year-old children has an even more obvious connection to support for media and technology in education. The push to wire all K-12 schools in the USA with full Internet access is proceeding at a rapid rate. According to an Educational Testing Service report, 64% of U.S. schools now have Internet access, and all U.S. schools, and more importantly, many of the classrooms within them, will be "wired" by the year 2000 [Coley et al., 1997]. Of course, whether students and teachers will be prepared to utilize the power of the Internet to support learning remains to be seen.

Third, with respect to higher education opportunities for 18-year-olds, it must be recognized that gaining entrance to higher education is just the beginning. Succeeding there is increasingly unlikely without media and technology skills unimagined in academe even a few years ago. Many university faculty have stopped romanticizing the lecture and are acknowledging the powers of multimedia to provide effective interactive learning opportunities. In fact, many U.S. universities have defined a minimum set of technology skills expected of all students before they enter postsecondary courses, as well as for faculty before they begin to teach [Harrison and Stephen, 1996]. Of course, if students are to enter higher education possessing robust media and technology skills, they must begin to develop these skills while they are still in K-12 schools.

Fourth, lifelong learning is rapidly changing from a "buzzword" to a mainstream expectation in business, industry, government, and other spheres of human activity. Winslow and Bramer from Andersen Consulting describe integrated performance support systems as essential to the levels of workplace performance required of all workers in organizations that hope to compete in a global economy [Winslow and Bramer, 1994]. They maintain that these support systems must be "multisensory," integrating a variety of media appropriate to the task to be learned or performed. Lifelong learners won't possess the necessary skills and experience with multiple forms of media unless schools include appropriate learning opportunities across the curriculum.

Given the increased investments in technology in education at the federal level in the USA, it is not surprising that educational media and technology are being subjected to severe criticisms by some. These critiques must not be ignored because critical analysis plays an essential role in a democratic society. Hence, the goal of this paper is not to dismiss critics of educational innovations, but to respond to the doubts expressed by three vocal critics of media and technology in education in a responsible manner. These critics render a great service by forcing us to examine our assumptions about media, technology, and education.

Future Schlock

In a cover story titled "Future Schlock" in the March 1997 issue of *Phi Delta Kappan*, Lawrence Baines, a professor at Florida State University, protests the "platitudes and fabrications" that underlie much of what is being proposed in the name of educational reform [Baines, 1997]. He is especially harsh on technology as a reform vehicle, listing as "Fabrication 1," the statement that "Technology is a moral imperative that will increase student achievement and make American students globally competitive" (p. 494). Baines concludes by proclaiming as "Reality" that "Technology can make learning more fun, easier, and cleaner. But no data supports the conclusion that technology causes gains in student achievement" (p. 495).

Baines' reality statement has a grain of truth in it, but it is ultimately misleading. Researchers have failed to reveal "causal" explanations for the impact of technology on learning, but that is because educational research, like all social sciences, is often limited to discovering relationships rather than revealing definitive causal explanations. However, there are hundreds of studies that support the impact of media and technology on achievement [Jonassen, 1996]. For example, meta-analyses of computer-based instruction (CBI) studies have revealed modest, but positive relationships between technology and achievement at all levels of education: elementary (0.47), secondary (0.36), higher (0.26), and adult (0.42) [Kulik, 1994]. Of course, it must be admitted that the average effect sizes for technologies such as CBI do not approach the two-sigma (2.00) difference often promised by commercial interests and other proponents of technology in education. Nonetheless, positive results are dominant in the research literature, as summarized in a 1997 report from the Educational Testing Service (ETS) titled *Computers and Classrooms* [Coley et al., 1997]:

> [CBI] can individualize instruction and give instant feedback to students, even explaining the correct answer. The computer is infinitely patient and non-judgmental. This motivates students to continue.... Students usually learn more in classes in which they receive computer-based instruction. Students learn their lessons in less time with computer based instruction. Students also like their classes more when they receive computer help in them. (p. 35)

Another misleading aspect of Baines statement is that he fails to point out that his critique is limited to studies that have examined the effects of learning "from" computers. Baines appears unaware of the evidence indicating that it may be more effective to engage students in learning "with" computers than "from" them. In most existing applications of computers in education, content and instruction are encoded by specialists such as instructional designers into predefined educational communications intended to transmit knowledge to students. Students are expected to receive these communications passively with occasional artificial interactions to let the computer know they are ready to receive more information. In this approach, students are expected to learn "from" computers which have been cast in the role of a surrogate instructor. An alternative approach involves using computers as "cognitive tools" that students learn "with" in a cognitive partnership [Jonassen and Reeves, 1996]. Cognitive tools refer to technologies, tangible or intangible, that enhance our cognitive powers during thinking, problem-solving, and learning. Cognitive tools have been around ever since primitive humans used piles of stones, marks on trees, or knots in vines to calculate sums or record events. Something as simple as a grocery list or as complex as calculus can be regarded as a cognitive tool in that each allows us to "off-load" memorization or other mental tasks onto "technology." Computers are extremely powerful cognitive tools. When software programs are used as cognitive tools in education, students use software to analyze complex problems, solve difficult tasks, access information, interpret and organize their personal knowledge, devise unique solutions, and represent what they have learned to others.

Although research studies on using media and technology as cognitive tools are relatively scarce, the results are often notable [Jonassen and Reeves, 1996]. For example, Lehrer has studied the use of multimedia construction software by eighth graders designing their own lessons about the American Civil War [Lehrer, 1993]. His work exemplifies the principle that: "Cognitive tools empower learners to design their own representations of knowledge rather than absorbing knowledge representations preconceived by others." Students in one of Lehrer's studies were high and low ability eighth graders who worked at the multimedia construction tasks for one class period of 45 minutes each day over a period of ten weeks. The students worked in a media center where they had access to computers, a scanner, sound digitizer, multimedia construction software, and numerous print and non-print resources about the Civil War. A teacher was available to coach students in the conceptualization, design, and production of their programs. Students created programs reflecting their unique interests. For example, they created multimedia about the role of women in the Civil War, the perspectives of slaves toward the war, and "not-so-famous people" from that period. According to Lehrer, "The most striking finding was the degree of student involvement and engagement" (p. 209). All students became task-oriented, increasingly so as they gained more autonomy and confidence with the cognitive tools. At the end of the study, students in the multimedia group and a control group of students who had studied the Civil War via traditional classroom methods during the same period of time were given an identical teacher-constructed test. No significant test differences were found. However, a year later, when students in the design and control groups were interviewed by an independent interviewer unconnected with the previous year's work, important differences were found. Students in the control group could recall almost nothing about the historical content, whereas students in the design group displayed elaborate concepts and ideas that they had extended to other areas of history, Most importantly, although students in the control group defined history as the record of the facts of the past, students in the design class defined history as a process of interpreting the past from different perspectives. In short, the cognitive tool approach lead to knowledge that was richer, better connected, and more applicable to subsequent learning and events. After this and other studies, Lehrer concluded that: 1) by using multimedia as cognitive tools, students' on-task behavior increased over time, 2) they perceived the benefits of planning and modifying their work during different stages of development, and 3) they developed generalizable skills such as taking notes, finding information, coordinating their work with other team members, writing interpretations, and designing presentations.

In an extensive review of the literature [Jonassen and Reeves, 1996], the theoretical foundations for using computers as cognitive tools are summarized:

- Cognitive tools are most effective when they are applied within constructivist learning environments.
- Cognitive tools empower learners to design their own representations of knowledge rather than absorbing the representations preconceived by others.
- Cognitive tools can promote the deep reflective thinking that is necessary for meaningful learning.

- Cognitive tools enable mindful, challenging learning rather than the effortless learning promised but rarely realized by other instructional technologies.
- Cognitive tools should be applied to tasks or problems defined by learners with the support of their teachers.
- Cognitive tool use for education should be situated in realistic contexts with results that are personally meaningful for learners.
- Cognitive tools can enable intellectual partnerships in the form of distributed cognitive processing. (p. 698)

The Computer Delusion

Perhaps the most talked-about attack on media and technology in education this year has been Todd Oppenheimer's cover story, "The Computer Delusion," published in the July 1997 issue of *The Atlantic Monthly* [Oppenheimer, 1997]. Oppenheimer starts his critique by reciting some of the overly optimistic predictions made about the educational benefits of earlier technologies such as film, radio, television, programmed instruction, teaching machines, etc. For example, he notes that Thomas Edison predicted that "the motion picture is destined to revolutionize our educational system and....in a few years it will supplant largely, if not entirely, the use of textbooks" (p. 45). Such predictions have always been easy targets, and there are no shortage of similar targets today. Consider this quote from Lewis Perelman's book *School's Out* [Perelman, 1992].

> Because of the pervasive and potent impact of HL (hyperlearning) technology, we now are experiencing the turbulent advent of an economic and social transformation more profound than the industrial revolution. The same technology that is transforming work offers new learning systems to solve the problems it creates. In the wake of the HL revolution, the technology called "school" and the social institution commonly thought of as "education" will be as obsolete and ultimately extinct as the dinosaurs. (p. 50)

With hyperbole like Perelman's, is it really surprising that pundits like Oppenheimer have concluded that many of us are blinded by technology? Ironically, Oppenheimer appears to exaggerate as much as Perelman, albeit in the opposite direction. For example, by taking quotes out of context and citing a few dubious studies, Oppenheimer claims that computers threaten to diminish the reading, writing, and self-expression skills of students while at the same time crushing their imaginations and stunting their socialization. The major thrust of Oppenheimer's critique is that "school districts are cutting programs - music, art, physical education - that enrich children's lives to make room" for computers while "there is no good evidence that most uses of computers significantly improve teaching and learning" (p. 45).

As with Baines critique, Oppenheimer's attack contains a little truth and a great deal of misinformation. Instead of being non-existent, the evidence of the effects of using computers in a tutorial mode is generally positive, albeit modest [Kulik, 1994]. However, when computers are used to enable innovative pedagogical approaches, results are impressive. For example, consider Apple Classrooms of Tomorrow (ACOT) project, a decade long initiative to introduce computers and associated media into schools and homes. The simple presence of technology and media had little impact in ACOT schools, but when the technology was used to enable enhanced pedagogical strategies such as project-based learning, collaboration, and extended time-on-task, the outcomes were quite positive [Fisher et al., 1996]. The results are summarized in an Educational Testing Service Report [Coley et al., 1997] as:

> ACOT students:
> - Explored and represented information dynamically and in many forms
> - Communicated effectively about complex processes
> - Used technology routinely and appropriately
> - Became independent learners and self-starters
> - Knew their areas of expertise and shared their expertise spontaneously
> - Worked well collaboratively
> - Developed a positive orientation to the future (p. 37)

Oppenheimer argues that it is the improved teaching and learning strategies that make the difference in success stories like ACOT, not the technology. He is correct that the enhanced pedagogy is what matters most [Clark, 1994], but he fails to recognize that such pedagogical enhancements would be impossible without the capabilities of new technology [Kozma, 1994]. The reality is that in most schools, technology is an essential vehicle for pedagogical change.

The End of Education

Neil Postman is probably the best known critic of media and technology in education. In *The End of Education*, Postman has taken educators to task for the adopting new technologies without questioning their impact on the basic goals and processes of education [Postman, 1995]. For example, Postman wrote:

> I do not go as far back as the introduction of the radio and the Victrola, but I am old enough to remember when 16-millimeter film was to be the sure cure, then closed-circuit television, then 8-millimeter film, then teacherproof textbooks. Now computers. I know a false god when I see one. (p. 50)

One response to Postman's concerns is that he too is focusing on media and technology as things that students learn *from* rather than tools that they learn *with*. This is hardly surprising given that most of the commercial advertisements promoting the use of media and technology in education emphasize the "from" approach. For example, a recent brochure from Macromedia, the company the markets popular authoring systems such as Authorware and Director, has the following message on its cover: "To better reach your students, don't change your message." Upon opening the brochure, the following message appears in ever bolder type: "Change your medium." The belief that the same old content and instructional strategies will somehow be transformed by delivering them via the latest media and technology is widespread in education, and Postman, Oppenheimer, Baines, and others are wise to question the validity of this approach. Significant educational improvements are more likely to stem from changes in the message (i.e., content and pedagogy) than merely switching to another medium.

Although often castigated as an Information Age Luddite, Postman actually concludes his *The End of Education* book with support for the integration of "technology education" into schools [Postman, 1995]. He defines technology education as a subject in which students address questions such as:

> How does information differ in symbolic form? How do ideographs differ from letters? How are images different from words? Paintings from photographs? Speech from writing? Television from books? Radio from television? Information comes in many forms, and at different velocities and in different quantities. Do the differences matter? Do the differences have varying psychic and social effects? The questions are almost endless. This is a serious subject. (p. 190)

Postman's conception of technology education stands in sharp contrast with more common approaches to technology education that are centered on the teaching of how to use technology. There are only a handful of schools where media and technology are considered as important subjects of disciplined study in and of themselves. Several notable experiments are highlighted in *Brave New Schools* [Cummins and Sayers, 1995]. For example, they describe an electronic telecommunications project at Cold Spring Harbor High School in New York in which U. S. students engaged Israeli and Palestinian students in a dialog about how the news media cover events in the Middle East with either a pro-Israeli or pro-Palestinian bias. The words of one of the participating students conveys the power of this experience:

> I have had the opportunity to accomplish what many other students may never even have a chance to attempt. Even though I do not have the influence to reverse the sometimes harsh sentiments of the people, I would like to come away thinking that at least I did something to help the peace process along.... Many people do not have the opportunity to tap directly into the minds and hearts of their peers who live thousands of miles away in troubled lands. I am very thankful to have worked on a project that has strengthened my communication skills and provided me with some of the most valuable lessons one can learn in life. (p. 76)

Although it is difficult to agree with Postman's conclusion that computers and other technologies are false gods, his concerns for the social and psychological effects of media must not be ignored. Technology affords us many benefits, but rarely without some hidden or unexpected costs. The examination of these costs within educational contexts is an important enterprise.

Conclusion

What can be concluded from this brief response to three of the major criticisms aimed at media and technology in education in the USA? My conclusions are in agreement with those of the Panel on Educational Technology that was part of the U. S. President's Committee of Advisors on Science and Technology. The Panel made the following recommendations [President's Committee of Advisors on Science and Technology, 1997]:

1. Focus on learning with technology, not about technology.
2. Emphasize content and pedagogy, and not just hardware.
3. Give special attention to professional development.
4. Engage in realistic budgeting.
5. Ensure equitable, universal access.
6. Initiate a major program of experimental research.

Numbers 1, 2, and 6 above are especially in sync with my own conclusions. Technology is best used as a cognitive tool to learn *with* rather than as a surrogate teacher. Pedagogy and content matter most; technology and media are only vehicles, albeit powerful ones. Most importantly, future efforts to use media and technology in schools must be guided by much more rigorous research and evaluation than in the past.

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IT Roles and Competencies: Are We Prepared for the 21st Century?

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Abstract: This paper highlights the findings of a study to identify evolving changes in Instructional Technology (IT) practitioner competency requirements, and consequent changes in instructional technology curricula. It then speculates on possibilities offered by technologies from a market perspective that does not assume only incremental changes in the education establishment. The study provides a benchmark against which programs can be examined; guidelines for establishing new programs; and another plank in the ongoing discussion about IT in education and society.

1. Introduction

This paper highlights the findings of a study to identify evolving changes in Instructional Technology (IT) practitioner competency requirements, and consequent changes in instructional technology curricula. As used in the North American context, and more specifically within the study, IT means instructional technology. This is defined by [Seels & Richey 1994] as "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning." In Europe, the term information technology is used to cover the corresponding field.

We find that key to achieving a quality, future oriented IT program are:

- a strong program core that focuses on ISD — an iterative process of design, development, implementation and evaluation of instruction and training for development or performance improvement — and encompasses the broad base of competencies within the total field that all students will require as IT practitioners; and,
- a program structure that fosters fullest diversity in the options, including highly specialized instructional technologies, in combination with the breadth of the program core; and, demonstrates timely, responsive and cost effective delivery.

In addition, recognizing the inherent applied nature of the field and the growing requirement to demonstrate continuous professional improvement, we anticipate that the preparation of a professional portfolio, now required in some programs, will become a core program requirement.

2. Methodology and Data

In coming to this conclusion the study employed descriptive-comparative analysis methodology, taking an interpretive approach to existing data on IT role competencies and programs, to identify the key domains of the field and develop a generic masters level program profile reflecting the core competencies of those domains.

2.1 Role Data

Roles for which competency data were reviewed included: instructor/trainer, instructional designer, educational media developer, educational computing specialist and distance educator. Over the past decade extensive national surveys have been carried out to identify practitioner competencies related to a number of these roles. In 1996, the British Employment Occupational Standards Council published standards and qualifications core to training and development roles which “are accepted nationally by all parties having an interest in training and development" [UK EOSC 1996, p. 5]. Canadian data are from 1986 when the Ontario Ministry of Education published the project report for a "review of the literature and field validation of the competencies of industrial and organizational trainers and educators" [Davie et al. 1986, p. 1]. In the U.S., the American Society for Training and Development (ASTD) study of human resources specialists led to identification of 16 core instructional design competencies and standards [IBSTIPI 1986]. Our study utilized the competency data derived from these studies, in conjunction with data from recent studies that have reviewed IT competencies: a) in the context of program content [Morlan & Lu 1993; Dempsey & Rasmussen 1993]; b) on the basis of practitioner surveys [Furst-Bowe 1996; Thach & Murphy 1995]; and, c) on the basis of future needs [Heideman 1991].

2.2 Program Data

Program data were collected to identify how the role competencies might be bundled within graduate courses; the specializations that could be built on these; and benchmark characteristics of quality programs. Initially, North American institutions that have an IT program with a strong reputation for quality or innovation were identified through the literature and WWW presence. Additional criteria for the selection of programs included recent doctoral graduates, and 3 or more full time faculty. This was determined on the basis of the quantitative data available for the 19 selected programs from *Educational Media and Technology Yearbook*, 1985-1997 and *Peterson's Graduate programs in the humanities, arts & social sciences*, 1995-1997

Secondly, descriptive data for the selected programs were gathered, primarily from the Internet. As part of this phase an instructional technology web site was developed which included links to various programs, as well as related background information. Program data were those available as of March 1997 and can be viewed, as updated, at URL http://www.ualberta.ca/~prempel/itfield5.html. The program data were reviewed to identify (a) core and specialization competencies as stated, or as reflected in course descriptions, (b) program entry and exit requirements, and (c) program structure and delivery options.

3. Program Core

Elements from the programs reviewed were utilized to develop a generic program core, with an added emphasis on two aspects that have been identified in the literature as critical — cost-effectiveness and a demonstrated practice of continuous professional improvement. Six program modules encompass the core competencies of the field.

3.1 IT Module 1 - The Field

The proposed program begins with a module that overviews the field as a whole, including definitions, history, relation to cognate fields, current trends and issues. Upon completion of the module students would be able to:

- describe the theoretic base of the field and how it relates to and draws from theories of cognate fields;
- describe how the ISD process relates to reflective teaching and performance technology; and
- discuss trends in research and technologies as they relate to IT practice and options.

3.2 IT Module 2 - Theory of Instructional Design and Development

This module provides a comprehensive overview of instructional theory, including learning and communication, as they relate to instruction, training and performance improvement. It also covers evaluation of instructional products such as CAI for independently meeting identified instructional needs. Upon completion of the module students would be able to:

- identify a range of instructional strategies appropriate to various learning objectives, learner characteristics, and settings;
- identify appropriate instructional materials to explain or present content; provide practice appropriate to the skill being learned; and
- evaluate instructional materials and modules for accuracy of content; against visual and learning design criteria; and for congruency with specified learning objectives, learner characteristics, instructional strategies.

3.3 IT Module 3 - ISD Process

This module covers the design of programs which meet identified learning needs for individuals and groups. Emphasis is on design issues and the selection of options for meeting learner requirements. Students develop individual and/or group projects. Upon completion of the module students would be able to:

- explain the value and application of systems thinking (ISD) in the planning and design of instructional programs and resources;
- explain the importance of evaluation of effectiveness, including cost effectiveness, of instructional sessions, programs and resources;
- explain how the instructional design process is applied in classroom instruction, adult learning settings and business training to improve learning outcomes;
- explain how the instructional design process is applied in classroom instruction, adult learning settings and business training to improve performance through increased transfer of learning; and
- demonstrate a working knowledge of instructional design.

3.4 IT Module 4 - Development

This module introduces students to technologies used for instruction and training and to the entire multimedia production process. The module emphasizes basic skills in instructional media production, quality assurance and group process. Upon completion of the module students would be able to:

- discuss and compare the capabilities and limitations of various instructional technologies;
- discuss the steps in the production process;
- discuss project management methodologies and tools; and
- apply basic skills in instructional media and presentation production

3.5 IT Module 5 - Implementation and Change

This module provides a comprehensive overview of systemic change in education and business enterprises; innovation and adoption practices; implementation analysis and strategies; productivity; cost-effectiveness; and preparation of training or technology implementation plans. Upon completion of the module students would be able to:

- discuss utilization of personal professional development plans to overcome individual resistance and barriers to change;
- discuss utilization of technology plans to overcome systemic resistance and barriers to change;
- discuss the utilization of cost-effectiveness analysis as a basis for selection among instructional delivery alternatives;
- identify human issues associated with the introduction and use of instructional technologies; and
- demonstrate development of a professional development plan.

3.6 IT Module 6 - Analysis and Evaluation

This module provides a comprehensive overview of data collection and analysis techniques, instructional analysis, measurement and evaluation. Topics covered will include: reporting skills; design of assessment situations; simple data summary, analysis and decision techniques including cost-effectiveness and cost-benefit. Upon completion of the course students would be able to:

- discuss utilization of instructional analysis and implementation analysis for planning;
- discuss utilization of evaluation results to monitor and improve learner outcomes, instructor performance and intervention effectiveness;
- develop effective evaluation forms for instructional sessions; and
- analyze various data types using a variety of methodologies.

3.7 Findings

With regard to content, there is a continual and dynamic trade-off between program breadth and depth; success is more art than science. However, these core modules reflect our findings that the broad competencies identified in various practitioner surveys as most important continue to form a relatively stable foundation in quality programs and in IT practice. What we also found are increasing expectations both in program and position pre-requisites that go beyond the computer based skill shift. Educators and educational systems are being deluged by technology marketing hype that is most particularly exemplified by the plethora of software programs, each of which focus on a minuscule portion of the spectrum of knowledge expected of functioning individuals. This marketing hype surrounding software, which relates to process rather than content, tends to become implicit in our judgments and results in a tendency to interpret the focus of an instructional technology curriculum as technologies of instruction. Education, however, is a combination of process and content and, if one looks to IT education as merely being the sum of these little process components, the end result is something that falls short of prevailing educational expectations.

4. Field Domains

On this basis, we identified four domains as core to IT performance — design, development, implementation and evaluation. The proposed common program core would provide a grounding in each of the four field domains within an ISD framework. Our findings do not support inclusion of a 'utilization' domain with demonstration level competencies.

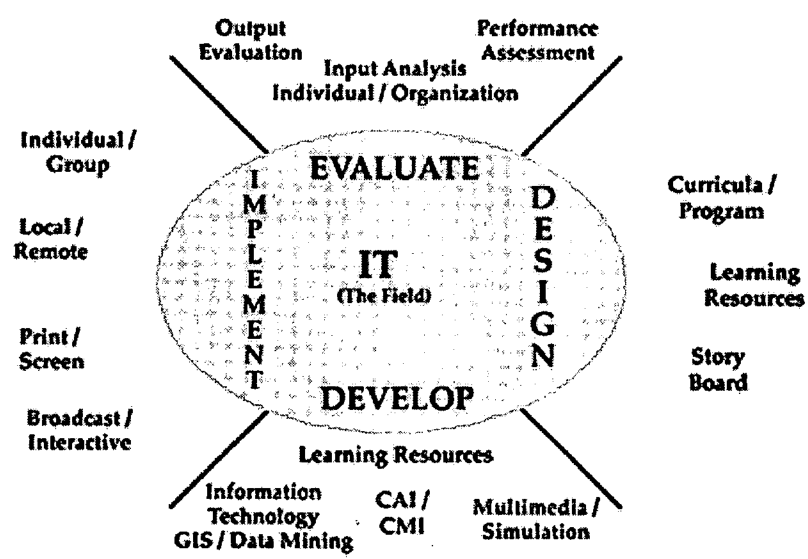

Figure 1: IT field domains and their relationship to potential areas of specialization within the field.

We have maintained an instructional systems approach underlying the inter-relationship of the domains, even though such a broad system approach can result in inflexibility and resistance to change when issues tend to be defined and addressed based on the assumption that, whatever the question, instruction or training is the answer. Furthermore, recognizing that teachers represent a significant program market, it may be critical to program viability to reconcile the current perception wherein North American K-12 teachers generally do not consider the ISD process to be relevant to classroom practice.

Our model is consistent with the programs at Indiana and Florida State. However, adoption of such a program must be tempered by the recognition that the market for IT practitioners is relatively small and is further limited by requiring mastery of all the identified core competencies. The Pennsylvania State program includes a similar core but offers application streams tailored specifically to business and the K-12 environments. A number of IT programs, while offering as options the courses that would encompass the core competencies required by an IT practitioner, maintain a smaller program core that targets a wider market. A major component of that wider market is instructors who do not aspire to be IT professionals but choose to acquire selected IT competencies adjunctive to professional or technical qualifications.

5. Program Structure

Relevance and viability, particularly in the general education market, would appear to mandate a compressed core program supplemented by tailored streams employing active field practitioners as instructors. Such instructors can deliver applied education that bridges content and process in a manner that is timely and cost-effective.

In an applied and dynamic field, the recruitment and use of practitioner-instructors would provide several benefits. Such a coordinated approach maximizes flexibility of organizational competencies at a time when requisite competencies cannot be accurately forecast, as has been ably demonstrated by none other than Bill Gates himself. It minimizes fixed costs, thus allowing effective response to the multiplicity of external demands, opportunities and emerging technologies. It would extend the range of optional course offerings while, at the same time, a strong program core would be maintained by full time faculty.

Quite aside from other tangible benefits, such deliberate and systematic outsourcing would 'freshen' the faculty perception, image and capability to delivery a timely and relevant knowledge/skills package applicable to real world demands and providing an identifiable skill base to potential employers. An obvious spillover would be a greater timeliness of faculty through the new ideas, seminars, topics of conversation, subscriptions and book selections, all of which contribute to faculty attractiveness to the student marketplace.

Collaboration could also extend to inter-institutional programs based on complimentary local expertise. At the same time, we suggest that students would choose optional courses that best fit their own background and specialization goals from one or more of the core domains, but would not be limited to courses within the program. For example, an IT student from the U of A might take the multimedia development component from East Anglia University.

Program delivery alternatives were not examined in this study, although it is clear that such alternatives will be an important factor in program restructuring and cost-effectiveness.

6. So — Are we ready for the 21st century?

We believe that IT programs, such as we have proposed, will be well positioned to respond to the exciting technology and market driven educational possibilities that are on the horizon. At the same time, we acknowledge Tom Peter's caution that, in our global market, excellence today can be irrelevant tomorrow without timely and cost effective responsiveness to market determination of value added.

The future survival of IT programs may well depend on their ability to develop both instructionally sound and commercially viable programs, including programs that could be targeted to specific short term market needs. However, the knowledge and skills required for cost analysis and decision making were conspicuously absent in the program data reviewed for our study. With respect to the programs themselves, market and cost data that will provide a basis for analysis and decision making are critical in determining readiness in light of the current environment of dynamic change.

Changes in three key elements — standardization, communication and transportation — were the basis of market-place globalization and commoditization. The dynamics underlying the changes in the global goods industry in turn initiated enormous change that, in little over a decade, resulted in the obsolescence of hundreds of billions of dollars in assets, skills of hundreds of millions of people, millions of jobs and the organizational structure and management of thousands of global corporations.

Similar factors are now diffusing through the service sector of the global economy with the expectation of similar consequences. Increasingly sophisticated educative software and hardware products, combining text, image and sound are available at rapidly and continuously declining cost. Already the availability of such off-the-shelf, relatively inexpensive, proven multimedia courseware, is reflected in its growing use [see Molenda et al. 1998]. Further on the horizon are integration of the capabilities of the Internet, NT computers, which are projected to overtake the PC market within the next two years, DVDs, megabit modems and products and services developed by those who, having grown up with these media and explored them unencumbered by our pre-dispositions, fully exploit the potential. Implicit demand for lifelong learning is most notably demonstrated by increased online usage among retirees. In addition, the availability of such options is changing attitudes to time and place of schooling and of employee training [see Molenda et al. 1998].

If we are to remain a developmental and shaping force at all, we must embrace the tools; we must understand the technology and how best to employ it; and, most of all, we must aggressively promote our capabilities in our chosen markets.

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Collaborative Technologies as a Catalyst for Changing Teacher Practices

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Abstract: Project Circle explored the use of network-based tools to help change teacher practices toward more student-directed and consturctivist approaches to learning. Through the use of groupware the project developed collaborative knowledge-building communities within two U.S. high schools. The project demonstrated the efficacy of the tools to help foster collaboration within and between classrooms and the use of high school students as technology mentors for teachers.

1. Introduction

Project CIRCLE, a two year project funded by the U.S. Department of Education, explored the use of collaborative technologies as a catalyst for changing teaching practices and development of knowledge-building communities within U. S. high schools. The study involved secondary teachers and students in two high schools, one is a low-income, inner-city high school, and the second, a high income suburban high school. The project was conducted by the University of Texas Learning Technology Center in collaboration with the Austin Independent School District (AISD), and the Eanes Independent School District (EISD). The study explored the use of *Daedalus*, *FirstClass*, and *TeamFocus* as tools to support collaborative learning projects in the partner schools. The project was designed to foster collaboration both within and between classrooms and schools. A virtual learning community between the project schools and university was created using network-based tools for collaborative learning and intellectual work. Through new collaborative technologies students and teachers accessed community-based curriculum materials, on-line mentoring and collaborative learning projects between university and high school students.

The project provided key teachers and administrators basic training and experience using networked software. They worked individually and collaboratively in designing and applying the tools within their content area courses or in collaborative interdisciplinary projects.

The project also involved the training and apprenticing of selected students at each site to serve as "in-house" mentors and technology assistants for their teachers and fellow students. The first-year cadre of teachers and student-mentors at each site served as the core group to assist and mentor teachers in the second year of the project and to help induct more teachers and student-mentors into project activities.

2. Project Focus and Goals

The project was based on a constructivist approach to the learning process. The constructivist model of knowledge emphasizes the active engagement of the learner to construct meanings in all levels of apprehending, comprehending, and processing the information. It also recognizes the importance of the social context as a required catalyst in the learning process.

The constructivist model of learning holds that new knowledge must be built through the socially dynamic and interpersonal interplay of experiences, beliefs, and prior knowledge each individual possesses and shares within a community of collaborative learners. In this model, knowledge is the result of work of the individual to make meaning out of information and to expand individually-held knowledge through the interaction of other learners in the social context of a learning community. The social component of knowledge-building is the catalyst in the process: as an individual makes sense of new information or experience, she or he expresses it to others who actively enter into the knowledge-building dialogue to confirm, modify, question, contradict, or correct shared information. In this collaborative knowledge-building process, all participants are acting independently and collaboratively to make personal and community meaning of new information as different partners find, question, create, share, correct, and argue ideas, concepts and principles.

Based on this orientation, the specific goals of the project were to:

1. *establish a collaborative knowledge-building community of teachers and students in the schools* to explore and model innovative constructivist uses of technology in the classroom. To accomplish this objective interactive networks were established and new telecommunication approaches were used to connect school and university members of the knowledge-building community to each other as well as to other mentors or experts locally, nationally, and internationally.

2. *develop the CIRCLE model training program.* Training programs were developed to introduce and develop initial levels of competency in use of the specific collaborative learning tools. It involved one day training sessions held in the university computer labs as well as on-site training. Training was also provided to students selected to serve as technology mentors to the teachers and fellow students. They received separately the same training in the application of the tools as the teachers.

3. *develop a self-sustaining program of training and technology infusion in the schools*. The study explored ways of sustaining and widening the circle of participating teachers and students in the use and integration of the collaborative technologies. It also explored the impact of the project on the teacher cultures within the schools.

3. Approach and Tools for Collaborative Learning

Project CIRCLE provided computers, modems, and phone lines to the participating schools. The project staff helped the schools configure the computers and, in some instances, helped in networking the computers. During the first year three intensive full-day training sessions were provided at the university for teachers to gain a basic level ofunderstanding and competency in using each of the three collaborative groupware tools. In addition, on-site, one-on-one, and small group trainingwas provided by University project staff. The student mentors received the same training as the teachers. During the week following the training, student mentors helped set up applications for use in class. During the second year, the first year cadre of teachers assumed the leadership role as trainer-mentors for the new participating teachers. All training was provided on-site and no full-day university training sessions were held.

Three major tools were used to support collaborative knowledge-building.

3.1 FirstClass

FirstClass provides an integrated cross-platform collaboration environment with powerful, flexible and intuitive features that supported all members of the knowledge-building community. It tied together participating high school teachers, students, university faculty and students and online mentors using state-of-the-art groupware for both LAN and Internet connections. Students and teachers were able to create and maintain their own individualized resumes and conferencing areas. For example, teachers had their own private conferencing area, *The Circle Bar and Grill,* to share problems and ideas. Teachers and students were able to collaborate with professionals through Internet newsgroups, and socialize through on-line chats. Class discussion conferences were created to support classroom learning projects both within and between the two high schools.

3.2 Daedalus

Daedalus is an integrated cross-platform suite of six programs that encompasses all stages of the writing process, from brainstorming and prewriting to drafting and revising to final production. Daedalus has been developed through years of research and field-testing by English scholars.

The programs include:

- The *Write* program is a simplified word processor which serves all other Daedalus programs. It is suitable for writing papers and is offered as freeware to the students in order to make their work on the system portable.
- The *Invent* program presents the student with heuristic prompts, or questions, to guide their writing.
- *Respond* guides critical reading by asking critiquing questions of a displayed text. Teachers may customize the prompts to fit their own purposes in both *Invent* and *Respond* .
- *Mail* is an E-Mail program specifically designed for use within a class or between many classes.
- *InterChange* is a real-time conferencing program in which an entire class can simultaneously write to a single document. Each student has his/her remark labeled with his/her name, and may reply to specific remarks that appear in the dialogue.

3.2 TeamFocus

TeamFocus is a network-based environment to support collaborative problem-solving, brainstorming, analysis, prioritizing and decision-making. The tool has been used primarily in industry and it was introduced to explore it's values in the science, social science and business curriculum.

4. Project Evaluation Methods

Project evaluation was conducted by an external research team comprised of a university professor and five graduate students from the Department of Education Psychology. The team developed an evaluation model that included both quantitative and qualitative components. Qualitative data included classroom observations, and in-depth teacher and student interviews. Quantitative data included statistical analysis of student responses on the *Student Perception of Collaborative Knowledge-Building* (SPOCK), an instrument designed and validated for the study, and student test scores on state standardized tests of academic skills.

5. Summary of Findings

5.1 The Project CIRCLE Training Model

The results of interviews suggests that university training and on-site training and support were positively received by the teachers. The first year training and support was highly successful but there were problems with the first year teachers serving as trainers and mentors for the teachers joining the project during the second year. A number of the second year teachers expressed their concern about the limited level of technology knowledge and skill they were able to develop through the peer mentors. The interviews and observations also indicated that the second year teachers were less successful than the first year teachers in implementing the technology applications within their classrooms. These trends suggest that the use of co-teachers as trainers and mentors related to innovative new technology tools may require more time and support to be successful. Mentoring and collaboration among the teachers and the use of student mentors as a support system, although useful, was not sufficient to help teachers develop levels of comfort and competency in the use of new technological tools. The general response of teachers indicated the need for more intensive training sessions, similar to those provided in Year 1 of the project.

5.2 Developing Collaborative Learning Communities

Over the two years of the grant, Project CIRCLE demonstrated that, with sufficient time, training and on-site support, teachers could infuse collaborative technologies into their classroom instruction. In addition, the application of the collaborative technologies may begin to transform the teaching-learning process, moving it toward a more collaborative, student-directed learning environment. The shared training, on-line communications, and tools for collaboration also helped foster the development of a knowledge-building community. An important attribute of this community was the honoring of the unique expertise and contributions of each member as well as the recognition that we were all co-learners together.....students, teachers, and university faculty.

Marked differences were observed between first year and second year project teachers in establishing collaborative communities within their classrooms. This suggests that teachers must have time, training, and support to enable them to embrace and adopt new technologies and teaching practices. As teachers became more experienced, they were able to develop higher levels of competency and comfort with the collaborative tools and explore changes in their classroom instruction. Teachers who had less time and support were less effective in integrating the tools into their instruction and experienced more problems in implementation.

Another critical factor in successful development of collaborative learning communities was the limited access to technology experienced by a number of teachers who were interested in participating in the project.

Results of the study indicated that teachers who used the new collaborative technologies to "do things differently" in their classrooms tended to be the most successful. The least successful were teachers who attempted to fit the collaborative technologies into their traditional teacher-directed approach.

In brief, the project results indicate that success in the adoption of the new collaborative technologies requires extensive training and support and easy access to the technology.

5.3 Develop a Self-Sustaining Program

The CIRCLE project explored factors related to the sustainability of the model of training and technology infusion. Sustainability requires both long term support from the school administration and the retention of an active, committed, and respected core cadre of teachers to continue to engage, interest, and support other teachers in the use of the new technological tools. This was evident from the loss of the two inner city high school teachers who were regarded as the project innovators and leaders. Their departure, coupled with a change in the school administration, greatly diminished the momentum and progress achieved in that school during the two years of the project.

Perhaps the greatest barrier to sustainability is teacher time. Teachers are continually overloaded with their regular duties. It was difficult for the teacher-mentors to have the time and flexibility to help provide one-on-one training or classroom assistance to teachers when needed because of their other duties and time constraints. It was also difficult for interested teachers to find time to be mentored or to explore the use of the new collaborative technologies. All these issues must be addressed in order to sustain and expand the implementation of the new collaborative technologies.

5.4 Teacher Utilization and Perceptions of Student Mentors

A key aspect of the CIRCLE model training program was the use of student mentors [students trained in the software] to provide on-going training and support to teachers and other students. Student mentors helped teachers learn the programs and served as in-classroom technical support staff. For example, student mentors would set up Daedalus interchanges, establish and maintain conference areas on the FirstClass system and assist teachers in other technical applications. Teachers felt that the student mentor component of the program was both useful and innovative. They indicated that, unlike themselves, students showed no anxiety about attempting new and challenging technology applications. They would set up the software programs for the teacher, and consequently, the teacher would begin to use them. Over time, the teachers developed deeper levels of understanding and comfort in the use of the collaborative technology.

5.5 Role of Student Mentors

Teachers noted that the student mentors were a valuable and effective technology resource and support system and was superior to more traditional types of teacher training and support. The student mentors were unanimous in their view that the role of student-mentor was rewarding and an effective means of providing technology training and support within their schools. A number of high-risk students serving as mentors indicated that their relationships and status changed positively both with their classroom teachers and their peers because of their role and expertise as a student mentor. When asked what was good about the model, the student mentors indicated that it was more personal than a class and that it helped ease teacher's anxieties about using computers. They also noted that "teaching the teachers" reinforced their own feelings of worth and contribution to the school. Similar to the teachers, the student mentors indicated that it would be helpful to have more time and flexibility to assist teachers when needed. To partially address this need, the inner city high school established a student mentor class that provided in-depth technology training and allowed the students to assist teachers during the class period.

Teachers indicated that another important benefit of the student mentor program was the improved behavior, attitudes, and engagement of the student mentors who had previously been disengaged from the learning process. Teachers in the inner city school noted that all of the student mentors now expressed aspirations for pursuing post-secondary education.

5.6 Effects of the CIRCLE Learning Model on Students' Learning, Performance, Behavior, and Attitudes

The results of the quantitative analyses, using the student perceptions survey, suggests that the intergration of collabrative technologies facilitates students' knowledge building and intentional learning in the classroom. Students in classrooms where CIRCLE software was implemented perceived increased cooperation, question asking, and knowledge building activities. These quantitative findings were supported by teacher comments indicating higher levels of cooperation between students and between themselves and students when they used CIRCLE software. These findings suggest that the CIRCLE learning model was successful in its goal of creating a collaborative, knowledge building community in the classroom. In addition, the study results indicated that, in the inner city high school, students in classes integrating the collaborative technologies had higher standardized test achievement scores than a control group within the same school.

The results also indicate a positive effect on students attitudes and motivation. Teacher responses suggest that implementation of the CIRCLE software improves student motivation, engagement, and attitudes toward learning, particularly among students who are not currently successful or highly motivated in the traditional classroom. Some students who are very successful in traditional teacher-directed classroom settings, however, are not as comfortable with the collaborative learning environment.

6. Conclusions

Results of the two year project indicate that the introduction of new network-based environments and tools for collaborative learning can be an effective means for helping teachers develop more collaborative, student-directed learning environments. The infusion of collaborative technologies, however, must be accompanied by extensive training, on-site support, easy access to the technology, and strong support from the school administration.

Sustainability of the innovative practices is dependent on the retention of a core cadre of teacher-leaders who continue to model and extend the circle of participants. In addition, the findings indicate that the use of teachers as mentors to their fellow teachers may not be effective unless the mentor teachers are provided with adequate release time to take on the added responsibilities and be available to respond to fellow teacher's needs.

The project results suggest that student mentors can serve as an effective technical support system for teachers who are implementing the new technology tools and applications. The role of student mentor may also produce benefits to the students including improved motivation, status, attitudes and post-secondary aspirations. In addition, it appears that "at-risk" students selected as teacher mentors may demonstrate greatly improved relationships with the teachers and increased interest in school and academic work.

Lastly, the study indicates that the creation of collaborative knowledge-building communities within the classroom results in an increase in student engagement, motivation and improved performance on standardized tests of academic skills by inner city high school students.

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A Methodology for Evaluating the Effectiveness of the Use of New Technologies in ODL

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Abstract: Developments in information and communication technologies, particularly those related to computer networks and hypermedia, offer new challenges in Open and Distance Learning (ODL). Evaluation of the effectiveness of the use of innovative technological media in ODL becomes of primary importance. In this paper, we will present a methodology which was used for evaluating the effectiveness of the use of new technologies, i.e. the hypermedia systems and computer networks, in ODL as a complementary delivery vehicle to the conventional mode of instruction. This methodology had been used within a European partnership project called "An Experiment in Open and Distance Learning using New Technologies (EONT)".

1. The context of study

Contemporary educational systems have been criticized as having many drawbacks. In particular, conventional Universities have been denounced for the constraints they impose on time and place of instruction delivery. Open and Distance Learning (ODL) can be used as a means for overcoming these constraints and contributing to the improvement of the state of higher education by complementing the conventional instruction delivery method.

ODL can be implemented with the use of various technologies. Among them, the most promising ones seem to be the computer networks and the hypermedia systems. The reason is that these technologies integrate various media like text, sound, graphics, images, animation and video in a single learning environment. In such an environment the courseware (i.e. a set of digital multimedia learning resources) can be stored in a server computer and accessed by client computers with multimedia capabilities that are connected to the server. This gives, among other things, the advantage of the easy update of the courseware. Furthermore, the interaction between the students and the instructor as well as between the students themselves is possible and easy through the communication facilities of the network.

The effectiveness of ODL implemented by computer networks and multimedia systems can be tested only through experimentation. Such an experiment was in progress within the EONT project [Papaspyrou et al. 1996]. EONT was a partnership project between seven Universities from seven EU countries. The partnership had been formed on the basis of the common interest the partners had in experimenting in ODL using computer networks and hypermedia systems with main objective to assess the effectiveness of this instructional delivery mode as a complementary approach to the traditional one.

In the first year (Dec. 1995-Nov. 1996) of the project, work was concentrated on the development of the required infrastructure, the EONT-ODL system, in order to perform the experiment (course delivery trials through ODL). The EONT-ODL system consisted of two basic components: (a) the learning environment and (b) the courseware. The former is a networked environment in which the courseware is stored in a server computer and the learners access it through client computers that are multimedia computers connected to the server via a computer network [Koutoumanos et al. 1996]. This networked environment is based on the hypermedia system HyperWave [Maurer 1996] which was provided by the Austrian partner who has developed it. It was chosen because it possesses innovative features, such as:

- powerful structuring mechanisms;
- private and public annotations;
- multilinguality;

- gateway to major systems on the Internet

The subjects of the courseware developed were related to the wide area of Informatics since all partner universities specialized in this area. Each partner developed courseware for one course. The courseware was initially developed in the native language of the respective partner (national version).

In the second year (Dec. 1996 - Aug. 1997) of the project, work had been focused on the user trials using the infrastructure created in the previous year (first evaluation round). Each partner delivered one course for which he had developed the national version of the courseware and a common evaluation process of the experiment had been followed. Furthermore, the courseware was translated into English (international version) in order to motivate students from the partner universities (and not only) to follow the courses for which the courseware had been developed. Table 1 shows the EONT project consortium and the courseware that each partner developed.

Partner	Full name of partner Institution	Country	Courseware
ICCS	Institute of Communication and Computer Systems	Greece	An Introduction to Software Engineering
IICM	Institute for Information and Computer Supported Media	Austria	Hypermedia Systems
			Relational Database Systems
KUL	Katholieke Universiteit Leuven	Belgium	Multimedia Modeling and Programming
OU	Open University	Gr. Britain	User Interface Design and Development
SHC	Stord/Haugesund College	Norway	Introduction to Operating Systems
UL	Université Lille 1	France	Elementary Course in Mathematics
FUH	Fern Universität Hagen	Germany	Software Engineering in Distributed Systems

Table 1. Courseware developed by the EONT project consortium

In the third year (Sep. 1997 - Aug. 1998) of the project, work was being conducted (not by all partners) on the delivery of the revised national and the international versions of the courseware, so that students from one country will be able to take courses offered in another country. The project works for the third year continue with the personal initiative and internal financial support of the partners.

2. Stages of the evaluation process

The evaluation methodology presented in this paper and followed in the EONT project, indicates that this process consists of a series of different stages which will guide the evaluators (or educators/trainers) in their choice of methods and tools appropriate at each stage. The stages which comprise the evaluation process are the following:

- Identification of the area of concern
- Theoretical foundation
- Decisions about the methods to be used
- Development of evaluation instruments/tools
- Data collection
- Data analysis and interpetation of results
- Dissemination of findings and policy implications

The sequencing of the stages does not always operate as shown above and the process often enables feedback looping, especially between the first three stages.This section will analyze each stage making references to the EONT project when necessary.

Identification of the area of concern

This stage is the triggering point of the evaluation process in so far as decisions must be taken with respect to what will be evaluated, why and for whom. Within the EONT project, the evaluation study focused on the measurement of the effectiveness of the use of new technologies in ODL. The EONT partners were interested in examining if the use of new technologies in ODL as a complimentary delivery mode to the conventional one was pedagogically effective. Not only that, but their concern was also to identify the main factors that could lead to draw a conclusion about the effectiveness.

Theoretical foundation

The detailed evaluation plan for a courseware will, to a considerable extent, depend on the theoretical approach used. The theoretical approach is also determined by the aims and objectives of the evaluation and in general the rationale for undertaking an evaluation effort. In this evaluation, it has been hypothesized that the "learning effectiveness" would be influenced by a number of independent variables such as:

- design of the learning material: composite variable consisted of eight items;
- learners' preference of mode of study: composite variable consisted of five items;
- learners' previous experience in computers: uni-variable;
- time spent by learners on working through the EONT-ODL environment: uni-variable;

Decisions about the methods to be used

Two are the basic evaluation methods: formative and summative. Evaluation is formative when it is used with the intention of reviewing, supplementing or improving the functioning of components of the courseware. When the intention is to form a judgment or conclusion about the end-product, a summative evaluation method is adopted.
Although it was initially planned in the EONT to perform a common formative evaluation procedure, the project consortium decided not to do it. Instead, each partner's development team used its own methods for testing the course materials and the learning systems during the development phase and proceeded in identifying where improvements should have been made according to their experience and preferences. Nevertheless, internal quality criteria for the learning material had been formed within the EONT project, which had been used as a framework for performing the formative evaluation. The EONT internal quality criteria are the following [Chambers 1995]:

- *criterion of appropriateness*: the courseware is appropriate to the learner body for which it is intented, i.e. expectations, preferences, learning styles, etc.
- *criterion of engagement*: the learners find the courseware and the instruction delivery mode interesting, challenging, easy to follow, etc.
- *criterion of learner performance*: the learners have acquired some knowledge and increased their skills.

Development of evaluation instruments/tools

Observation, interviews with the learners, educators, tutors, etc., questionnaires are the main instruments/tools commonly used in evaluation studies. Within the EONT evaluation study, two kinds of questionnaires had been given to students attended the course.

The first questionnaire was a "pre-test" one, aimed at identifying the expectations of the learners from such an instruction delivery model. This questionnaire was administered during the first days of the course delivery and not later than the first week and it consisted of 12 questions measured by a five-point Likert type scale.

The second questionnaire was a "post-test" consisted of the pre-test questions properly rephrased and a wide number of close-ended and open-ended questions, which reflected the concepts that formed the conceptual approach of the evaluation study. The first part of this questionnaire aimed at eliciting quantitative data and the second part qualitative data. These two sets of data, although the qualitative part played a suplementary role, were necessary in understanding and interpreting the quantitative outcomes [Makrakis 1997]. The open-ended questions concerned with issues related to preferences and the dislikes of the learners concerning the course content, the design of the learning material, the mode of instructional delivery and their suggestions for improving the system and the courseware. The "post-test" questionnaire can be found in [EONT 1997]).

All the composite variables developed of multiple items, each measuring a slightly different aspect of the main variable, were first scrutinized for 'face validity' and in the sequence each composite variable was subjected to a Cronbach's Alpha reliability analysis for internal consistency. To arrive at the final composite measurement indexes, every item which substantially lowered the Alpha coefficient was omitted and a new analysis was conducted in order to arrive at an index which had the highest possible reliability measure. The reliability tests revealed that the three composite variables developed, that is «effectiveness», «design of course material» and «preferred mode of study» reached ALPHA coefficients of 0.93, 0.82 and 0.81, respectively.

Data Collection

Experience from practice shows that there is a high possibility in collecting less amount of data than expected. The reason is that learners are not keen on filling in questionnaires. Learners need a lot of pressure and high degree of motivation in order that the goals of this stage are to be accomplished. The EONT project was not the exception from the rule and the amount of the collected data were not the expected ones. Only one institute, the ICCS, managed to get a significant high number of "post-test" questionnaires with a 90 percent response rate. However, the returned "pre-test" questionnaires fell ultimately short to the expectations of the consortium.

Data analysis

The analysis of the structured part of the questionnaire was based on univariate and multivariate statistical analysis and the open-ended part on qualitative content analysis, employing the constant comparative method of analyzing qualitative data [Lincoln & Guba 1985, Maykut and Morehouse, 1994]. This method started with an inductive category coding and simultaneous comparing of units of meaning across categories identified in the text of open-ended questions. A refinement of categories followed which led to the exploration of patterns and relationshipa across categories.

Dissemination of findings and policy implications

The target group of the dissemination of findings is those primarily concerned with the design and development of the system and courseware. Other target groups less close to the evaluation study might also be interested in it is of primary importance to disseminate the findings as much as possible.
Moreover, the findings should not only be disseminated but seriously taken into consideration especially in cases when the study has shown that certain changes need to be made in the area of concern. As far as the EONT evaluation study is concerned, the findings were distributed among the key interested people, i.e. the EONT partners and the Socrates ODL committee. Furthermore, each partner used the findings and the lessons learned in his own way in order to improve the instruction delivery mode based on the new technologies and review/supplement some of the issues that the learners have identified. More details about the EONT evaluation results can be found in [EONT 1997, Makrakis et al. 1998].

Concluding remarks

The convergence of new information and communication technologies as well as the pervasiveness of the computer networks and hypermedia systems– the Internet and the World Wide Web in particular– have great potential for transforming ODL to meet the contemporary needs of the learners and educators. Evaluation of the various experimental efforts in using new technologies in ODL need to be made in order to reach a tentative or firm conclusion about the learning effectiveness of such efforts.

However, evaluation must not be ad hoc. Methodological approaches suitable for the specific area of concern are needed [Garzoto et al. 1995]. In this paper, an evaluation methodology was presented which was followed in the EONT European partnership project. The main advantage of this methodology is that the evaluation process was divided into manageable stages, each one with clear objectives, inputs and outputs.

Nevertheless, a number of lessons learned while the evaluation process following this methodology.

1. Things did not always go as planned. For example, the formative methods were performed individually (though a general framework had been designed) and the questionnaire response rates for most institutions were low. There is a need to identify the reasons for not answering and find solutions for increasing the rate of return. Unfortunately, there is no "silver bullet" or "rule of thumb" for persuading learners to participate in the evaluation process.
2. The evaluation process should focus more on the design of the learning material. Learners should have been observed while using of navigational aids, metaphors, etc. of the learning material because the design and the interface can actually hinder learning and undermine the learning effectiveness.

Concluding, the evaluation methodology was going to be further evolved during the life cycle of the EONT project which was initially three years. A second evaluation round adjusted to the findings from the first round and modified according to the lessons learned was intended to be performed. However, due to the reject of the renewal application for a third year funding, both the project's evaluation findings fell short to the initial expectation of the project consortium and the evaluation methodology will be evolved within future projects.

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CLEW a Cooperative Learning Environment for the Web

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Abstract: This paper outlines CLEW a collaborative learning environment for the Web. The project combines MUD, workflow, VRML and educational concepts like Constructivism in a learning environment, where students actively participate in the learning process. The MUD shapes the environment structure. The workflow system allows the execution and coordination of the course activities. The VRML establishes the presentation format of the courses' virtual worlds. Finally, the educational concepts influence the way the didactic material is published.

1. Introduction

CLEW (the thread used by Theseus as a guide out of the Labyrinth) combines the presentational format of the VRML with the MUD's interaction style and the coordination mechanism associated to workflow management systems. The objective of CLEW is to create a cooperative platform of structured courses. Constructivism, learning metaphors and immersion shape the educational basis of the project.

The structure of CLEW follows the main aspects of a MUD, which is to divide the environment into regions. A MUD is an environment based on the interaction between its participants, providing access to a shared database of rooms, other objects and exits [Pavel and Nichols, 1993], thus creating a kind of virtual world [Busey, 1995]. Virtual worlds supporting multiple users give rise to a virtual community [Hughes and Moshell, 1997] which can provide the settings for productive, remote cooperative work [Rheingold, 1994].

The interactive aspects of a MUD allow the creation of a powerful collaborative environment; however, it lacks coordination. CLEW uses the characteristics of workflow to provide a way of coordinating this loose environment. As defined in [Casati, Ceri, Pernici and Pozzi, 1995], a workflow is a set of activities evolving the coordinated execution of multiple tasks. A workflow management system (WFMS) is a system that completely defines, manages and executes workflow [Hollingsworth, 1995]. The CLEW environment uses the presentation format of the VRML, allowing its users to navigate through a graphical virtual world. So the users can construct their knowledge by actively interacting with the graphical environment objects.

1.1 Related Work

Some other systems bear similarities to CLEW. The coMentor [Gibbs and Henry, 1996] is a multi-user learning environment for part-time students on theoretical social science or humanities modules, developed at Hudersfield University. The coMentor is a visual MUD on the WWW, structured in rooms. Besides these rooms, a student can access information repositories that contain previous discussion data. The coMentor does not have mechanisms to support the generation of courses and student evaluations.

Another MUD environment on the Web is the Athena - Virtual Online University (VOU) [Duckett et al., 1995]. In VOU, participants can interact simultaneously, carrying out discussions, mediated by instructors, about the study topics. Again, mechanisms to support the generation of courses and student evaluations are not provided.

ExploreNet [Hughes and Moshell, 1997] is a graphic environment used to create virtual worlds in which learners and mentors can interact. Players interact in a virtual world via their animated alter egos, called "avatars". ExploreNet uses the concepts of immersion to elaborate a course.

1.2 Outline

The paper is organized as follows. The next section discusses the educational background that guides the environment. Section 3 presents the main elements that compose CLEW. Section 4 describes the system architecture. Section 5 comments on the environment structure, describing learner participation and the services available. The last section concludes this work.

2. Educational Background

The educational theory used in CLEW is Constructivism [Bruner, Goodnow and Austin, 1956]. Through this approach, the learning process becomes more effective since the knowledge is actively built [Sherman, 1991]. In constructivism control of the learning process is shifted to the students, [Henderson, 1986; Garner, 1992]. As stated in [Salomon, 1992], the computer has an important role in the transformation of the learning process from a simple assimilation [Piaget, 1950] to an active process.

Immersion and learning metaphors complement the constructivist ideas used in CLEW. Learners needed to be engaged deeply enough to feel they are part of the environment both physically and psychologically [Low, Venkataraman and Srivatsan, 1994; Laurel, 1991]. As stated in [Wynn, 1996], situated cognition gives learning a context similar to that of the real world, providing authenticity to learning. This makes learning an exciting task. Taking advantage of the motivation induced by immersion, learning metaphors shape the semantics of learning subjects, suggesting a comparison between the system characteristics and the experiences of the real world. As stressed in [Davis and Bell, 1995], it is important to create learning models that get close to the students' reality, so that they can better assimilate a new concept.

3. The Environment Components

3.1 Participant

A participant is a player in the environment who is identified by a name and his avatar. An avatar is the element that represents a user in a virtual world. Avatars communicate with each other to engage in cooperative missions. Each mission has a pedagogical semantics specially designed to present a specific learning material. A participant also has a memory that is able to store the information he considers relevant. This memory could be shared with other participants, allowing the creation of a group memory.

The participants are categorized in types. Each type defines how a participant interacts with the environment, assigning him functions and privileges. The learner uses the environment as a consumer, participating in courses. The administrator manages the environment, accomplishing the activities related to the course, region and object supervision and maintenance. Professors are responsible for the didactic part of a course. Since a professor has several specific tasks, this type is subdivided into:

a. designer: he designs the course structure through the specification of its workflow. He is able to create, modify and remove regions and objects from the environment, allowing the adaptation of these elements to the course needs;

b. author: he is able to elaborate and insert the didactic contents of a course, which was previously structured by a designer;

c. evaluator: he works on the questions, tests and challenges that evaluate a learner during a course;

d. instructor. An instructor directly interacts with the learners during a course, helping with the participants' doubts.

3.2 Region

A region is an area without a severe border that groups participants and objects. The creation of regions may follow a learning metaphor to provide the participants' engagement with the learning activities. For example, in a course intended to teach the basic mechanisms of chained lists, a region could be configured to give the idea that a participant is travelling through the cells of a list.

These regions offer a structured way of expansion. Each new region is connected to the others, increasing the environment dimensions and its richness of metaphors. VRML files are used to generate the regions' 3D interface. The environment provides a main region where a participant has access to information regarding courses and enrollment procedures.

A region contains different objects and metaphors depending upon the course in which it is being used. Vision of a region is a set of properties that define its semantics in a specific situation. The creation of several visions of a region allows the designers to reuse the same set of regions.

A vision of a region has a memory. This memory lets the participant leave some information telling the other participants about his experiences in this region. This facility assists the collaboration between the participants and may stimulate the interest of each one in exploring the environment. This approach does not force the cooperation, letting the participant choose if he wants to cooperate or not.

3.3 Object

Interaction between participants and the environment is carried out through the objects. The objects are elements similar to those found in the real world; however, in CLEW, these objects have specific properties to provide didactic information. The objects are created using VRML files. There are two types of objects in the environment: local and shared objects.

Local objects are instantiated for each participant's interface. If a participant acts on a local object, the other participants in the same region cannot see the result of his action. If this object were shared, all the other participants would be aware of its changes. The shared objects have one instance for all the course participant interfaces.

Like the regions, objects can also have different semantics according to the course they are in. For example, a Greek geographical map could represent a map of present day Greece or of Ancient Greece. Visions of the same object increase the flexibility of CLEW, allowing its reuse in different courses.

4. System Architecture

The architecture consists of six layers: the presentation layer, the application layer, the management and control layer, the adaptation layer, the external services layer and the data layer [Fig. 1].

The Presentation Layer comprises the interface modules customized for each existing participant type. It groups the available services according to the participant's function.

The Application Layer includes the modules concerned with the creation and maintenance of the courses and with the administrative tasks. This layer provides the functions that the participants use to create objets and regions and to perform the course maintenance.

The Management and Control Layer groups the environment servers. These servers control all the functions related to the environment simulations.

The Adaptation Layer consists of the communication interfaces between the environment and all the external services.

The External Services Layer embraces the tools that the environment uses to control the sequence of the course's activities and to create and correct the students' assessment.

The databases needed to uphold the environment structure, supporting the use and integration of the available services constitute the Data Layer. This layer also comprises the VRML files that presents the environment objects and regions of CLEW.

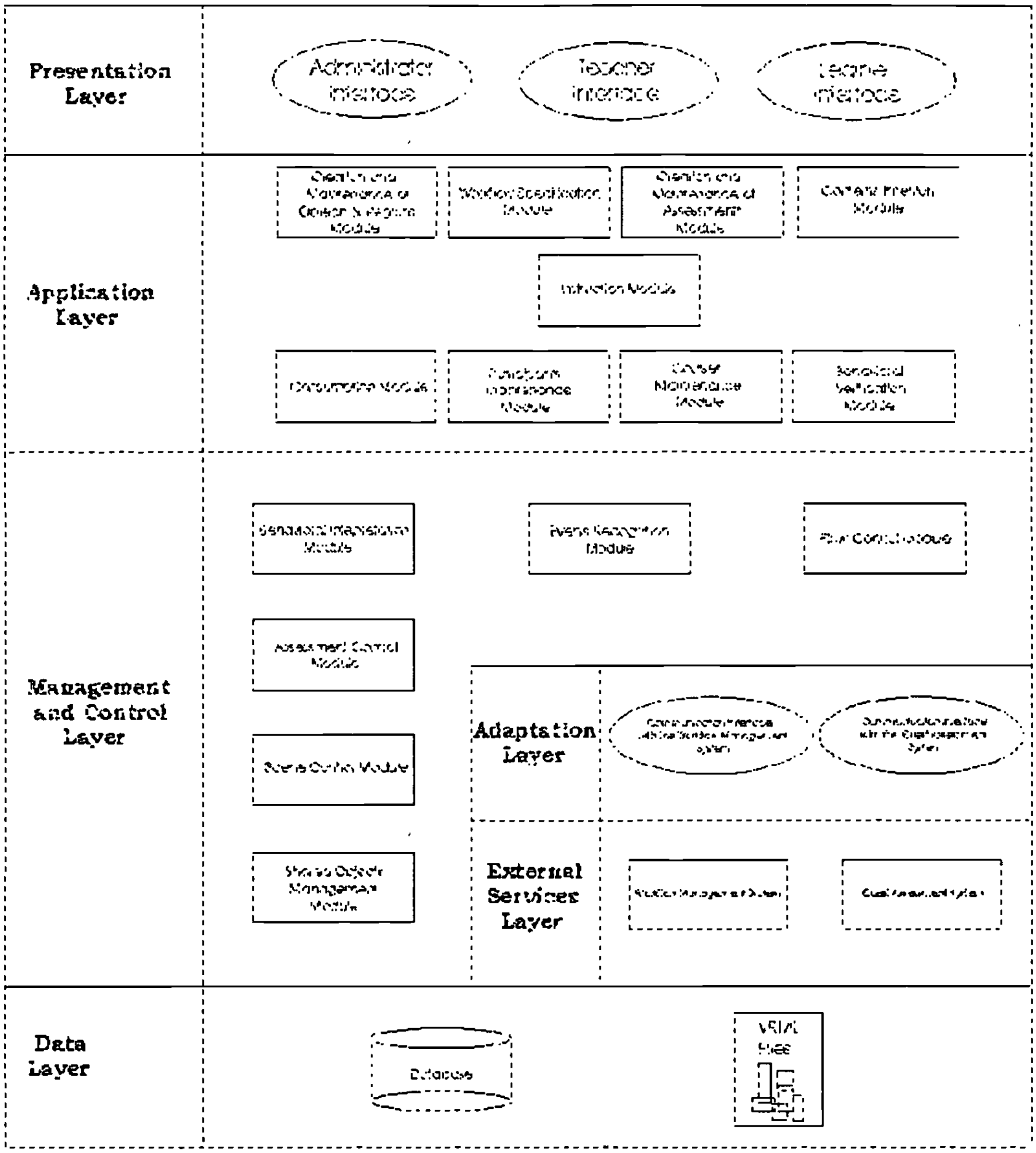

Figure 1: The System's Architecture

5. Course Development

The regions and integration between the participants and the objects that are inside them define the activities that will be carried out in a course. These activities compose a workflow that should be enacted by a participant.

5.1 Structuring a Course

The first task in a course elaboration is to create the regions and objects it uses. This can be done by a modeling tool provided by the environment. The second step is the definition of the course workflow process. This includes information about its starting and completion conditions, constituent activities and rules for navigating between them.

The starting conditions of a course are usually related to administrative information such as enrollment or attendance to a pre-requisite course. The completion ones depend upon the participant performance computed by the indexes previously described.

The activities and the rules for navigating between them make the instructional sequence of a course. To define an activity means to build part of the virtual world since an activity happens in one or more regions. The designer may use a learning metaphor and create or reuse regions, inserting or configuring the necessary objects. An activity consists of three parts: the pre-activity conditions, the actions and the post-activity conditions. The pre-activity conditions indicate a set of attributes a participant must have to be able to start the activity. The pre-activity conditions of the first activity form the starting conditions of a course. The actions define the interaction rules between a participant and the elements of a virtual world; that is, they define the tasks to be performed. Some examples of actions would be to catch an object, to talk to another participant, to answer a question posed by an active object, etc. The post-activity conditions consist of a set of attributes a participant shall obtain after he completes the actions of the activity. The post-activity conditions of the last activity are the completion conditions of the process, pointing the end of a course.

5.2 The Participant's Perspective

A course appears to a participant as a journey in a virtual world specially built to learn about a subject. To construct their knowledge, participants should complete the tasks described in the course activities. Those activities should convey engagement as a challenge or a game, to catch the learners' attention.

Let us see an example of a course on data structure. One activity would be to learn search algorithms in sequential lists. An audio tape could be used as a metaphor to represent a sequential list. There could be an active object that would ask a participant or a group of participants to look for some specific song in the tape. In order to "win the game", the participants would have to learn the search algorithms.

Another important aspect of a course is the evaluations. The evaluations should be elaborated to keep the motion of the play; thus they can not only be simple tests as a final exam. It is interesting that evaluations indicate the progress of participants as does the score of a player in a game. To offer this way of evaluating, some defiance questions may appear during the completion of the tasks, looking like obstacles in a game. This "show me what you know as you go" approach [Wiggins, 1997] provides more didactic resources to professors, and is more stimulating than only using more conventional examinations which can sometimes be boring.

6. Conclusion

The creation of learning environments that renders learning more active is initiating new challenges for research on learning [Barfurth, 1995]. The first prototype of the proposed environment is now under construction and clearly, it will need further development to be able to become a really useful learning framework.

Although the environment is still at an early stage, some other aspects may be considered such as: free navigation, to provide a way for a participant to use the environment without being enrolled in a course; co-authoring tools, to help the different types of professor coordinate their activities while constructing a course; and distributed VRML objects, to allow the insertion of objects at run-time in a region scene.

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Write Once, Publish Many : Multimodal Courseware Development

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Abstract: Edith Cowan University is developing interactive WWW courseware which offers flexible, integrated delivery to both internal, external and mixed mode students. Content units are developed using a template which readily translates to a variety of publishing mediums including print, WWW, Acrobat and CD-ROM. The notion of 'Write Once, Publish Many' is being used to streamline unit development and to allow for regular updates to unit content. Units mounted on the WWW and on CD-ROM are enhanced by the inclusion of interactive multimedia techniques and are supported with a variety of computer mediated communications methods. In this paper, the process is described and experiences from the first pass through the process are related.

Introduction

Edith Cowan University (ECU) is one of the larger universities in Australia with some 20,000 students. Of these students, approximately 4000 study in external or off campus mode making ECU the seventh largest university provider of distance education in Australia. In addition to this, approximately 900 students study in mixed mode with some units taken on campus and some off campus. Most of these external students undertake courses off-campus due to geographic isolation however an increasing number are undertaking off-campus study due to personal circumstances including: employment, family commitments, international students returning home and also preferred learning styles. As personal circumstances can change unexpectedly, the university is designing its learning materials to be equally flexible to ensure that any transition between on and off-campus modes of study is undertaken with minimal disruption to course progress.

The Way We Were

Distance education at ECU has its roots in the correspondence system of the past. Traditionally, it has centred around some form of printed study material and written communications between the student and university tutors and administration. For many years, printed and written correspondence by mail was the only mode of delivery utilised. However, with recent technological advancements, this has since developed into a comprehensive range of academic and administrative support services. Students who previously needed to write a letter or make a telephone call can now perform many administrative functions interactively via computer-based telecommunications giving faster turn around time on queries and changes.

Study materials have also changed and today often incorporate a variety of media including audio and video tapes, personal computer floppy disks and compact disks (CDs). At ECU, these technologies have been integrated into the teaching of a number of external courses. For example, several courses use a program of on-line tutorials which enable students and tutors to engage in meaningful "conversation" electronically while others courses are using listservs and web-boards to facilitate ongoing debate of issues and to encourage participation in group activities. However, despite the increasing availability of multimedia, print still seems to be the medium most widely utilised for distance education packages at ECU and at other institutions [Kember 1995].

The Need for Flexible Delivery and Development

The development of distance education programmes in Australian universities over the last 25 years has largely been in response to the growing demand for places in higher education. Where as, historically, distance education students were those living in rural and isolated communities, an increasing number of students today complete part of their course on-campus and the remainder off-campus as an external student. There are also international students who enrol externally to be able to complete an Australian degree without the associated expense of living away from home. In addition to the traditional undergraduate courses, an increasing number of post-graduate courses are being offered to meet the needs of busy professionals who are not able to attend regular classes. Many of the students in these courses live in SE Asia.

At ECU there is an equivalence of content between subjects taught face-to-face and those taught from a distance and often the same tutor is responsible for both modes of learning. There is no distinction on the student's parchment to indicate whether they came on-campus or whether they completed their award externally.

ECU has developed its own Virtual Campus which provides an extensive range of services which allow users to have the electronic equivalent of on-campus facilities. Users can now interact with ECU from anywhere in Australia, Southeast Asia and beyond. This allows for delivery of learning materials, access to computer mediated communication support such as email, bulletin boards and internet chat, and generally provides students with increased flexibility in choosing how, where and when to learn.

In times of constant change, particularly in technology related fields, it is essential that course content is updated on a regular basis to maintain its 'leading edge' focus. In some courses offered at ECU, for example computer security, multimedia and information engineering, material needs to be constantly monitored as new developments and latest technologies and methods are released. Published course materials, particularly in bound book form, can lag behind current developments due to inherent time delays between authoring, production and delivery to students. In order to be responsive to student-client needs and to keep materials current in all delivery modes it is essential to have a flexible, efficient and effective method of course development and delivery.

Student Access to Technologies

An increasing number of households within Australia now possess computers with multimedia capabilities, and it is anticipated that in the next year or two a much higher proportion of students will have the equipment and the skills to communicate with the university electronically. The Australian Bureau of Statistics reported that in February 1996, 30% of all Australian homes used a computer. Surveys conducted at ECU in recent years report that 82% of internal students have access to a computer at home [Oliver 1997] and that 79% of external students had access to a computer with 80% of these having access at home [Ring & Omari 1996].

In addition, teaching materials for a growing number of courses world-wide are now available on-line (WWW) or off-line through the use of CD-ROM, cable TV and video. It is therefore expected that in the near future most students will access learning materials using modern methods of tele-communication.

Although the numbers with access to technology are growing, some students still have little or no access. To enable all students to continue their studies it will be necessary in the next few years to provide a dual system in many courses. This will allow some students a choice of whether or not to access information electronically, while others will have no choice but to continue to receive their materials in the traditional print format. However, care must be taken not to educationally disadvantage those students who do not have access in this transition period.

The Importance of the Content-Expert Author

The most important part of courseware development is the quality of the content and this is determined by the quality of the authors. Good authors are usually academics or industry specialists who are experts in their field. They know their field intimately and are experienced in writing and teaching in the discipline. They are also the most expensive part of the courseware production cycle. Their time is valuable and often limited. To have an author prepare one set of materials for print, another for WWW and yet another for CD-ROM is prohibitively expensive.

An additional problem is that most authors are not experts in Web authoring or multimedia development and concern about the perceived need to become experts in WWW and multimedia development has caused some potential authors to avoid involvement in multimodal courseware development. The loss of their valuable input into the courseware development process must be minimised through the use of a methodology that allows them content input but does not require them to have multimodal expertise. It is a waste of valuable time to have content experts grappling with technologies such as Web authoring or multimedia development when this could be handled far more cost efficiently by a technical person.

Write Once, Publish Many

The main aim of the Write Once Publish Many methodology is that authors only have to do what they do best - write about their subject. The written materials are then published in a variety of mediums for delivery to students. Currently the delivery mediums supported at ECU are: print-based for students without access to computer technology; WWW or 'on-line delivery' and CD-ROM or 'off-line delivery'.

Authors write the content once into a prepared word-processing template, using prescribed styles. The final document is printed as photo-ready material for paper-based delivery. An electronic version of the document is handed to technical team members who pass it through a conversion process to produce Web documents. The web documents then form the basis of the CD-ROM version of the courseware.

The master copy of the courseware is the word processed version. As time passes and evaluations of the running courseware indicate that revisions and updates are required, the process begins again with the author working at the word processor. The revised document then passes through the other stages to emerge as revised versions of the original multimodal courseware. The cycle with its four developmental stages is represented graphically below [Fig. 1].

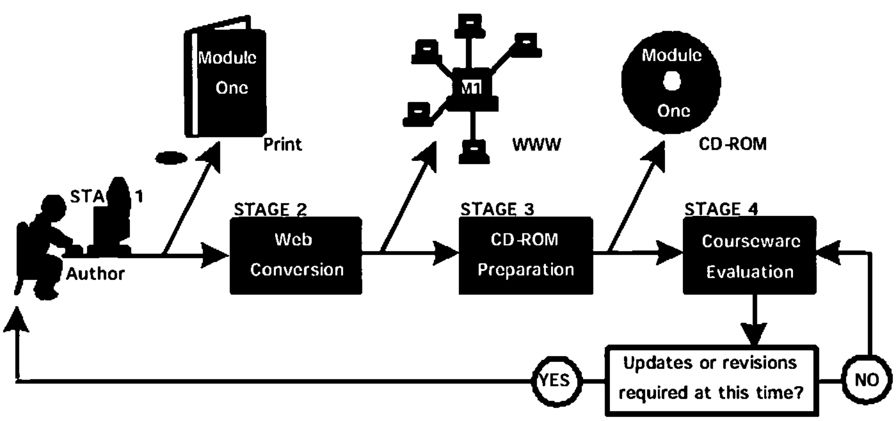

Figure 1: The Four Stage Multimodal Courseware Development Cycle.

The integrity of the content is maintained by having a single content entry point. Support materials may differ according to mode. For example, the CD-ROM version may contain interactive multimedia examples while the print version may be supplemented by video tapes that allow students to 'walk-through' an interactive experience.

Multimodal Courseware Development Team

An efficient methodology needs to be cost effective and provide timely delivery in a variety of modes. To do this, the methodology must minimise the number of steps between authoring and production. It needs to divide up tasks and apportion them to appropriate personnel within a multimodal courseware development team.
The team assembled by ECU in the School of Computer, Information and Mathematical Sciences (SCIMS) consists of the following personnel:

- Team Manager: overall coordinator of the project. The manager is responsible for timelines, budgets and all administrative matters.
- Instructional Designer: works with authors and other development team members to ensure that the courseware materials are educationally and instructionally sound.
- Authors: academics or other content experts with expertise in the content area, often working in teams. They write the content and design other supporting materials.
- Library Technician: responsible for copyright clearances, referencing and location of additional reference and support materials.
- Web Programmer: converts material into WWW format, creates and tests links, builds additional pages such as content indexes and course organisers.
- Multimedia Programmer: develops interactive animations and interactions, converts them to Shockwave for WWW delivery, responsible for the preparation and production of CD-ROM masters
- Graphics Designer: creation of original graphics for print and electronic delivery.

The team also has access to ECU's Media Production Unit who create digitised video clips and prepare them for inclusion in online courseware, mounting on CD-ROM and outputting to video tapes.

The Flexible Development Process

The flexible development process has four major stages and these are outlined below along with comments related to our first pass through the process.

Stage One: Preparation of Content Materials

In this stage, the author writes the text directly into the prepared word processing template, designs tutorial and workshop exercises and locates relevant references and supporting resources. Authors are encouraged to use full colour illustrations and diagrams in their documents.
The instructional designer works closely with the author to provide the best possible instructional framework for the courseware. The author and the instructional designer work together to design interactive multimedia modules to complement the text-based instruction while the library technician is active gathering copyright clearances and locating additional resources and reference materials.
At the end of Stage One, the courseware is printed off as camera ready originals for print based materials. In addition, original multimedia and graphical materials have been designed for use in Stages 2 and 3.

Stage Two: Production of WWW Version

The web programmer passes the word processed document through the web conversion process. The process uses a 'black-box' program which takes the original file and generates a full web site with the contents broken down into navigable sections and any illustrations converted to web file format. Each web page is automatically given headers and footers that identify the unit and the place of the current page in the content. An email link to the tutor is added to each page and any URLs embedded in the content become live.
The web materials are then edited to incorporate any interactive applets, digital video clips or animations previously designed by the author and instructional designer. Master menus and links to other modules and units within the course are developed, pdf versions of content are added for download, and the whole structure is tested for functionality and correctness.
In addition to the content modules, the process adds other interactive components to the home page of each unit in the course. These include a web-based notice board, a link which dynamically creates an IRC session or

Chat Room for the unit and links to resources needed to use the site. A listserv is also created for the unit but not as part of the automatic process. The content area is passworded to protect intellectual property however a public area, usually with sample modules, is left open.

Problems Associated with Stages One and Two

The problems in the first pass were mainly related to time, delays with copyright clearances, and some template and word processing problems. The authoring of quality instructional material is a time consuming task and most of the authors underestimated the time it would take to complete content modules and the associated independent learning activities. This lead to panic as the print-copy deadlines, driven by the need to get materials into the large external studies print queue, approached. By comparison the conversion to web form took only minutes. Most web conversions were trouble free with the notable exception of two cataloguing units that required detailed pictures of book covers, title and verso pages. The need to reproduce images of essentially textual information proved to be troublesome and held up web production until suitable image techniques could be devised.

The word processing template presented no problems for those authors accustomed to using styles. The commonest error was to forget to set the unit code in the header, an error usually discovered on final print out. However, those who's knowledge of word processing was more of the electronic typewriter variety needed instruction in style use. If the styles were applied correctly, the web conversion process was trouble free. However, some authors refused to give up their word processor of choice or to adapt to new word processing techniques. Their documents were camera ready so could be placed in the print queue but the web conversion of their documents was held up. A support person was required to go through and clean up the document to prepare it for conversion. In most cases the clean up took several hours however one document filled with tabs and line-feeds took several days.

Copyright clearances were ruthlessly followed up by the Library Technician who maintained a database of all requests and replies. Replies ranged from good natured authors who offered to update their work first before letting us use it copyright clear in all mediums, through those who gave limited permission based on medium and/or time to those who wanted huge sums of money and charged by the word. Where clearances were denied or considered too costly to pursue, the Library Technician then sought alternatives. In most units, some articles could only be distributed in a paper based reader as covered by the standard 'fair dealing' copyright laws. As full paper mode had to be supported this did not prove to be a problem however in future years, it may be that articles not cleared for electronic reproduction cannot be included in the course materials.

The development of enhancements such as digital video and animations has lagged behind the conversion of the text-based content. These elements take longer to produce and require specialist staff and equipment. The production unit in its current form has not been to handle the sudden increase in demand and a priority queue has been established to bring units up to full digitally enhanced mode. Plans are now in hand to expand the size of the media production unit.

Stage Three: CD-ROM Production

The programmer edits the web materials so that links to sites for which copy permission has not been obtained are returned to URL reference only. Electronic versions of copy cleared materials are gathered together and linked to the existing structure. The multimedia programmer prepares a CD-ROM master that contains the altered web materials plus additional interactive multimedia activities, sample programs and other electronic materials. The CD-ROM version is then checked to ensure that content and instructional integrity have been retained before copies are made.

The CD-ROM version is essentially an enhanced local web site with added resources. Students can browse the site at their leisure without the overheads of connection costs. However, if they require access to materials other than those on the CD-ROM, or if they wish to join an online tutorial, then they need to go online.

In the first pass of the process, only two units reached this stage; a multimedia unit and an information technology unit. Write-many, multiple format CDs were used and the process proved to be trouble free.

Stage Four: Evaluation and Revision

Formative evaluation takes place in each of the first three stages. Authoring is often done in teams or groups where several authors are working in related content areas, possibly on different units within a course. Authors are encouraged to critically evaluate each other's work to ensure the overall consistency and quality of the courseware. The instructional designer is also active in the early stages, working with authors and evaluating materials as they are in progress.

Stages Two and Three involve user testing of the courseware environments to ensure that students will be able to navigate through the content modules and that they will be able to successfully complete set interactions. Internal students have proved to be very helpful in this activity. Units are developed a semester or two ahead of delivery to off-campus students and as content and resources are developed they are made available to internal students in the same unit or course. The internal students work with the materials and offer constructive feedback on methods, content coverage and resources provided.

Summative evaluation takes place at the completion of each semester. Student feedback is gathered and collated with the aim of improving the courseware for the following semester. Student achievement is being reviewed to find out if the courseware is achieving its intended aims and objectives. At the time of writing, no summative evaluations are available. However, a detailed evaluation of the multimedia unit that passed through the process is currently being carried out [Ring, Jadav & Pagram 1997].

Revisions are normally made at the end of each semester to update content for the next run. Interim updates, revisions or errata information are made available to students as necessary in a form suited to their mode. Print-based and off-line students receive a mail-out while on-line students have the same material placed on the web. The next developmental cycle would then incorporate the new material into the courseware.

Document and version control is a particularly important aspect of the review and re-publish cycle, particularly where units are offered in a variety of mediums and modes. Several alternative systems and approaches are currently being investigated.

The Way Forward at ECU

In 1997, SCIMS at ECU mounted the first 30 units in full multimodal format, 15 in semester one and another 15 in semester two. These are drawn from courses in Multimedia, Teacher Librarianship, Library Technology, Computer Science, Computer Security, Mathematics, and Communications and Information Science. In the first semester of 1998, 98 units were available online. The majority of these are in the first stage of the process and do not yet have extensive media enhancements.

Over the next three years, further development will be undertaken so that all courses in SCIMS will be available in multimodal format. This initiative is in line with ECU's strategic planning directive which aims to have the majority of its courses available via flexible delivery through the ECU Virtual Campus by the year 2002.

The Multimodal Courseware Development initiative will assist academics in the preparation of flexible delivery materials and therefore provide students with the flexibility to study on or off campus, within or outside of Australia using their own choice of medium with the confidence that they are gaining the same quality education and support as any other student in the course.

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Distance Learning with a Difference: Using the Internet to Deliver Higher Education

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Abstract: This paper reviews the development and delivery of a higher education module as part of the University of Plymouth's Integrated Masters Programme (IMP) through the Rural Area Training and Information Opportunities (RATIO) telematic centres. The aim of the project was to provide computer supported solutions that could assist remote learners living in the South West of England to access higher education as part of a technology assisted distance education programme. The module represented a shift from traditional educational delivery systems with the use of Internet web site pages, email and videoconferencing in its delivery. Out of the 16 participants who enrolled in the Masters module, four completed the learning sessions and 2 submitted final assignments. The mainly positive experiences of the remote tutor and the students in such an initiative and the implications for the use of the Internet for distance education are discussed.

The key purpose of this project was to take advantage of the opportunities offered by the Rural Area Training and Information Opportunities (RATIO) initiative to create an experimental web site through which to offer a Masters degree module. Because it was considered that students who were interested in information technology might be attracted to such a format, it was decided to develop a module with high information technology (IT) content entitled 'IT for Personal Development and Project Management' into appropriate telematic course ware, capable of both dissemination and assessment through interactive student participation using the facilities at selected sites. Careful development of both a telematics quality policy and model needed to be identified in order to meet the underpinning academic task criteria for all Masters modules. These tasks require learning opportunities to enable learners to develop academic skills covering the following five assessment areas: critical review of a body of knowledge, data collection and analysis, developing practice through a project, reflecting on practice and making an argument. All of these areas are underpinned by deep criteria where the learner is expected to demonstrate abilities covering personal skills which involve research and investigation, organisation and preparation, appropriateness of medium and process, practical competence, coherence, legibility, inventiveness and independence of thought, understanding of relevant historical, critical and cultural contexts and critical evaluation. The challenge of this project was to ensure that the technology-assisted solutions developed were suited to fulfilling the learning requirements outlined above. This project aimed to field test the telematic resources developed with a small group of remote learners. The experiences of these remote learners were collected in order to evaluate the effectiveness of the technology adopted and the distance education delivery systems implemented. The identification, development and testing of a web-page authoring kit, suitable for practical university staff development, represented both an original contribution towards staff development. It also achieved viable solutions to some of the recently raised issues highlighted in the Higginson report regarding implementation of flexible distance education, information technology learning curricula and superhighway learning resources (Higginson, 1996). These issues have also been recognised in the European Union's recent white paper on education and training which has implemented a wide range of telematic-assisted learning projects (EU DGXII, 1995).

Aims

1. To develop a University of Plymouth Internet web facility for the Masters programme, capable of telematic organisation of flexible distance learning packages;

2. To pilot the conversion of the module 'IT for Personal Development and Project Management' into such an flexible distance learning package;
3. To develop flexible distance learning real-time interactive face-to-face solutions for seminars, tutorials etc., through RATIO video-conference centres across the region;
4. To evaluate the effectiveness of the flexible distance learning solutions developed in terms of key findings gleaned from involved staff and distance education participants, identifying key lessons learnt with consequent implications for teaching and learning in higher education.

The implementation of the project

The implementation of the module is described in three stages: the recruitment of participants, the delivery of the module and the evaluation of student and tutor experience.

1. The recruitment of participants.
Given that this project was an experimental initiative, it was advertised apart from the University's normal advertising for Master' programme. From this mail out to selected post graduate student groups and through and word of mouth, approximately 60 people requested additional information about the module. Twenty prospective students attended an Introduction and Induction evening with 16 people completing formal enrolment procedures. All of the students had appropriate entry qualifications for enrolment in the Integrated Masters Programme and were mature adults who were or had previously worked in education, training or related fields. Difficulties in obtaining access to suitable hard ware and venue sites were the reasons that four people did not complete enrolment. This factor proved to be significant in later drop outs from the module. During the course of the session, the 16 students were asked to complete a short questionnaire relating to previous IT experience in order to ascertain anticipated need for IT support during the module.

2. The delivery of the module
Once enrolled, the 16 students were provided with the module's world wide web address, user name and password to access the seven learning sessions. The module was authored in such a way to allow public access to some information but the learning sessions were protected by a user name and password. Students were asked to signal their participation in the content of the module by constructing an email of introduction about themselves for the tutors and fellow students. Shortly, after that, students were asked to respond to the tutor's email requesting details about their assignment. A distribution list was set up to facilitate communication between tutors and students. Students then were required to access and complete the learning sessions in their preferred venue, own time and at their own pace. The tutors encouraged students to communicate about difficulties encountered during the module and distributed email responses to frequently asked questions to the group members. Students were also encouraged to communicate with fellow students about their experiences encountered while undertaking the module, thereby encouraging the establishment of a support group. The learning sessions needed to be completed in sufficient time for students to prepare and submit an appropriate assignment by a set date. At least one videoconference session was planned during the delivery of the module. Numerous problems related to the delivery of the module emerged.

3. Evaluation of student and tutor experience
Project evaluation was carried out in a number of areas. Qualitative analysis of the following key areas was investigated:-
1. the ease and social pragmatics of developing a flexible distance learning package by university staff;
2. the extent to which the aims of the module were actually achieved through flexible distance learning assessment methods;
3. student attitudes regarding both participation and learning through a flexible distance learning delivery format. Interviews, personal and e-mail, coupled with post-module evaluation feedback reports were deployed;
4. tutor experience of, and attitudes to, teaching and delivering a module in this particular format via chronological recording of key personal learning events in a personal learning biography.

Research findings

Data were collected on student attrition, previous experience in using IT, email correspondence, personal reflections of the tutor as means of evaluation.

1. Student attrition

Student attrition was a major issue in the delivery of this distance learning module. In the four weeks following the Introduction and Induction evening, 50% (N=8) of the enrolled students withdrew from the module. The main reasons were associated with lack of accessibility to suitable hard ware and pressure from employment. The project was dependent upon the operation of RATIO centres throughout the south west of England. The delivery and installation of equipment for accessing the world wide web and to participate in videoconferences was running well behind schedule which meant that none of the RATIO centres were able to be used by students. Students then had to find alternative venues which proved extremely difficult and resulted in 5 students abandoning the module. Pressure from employment proved to be another factor in student attrition. A majority of the students worked in higher or further education as trainers. These sectors were and are experiencing major structural upheaval which resulted in three students having to take on additional responsibilities in order to retain their jobs. These students would have withdrawn from the module regardless of its mode of delivery.

During the next four weeks, another four students withdrew. Two students considered that their low level of competence with IT would result in their inability to successfully complete the module. One student who suffered from multiple disabilities withdrew because the University finally was unable to meet her need for a voice activated computer. The final student withdrew because he was returning to Cyprus for the summer and was not able to access suitable equipment in Cyprus which would permit him to meet the assignment deadlines. The remaining group of four students progressed through the learning sessions over a period of approximately four months. However, only two students completed the module by submitting and passing an action research assignment. The other two students were lecturers from a partner FE college who merely wanted to experience distance learning as a means of evaluating its suitability for FE courses. While they completed the requirements of the learning sessions, they were not prepared to put the effort required in submitting a rigorous post-graduate project assignment.

2. Survey of previous experience with IT

All of the original 16 students who enrolled in the module completed a short one page questionnaire which aimed to identify their previous experience with the type of technologies on which the module was based. The results revealed that 96.8% of the students were experienced in word processing, while 43.8% had experience with email, and 56.3% had experience with the Internet. Only 6.35% of the students had previous experience with videoconferencing. In relation to the venue where the module would be accessed, the workplace (50%) and home (25%) were specified by the majority of students. Other venues specified were the University's computer centre (12.5%) and various RATIO centres (12.5%). 68.75% of the students (N=11) indicated that they probably would use a combination of the above venues to participate in the module. Given that the RATIO centres were not fully operational during the module, two students eventually had to find other suitable venues. Finally, the students were asked to rate themselves in terms of their level of confidence for using IT on a four point scale (very confident, confident, unconfident, very unconfident). Half of the students (50%) reported that they felt 'confident', 43.75% (N=7) reported feeling 'unconfident' and one student reported feeling 'very confident' in using IT. Interestingly, only two students withdrew because of feelings of incompetence with using IT. These data suggest that student attrition mainly was associated with factors unrelated to lack of confidence in using IT.

3. Qualitative analysis of email correspondence

Email correspondence (and four telephone calls) generally related to technical and academic related problems. The biggest technical problems were related to obtaining the correct address for accessing the module on the world wide web and incorrect or changed email addresses. Unfortunately, following the Introduction and Induction evening when the module's address on the Internet was provided to students, it was decided by technical support staff from the University's Computer Services to change the address. Although inserting the new address into the home page rectified the problem, it resulted in considerable student confusion. The change of address was followed almost immediately by the University's system 'going down' for a couple of days, a situation for which the students had not been forewarned. In setting up the module on the Internet, technical staff from both the Faculty and Computer Services had been involved. It is important that one department only be responsible for 'webministration' services, especially for creating the address and setting the password so that responsibility for coordination of all information may be disseminated to all system users.

Owing to a lack of central webministration service, the distance education learners were not adequately informed about any vital system changes, such as incorrect and changes in email addresses. In the early stage of the module's delivery, one of the tutor's took up employment in Singapore resulting in a change of email address. Some students who had limited understanding about the precise nature of email addresses provided incorrect contact details. One student changed her email address during the module and provided incorrect details which took some time to unravel. Consequently, the distribution lists became incorrect at frequent intervals which resulted in students not receiving replies to emails or emailed correspondence. As initial technical problems were overcome and the student group decreased to four, the type of technical query changed from simple problems as described above to more complex problems, such as encoding and decoding email attachments between different systems, accessing different web sites, creating and saving of graphics as GIF files and word processed material so that they can be sent as split text and graphics and. queries related to the setting up of and preparation for a videoconference. It is essential that students have immediate access to technical support for such a technology-dependent learning system.

Because of tutor unavailability due to holiday periods and absences related to other academic duties, some students reported concern about delays in responses to emailed correspondence. Students also could not be raised by tutors sometimes which created uncertainty about their continued participation in the module. It is important that all participants alert group members if they are going to be 'off line' for any period of time. A transparent communications protocol linked to webministration, administrative and technical support services, tutor academic support and distance learner participants are recommended as essential infra-structure for any expansion of this service. A range of academic queries were raised in student emails. These related mainly to definitions of academic terminology, requests for feedback on student work, questions about theoretical and methodological issues, requests for traditional printed resource materials, request for information about administrative and library matters, the use and value of reflection in academic work and other matters directly related to the academic content of the module. Where appropriate, the tutor's reply was distributed to all of the group members as were relevant suggestions and comments from students.

Although traditional written end of module evaluation could have been undertaken with the completing students, the small number of completing students made this less relevant. Instead, the two students who successfully completed all seven learning sessions and submitted an appropriate assignment were contacted personally to discuss their experiences, the strengths and weaknesses of distance learning. The general consensus was that there was more time and work associated with undertaking a module in this format than in traditionally delivery modes. While the students thought that they had learned a lot, they described some of the theoretical on line reading as 'heavy going'. The students thought that two demands were made on them: first, the learning of IT skills to enable them to undertake the distance learning module and second, the learning related to academic content requirements. The students recognised that there were initial 'teething problems' associated with technical aspects of the module but considered that these were overcome by the regular emails and encouraging personal support offered by the tutors. The lack of face to face interaction with the group was considered to be a disadvantage. It was thought that this aspect would have been overcome with videoconferencing. As it turned out, only one videoconference was able to be organised in which only one of the students could participate at the University due to technical and time difficulties. The other student linked up separately via her school's videoconferencing resource but all three venues could only communicate via point to point. A multi point bridge server was not available between the three venues, so three way communication was stymied. The tutors recognised that some of the students' problems with the module were associated with their inexperience in authoring telematic based course ware, that is disseminating appropriately formatted graphics and text files over the email Internet systems used. These problems are likely to be overcome in future distance learning packages.

4. Personal reflective journal of the tutor

The remote tutor identified and recorded a wide range of problems and successes associated with the delivery of this module, with the key issues as follows.

1. The lack of a distance learning systems protocol that delineates open support between the three core
user areas of on-line administration services, IT technical services and academic services. These were
mostly left to the on-line module tutor to sort out.

2. The lack of a user-friendly videoconference facility that could easily connect the tutor and the group
together for multi-point private conversations.
3. The need for a clear web etiquette and on-line protocol from which both distance learners and module tutors can overcome the problems of remoteness and lack of face-to-face contact.
4. While the student attrition dropout from the module was high the completed projects were of a very
high standard and validated the academic value of accrediting community-based action research projects
via a university distance learning programme.

From these problems the tutor has recommended the following solutions towards any future expansion of the distance learning IMP. First, the creation of a webministration service to centrally co-ordinate the distance learning support service. That is, both a forum and intermediary through which the IMP distance learning modules may be administered. The service would include on-line registrations, dissemination of necessary regulations and user contact protocols, assistance with IT technical problems. The webministration coordinating facility would form the academic support infrastructure of a distance learning virtual faculty and could offer global access to the IMP. Second, the 'big' studio-based videoconference facility offered by providers such as PictureTel Corporation are considered to be inappropriate and inflexible to the distance learner's needs for an easy-access face-to-face solution. Instead, the tutor has recommended a desktop videoconference solution which offers server space for 'bridging' multi-point desktop videoconference sessions via the client-users own PC.

Outcomes and discussion

Several key benefits and outcomes stemmed from this project and included the following:
1. the development and running of a dedicated web site which included full interactive student participative features such as Internet e-mail;
2. the conversion of an existing module into suitable flexible distance learning format;
3. the identification and development of a suitable HTML editor which was capable of being used as a staff development authoring tool by current staff;
4. the piloting of videoconference resources as a means of satisfying the perceived face-to-face requirements underpinning delivery of a higher education programme;
5. a demonstration of applying telematics in the delivery of higher education programmes.

Although the final group of students was small, the quality of their submitted responses to the seven learning sessions and assignments demonstrated that the project had a significant impact on the quality of learning. The most important quality-related issue is that of improved student access to postgraduate professional training programmes. The students who completed the module would not have enrolled in a traditional delivery mode because of various commitments. Higher education learning opportunities were therefore realised through the medium of telematic assisted flexible distance learning in a geographically sparsely populated region, with consequent lessons and implications for similar programmes adopting the same model.

An important impact on the quality of learning was the creation of a flexible distance learning medium which promoted the ethos of student autonomy with regards to their own learning, thus underpinning the aims of effective adult learning and the deep learning criteria previously outlined. Good quality telematic assisted learning programmes, with proper higher education accredited status, can achieve Boud's vision of developing the educational qualities and personal skills that underpin the successful performance and capability of the autonomous learner (Boud, 1981). This is further underpinned by Harri-Augstein's and Thomas' notion of the self-organised learner (Harri-Augstein & Thomas, 1991), whereby an individual's learning capabilities can be enhanced through technology assistants which they refer to as an Intelligent Learning System. Coombs (1995) further elaborates this notion of an Intelligent Learning System in terms of a Knowledge Elicitation System, whereby, information technology-assisted learning is considered in terms of its interactive learning capability with an individual learner. It is therefore understood that the quality of learner-learning with an information technology software system can be explained in terms of the learner being able to systematically manage their own elicitations in the form of self-organised reflective construing experiences. From this perspective, knowledge is considered as being relative to the user - as learner - via focused information technology-assisted reflections, construed and elicited by the person in the form of meaningful Learning Conversations. Given this understanding of how information technology/telematic learning systems may impact upon the personal learning capability of the learner, coupled with the demands of higher education, such as developing the learner's reflective skills, it can be seen that appropriate learning technologies could bring considerable benefits to outreach members of the community participating in a distance education scheme.

Additionally, the personal involvement of the tutor in developing his/her curriculum through an action research project is supported by educational critical thinkers such as Stenhouse (1975) and Elliot (1991) who support the notion of teacher as an experimenter of his/her curriculum. Evaluation of the on-going curriculum development experiences of the tutor involved in converting a module into an flexible distance learning format was a valuable staff development exercise. A reflective learning biography was kept as a means of project management review and evaluation of important lessons learnt, as experienced in real time, on the job.

The module chosen as a pilot for this project offered a diverse curriculum range which both embodied the spirit of the central IMP tasks and deep criteria, whilst lending itself towards the use of technology-assisted reflective tools. Clearly, the telematic media adopted, that is, Internet web pages and PictureTel videoconference facilities lent themselves to the central ethos of the module itself. This enabled participants to critically appraise information technology-assisted learning systems in terms of their ability to operate them successfully as knowledge elicitation systems. A central axiom of the module critically appraises information technology in terms of its ability to be used as a conversational learning tool that can be employed as a means of personal development. These IT reflective tools assist participants to carry out a small scale action research project from within their own social and working environment. Information technology project management techniques included the use of the Internet to research contemporary background information of a participant's subject/professional development field, e-mail to share research questions and concerns with project supervisors and other team members, spreadsheets for quantitative data analysis and graphical presentation and wordprocessing facilities to keep a computerised reflective log/account of key project events and submit the final assessment dissertation.

A key part of the module required one-to-one tutorials to negotiate the participants' project and discuss individual needs and assessment methods best suited to achieving the assessment task. Videoconferencing provided a means of giving this kind of support to distance learners but in practice proved to be impossible to implement owing to the unwieldy nature of studio based videoconference solutions such as PictureTel. However, PictureTel does provide the bonus of sharing an information technology task with a distance learner despite the fact that it was difficult to access and use. Therefore, it is possible to conduct interactive information technology software demonstrations and exercises from the module that currently involve the use of Excel and SPSS. However, a more user-friendly desk top videoconference system would allow for easier user access and is recommended for future use.

Difficulties Encountered

A number of obstacles to the development and delivery of the module were encountered by the tutor and students. For the tutor, lack of support in the administrative, library and technical areas, inadequate time allocation and resourcing for the development of the module and recognition by the university administration of the needs of a remote and/or home tutor were identified. For students, the major obstacle was accessing equipment to undertake the module tasks. Contrary to expectation, the RATIO centres were not resourced with the equipment necessary for students to undertake the module during the trial period. In addition, a student with multiple disabilities was not able to gain access to equipment which would have enabled her to undertake the module. Where alternative venues were identified, such as colleges, schools or home systems, the capacity of these systems could not always handle the demands of the technology. Some students found that the challenge of mastering the technology were greater than expected and thought that they could not handle both the technology and content together. However, most students reported that the major advantages of the module were working in their chosen venue, in their own time and at their own pace.

Conclusion

In conclusion, the key benefits of this project should impact upon those participating students drawn principally from the South West of England who wish to pursue professional development in Higher Education. Another key benefit is the staff development of all those involved in this project, including the participating project team, through personal experiences of innovative practice that leads to new and further pedagogical knowledge and skills. As a consequence of cross-institutional collaborative involvement, the RATIO partner institutions will clearly benefit in the future through the perceived enhancement of their reputation as leaders in distance education, despite the set backs reported in this project. The general education profession will gain some valuable insights from this distance learning project which has made an original contribution impacting upon the management, theory and practice of teaching and learning in Higher Education.

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DEVELOPING A DISTANCE EDUCATION PROGRAM USING TELELEARNING AND OTHER MULTIMEDIA

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Abstract: Oregon State University (OSU) has been challenged by the State Board of Higher Education, and the University president to create a "Next Generation University" that is more accessible and better meets the needs of the citizens of Oregon. The initiative to transform the university to one that provides access to all Oregonians as a primary goal is called OSU STATEWIDE. This initiative includes practices for rapidly developing a distance education program that are transferable to other universities. These practices include empowerment of a distance education program development team, completion of a business plan, and focusing important university assets and resources - particularly distance education development and delivery assets, and faculty and student services. This paper describes some of the important changes necessary to develop a comprehensive distance education program within an existing university structure.

1. Introduction

Fundamental change is required to move from a primarily campus-based institution to an institution that supports its claim that the "State is our campus". During the past year, Oregon State University established "OSU STATEWIDE" as one of its primary initiatives. This initiative which envisions making the university accessible throughout the State of Oregon, is closely aligned with the three University goals that have been articulated by the University president, Dr. Paul Risser. The goals are:

- To create a compelling learning experience for students, staff, and faculty
- To be recognized as a top-tier university on all scales of measurement
- To serve the State of Oregon as the campus of Oregon State University

2. Background

Oregon State University is an American Land Grant University, and has had throughout its history a responsibility for providing research, education and service throughout the State. The OSU STATEWIDE initiative serves to focus those responsibilities. While the research and services areas of these responsibilities have been well served by organizations such as the OSU Extension Service, the Agricultural Experimentation Station, the Marine Science Center, and others which are separately funded by the Oregon Legislature, the instructional aspect of this responsibility has not been as forward moving and has had to function on a self-support basis.

3. Approach

OSU STATEWIDE instructional outreach is being developed for several reasons, including, and foremost, the need to provide access and choices to Oregonians who are place or professionally bound and cannot come to either the OSU campus for programs that are unique to the university, or do not have a four year institution near where they live for more general degree programs. OSU STATEWIDE t has economic development as its underpinning. In addition to being a primary University goal, as previously noted, providing access is also part of the long term vision of the Oregon University System Board. The initiative is also seen as a way to increase declining enrollments and to help the image of the University, which may lead to improved funding.

3.1 Extended Education Development Team

To help meet the goals of this ambitious program during a time of declining resources, it has been necessary for Oregon State University to significantly refocus existing resources. To start, an extended education development team was formed. This team included the following:

- Provost (stature and access to the entire university resources)
- Director of Extension Service (statewide responsibility)
- Associate Provost for Information Services (technology assets, ideas)
- Faculty Associate to the Provost (curriculum expert)
- Director of Continuing Education (logistics, student services support, marketing)
- Director of Distance Education (technology and faculty training emphasis)
- Support from the Media Center (instructional development and delivery)
- Registrar (university admissions and student records/management systems)

The establishment of this working team proved to be extremely valuable. As a team with the expertise and contacts to develop a distance education program, it was able to work very quickly, bringing together other areas of the university to deliver the program. Each in their own specialty area of expertise and responsibilities, the team members went about making the necessary changes to foster the development of distance education on the campus. Important to its success, the team leadership was empowered to have contact with all levels of the university along with direct and continuous access to the top administrators.

3.2 Business Plan

The university had been delivering a limited number of distance education offerings in key locations for a number of years. In order to determine how to move forward with new offerings, a business plan was developed that included assessments of need, a technology strategy, recommendations for student and faculty services, income and cost analysis, funding strategies, recommended programs for delivery, and marketing and sales strategies. The business plan also demonstrated the need for focusing campus instructional development resources to the distance learning program.

3.3 Delivery of the Distance Education Program

Historically, Oregon State University has provided distance education programs for over twelve years. Beginning with computer science courses transmitted over microwave to the high tech community near Portland, Oregon, the program expanded to include other engineering courses in electrical and manufacturing, as well as education, and liberal studies programs. Some of this growth can be contributed to a state infrastructure consisting of two-way compressed satellite video that was made available in the early 1990s. Part of the growth was also spawned by place-bound persons or professionals who requested direct access to a four year institution.

Today, through OSU STATEWIDE, the program delivery has expanded to five baccalaureate completion programs in partnership with the community colleges in Oregon, and five masters level degree programs. Many of these are developed as "cluster" programs. Courses are chosen for development and delivery that meet the needs of multiple programs. By clustering programs that require common courses (e.g. a course in environmental policy will work equally well for Liberal Studies, Environmental Science, and Natural Resources) the STATEWIDE initiative is better able to aggregate student numbers to make the initial offerings cost effective, and to provide the necessary resources during the startup years.

PROGRAM	DEGREE	START
Liberal Arts	B.S.	ongoing
Business Administration	B.S.	1997
Environmental Sciences	B.S.	1998
Natural Resources	B.S.	1998
General Agriculture	B.S.	1998
Adult Education	Ed.M.	ongoing
Education	Ed.D	ongoing
Manufacturing Engineering	MEngr	ongoing
Nutrition and Food Mgt	M.S.	1997
Public Health	M.P.H.	1998

Figure 1: OSU Statewide Degree Programs

3.4 Partnerships with other Education Institutions

In order to provide degree programs in a relatively sparsely populated state, OSU has actively pursued partnerships with other educational institutions, particularly the Oregon community colleges and other Oregon University System (OUS) four year institutions. Numerous community colleges are engaged in the baccalaureate completion 2+2 programs where the students can take the two year lower division instruction in the local community, and then, while staying in the community can complete the upper division course work from OSU on the community college campus through OSU STATEWIDE. Several of the OUS four year institutions are also partnering in both baccalaureate completion and graduate level programs. These joint program arrangements provide access to specialized coursework from OSU at distant locations, while at the same time, provide courses from the other institutions to the students.

3.5 Technical Delivery Systems

The goal of OSU STATEWIDE is to offer access to a 21st century education through various delivery systems - including traveling faculty, video workbooks, Internet and Web based courses, interactive video courses, and a combination of technologies - for learners who cannot relocate to a university setting to pursue a degree or a new minor. The primary technology that is being employed at this time is interactive video through several technical systems including compressed two-way satellite video, terrestrial two-way compressed video (PictureTel), IP video over fiber, and Instructional Television Fixed Service (ITFS). There is also a growing number of Web based courses being developed as instructional management tools improve and more faculty are exposed to this methodology.

3.6 Development of the Distance Education Alliance

In order to meet the challenge of providing adequate faculty resources, particularly in the area of instructional development, it was necessary to focus the majority of the instructional development resources present on the campus to this initiative. This was accomplished through the development of the Distance Education Alliance. The Oregon State University Distance Education Alliance is a place for intensive faculty training, course development, and research on the effectiveness of distance education. It is the goal of the founders to have it become nationally known as an Oregon State University Center of Excellence.

The following activiities are examples of how the Alliance serves OSU as a site for the development and promotion of distance education instruction.

- Prepare faculty and support staff to have intensive knowledge of new distance education delivery methods through workshops, seminars, and mentoring.
- Provide instructional design elements and course development, with staff producing courseware for the expressed needs of the faculty.
- Adapt new technologies to the instructors' needs.
- Provide training on-line, thereby modeling the technology to be used and making it available to a broader audience.
- Research and test resources, including focus groups and lab research to test effectiveness of distance education methods. From the knowledge that is created, articles and other output will result, marking OSU as a center of excellence in distance education.
- Create an environment that will stimulate faculty work in distance education. Faculty course developers will serve as researchers, training assistants and mentors to other faculty researchers. The Alliance will be a physical location where faculty can come to receive support and/or to help mentor other faculty.
- Assure OSU currency in new technologies for both asynchronous and interactive video instruction. Research and track state of the art technologies and tools so the Alliance can provide the highest possible quality work.
- Provide central resources and training for collaborative projects with faculty from other institutions.
- Provide technology transfer, facilitating the sales of new instructional management software and technology based content developed by OSU faculty or through collaborative projects.
- Represent the university in national activities relating to the development and growth of distance education.
- Provide adaptive technologies for students and faculty with disabilities.

3.7 Faculty Training

Through the Distance Education Alliance, faculty workshops are provided to train faculty on the uses of the technologies available for delivering instruction. These training workshops are conducted by the expert on-campus staff and includes hands-on experiences using the technologies. The training sessions are provided in group sessions at several times during the year. Training assistance is also available to faculty on a personal one-on-one basis throughout the year. Instructional design consulting help is also available for the faculty as they develop their distance education courses.

3.8 Other Distance Education Services

In addition to training, course development and program delivery, other distance education services are being coordinated by the Distance and Continuing Education, STATEWIDE office to better facilitate the needs of the students and teaching faculty. These additional coordinated services include library support, on-line registration, tuition payment, transcripting offered through the OSU Valley Library and the Registrars office, on-line student writing assistance, technology infrastructure development and support, and other student services support. The STATEWIDE team also provides facility and technology scheduling, travel arrangements, class materials distribution, proctoring exams, program marketing, evaluations, catalog development, and more. The STATEWIDE team also works closely with on-campus services available in the Financial Aid office.

Through the engagement of the university marketing office, the distance education program is marketed in a comprehensive way through a variety of methods. This includes, radio, newspapers, community college catalogs, ads on computer mouse pads for partnering community college computer labs, infomericals for the interactive video courses and outdoor billboard advertising.

4. Conclusions

The OSU STATEWIDE program is changing the university culture by providing degree programs to numerous locations around the state. This change is substantial, one that involves presidential and provost support, and the empowerment of a small leadership group to move forward quickly. It also involves the reorganization and refocusing existing resources, significant course development by those early adopter faculty and active conversations and debates with the others, and continuing hard work by the leadership of the initiative.

OSU STATEWIDE will provide access to the numerous programs in areas of the state and elsewhere where they are not now available. It is likely that this new direction will change the way the university is perceived around the state and nation. Will it lead to most of the programs presently being offered on campus, eventually being offered at a distance as well? That is doubtful. However, numerous offerings will be made available in a variety of formats, some through partnerships with other institutions, and some through multiple modes of technology and instructional methods which may or may not include face to face instruction. Are we helping to shape the "Next Generation University"? For Oregon State University, we believe the answer is yes.

Developing Intelligent Hypermedia Systems On The World Wide Web For Distance Learning

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Abstract: Educational applications of distributed hypermedial systems constitute a research sector which is presently in fervent activity. The advent of the WWW, which offers access to hypermedial resources available on Internet, has facilitated the use of hypermedial resources in teaching and learning phases. However, the original problems regarding the question of control of the learning phase, together with the problem of the passivity of the courseware, in practice no more than a text-book, have remained unsolved.
To ensure that an interactive educational environment promotes effective learning, an adaptative component should be incorporated to guide the learner towards valid learning goals. In this paper we describe our approach to the development of an Internet-based course designed for distance education and aiming to support the learning of medical English. The course embodies a tutoring system which can be activated on request by the student, to orient his choice of learning path.
Its implementation on the Javascript platform circumvents the limitations of the World Wide Web.

Introduction

The phenomenal growth of the Internet over the last years and the development of various multimedia applications have led to far-reaching changes in educational models.
Beside the traditional didactic method based on a teacher standing in front of a class, distance learning is gradually taking its place thanks to the World Wide Web. This provides a unique challenge as a new delivery mechanism for course material allowing learners to take a course from anywhere in the world.
Marchionini and Maurer have pointed out that an important factor which will have a strong influence on teaching and learning methods in years to come is the possibility of consulting enormous digital libraries which will constitute a most valuable teaching resource as sources of updated and updatable material [Marchionini & Maurer 1995].
Thus, World Wide Web offers a platform which allows didactic systems to be defined having global education as their aim.
As reported by Bouras et al., a hypermedia tool for distance education (HTDE) aims to provide its user with the ability to access educational material that has been created by experts, structured as a hypermedia document and stored in a library [Bouras et al.1997]. They emphasize that the distance education system using the Web as the underlying platform for its implementation exhibits all the advantages of the Web itself (support for hypermedia documents and links, universal and standardized graphical user interface, excellent navigational control, adequate support functions, independence of hardware platform, reusability of courseware and ability to connect with database systems). However, it also features all the Web's disadvantages, such as poor support of stream data, small degree of interactivity, poor support of one-to-many sessions and so on. Using

programming environments like Java, Javascript and ActiveX, sophisticated networking applications can be developed that exploit the advantages of the Web.
Schank speaks of "active learning" and says that interactive multimedia training can enhance learning by allowing students to go back over a subject or else fast-forward over an area that they already understand or do not need [Schank 1994]. On the other hand, although WWW inspires enthusiasm among educators, it creates some problems due to the passivity of the courseware, in reality no more than a textbook, and to the lack of monitoring and control exerted by the system on the student learning process.
Several papers [Beumont & Brusilousky 1995] [Hekmatpour 1995] have focused on adaptative educational hypermedia interface while Nkambou [Nkambou & Gauthier 1996] presents a system which uses HTML documents as pedagogical material under the control of an Intelligent Tutoring System.
Earlier experiments [Altamura & Roselli 1995] [Roselli 1995] [Roselli et al. 1996] with standalone hypermedial courseware have demonstrated that the freedom of action offered by the hypermedial educational system needs to be integrated with more explicit control and direction to make sure that the learner is guided toward valid learning goals.
In this paper we describe our approach to the development of an WWW-based course designed for distance education and aiming to support the learning of medical English.
The course embodies a tutoring system which can be activated on request by the student, to orient his choice of learning path.The development platform used is the Javascript language developed by Netscape which has made it possible to circumvent some of the WWW limitations.

NetMedEnglish Architecture

NetMedEnglish constitutes hypermedia courseware possessing some of the features of the ITS. Its main characteristic is that it can adapt to the level of knowledge and understanding acquired by the student. It is presented as a traditional hypermedia but supports student interaction in order to reduce the disorientation and cognitive load problems that typically affect hypermedial systems.
NetMedEnglish has a server/client structure based on the architecture of WWW and the hypermedia courseware resides on the server. The latter consists of a conventional WWW daemon used for communication between server and client, while the client system includes a WWW browser: Netscape, as well as the NetMedEnglish process and student information.
The system is organized in the form of four basic modules[Fig. 1]: Interface, Tutor, Student and Domain Modules. These are explained in the relative subsections below.

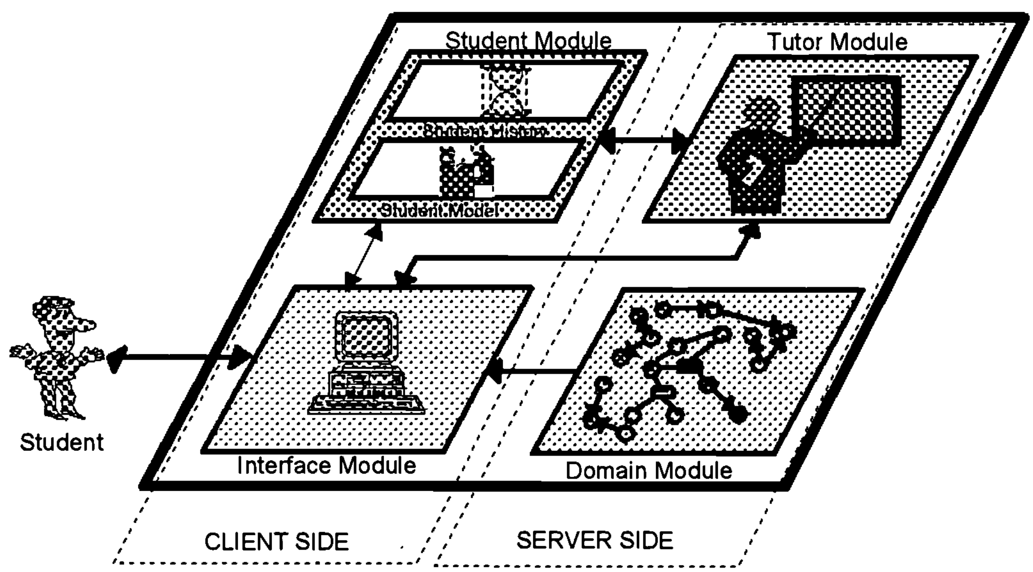

Figure 1: NetMedEnglish Architecture

Interface Module

This module interacts with the user and consults with the domain to see which node comes next after selection of an anchor. It then decides which nodes should be presented on the basis of the information received from the Tutor Module.

Tutor Module

This performs intelligent decisions adapting the courseware to the student, basing its behaviour on the data received from the Interface Module and the Student Module. Unlike the classical Tutor Module present in ITS, it works fully transparently and intervenes only on specific request by the student who asks for guidance. Thus, the philosophy underlying the use of hypermedial systems is preserved intact for those students who are able to manage their learning processes alone.

When the Tutor Module is activated it carries out the following functions:

- it interacts with the Interface Module to receive the requests for access to a new logic node in the hyperspace;
- it verifies that this information can be presented, by consulting the Student Module and activating the instructional rules. If the information cannot be presented, it informs the student, by means of an explicit warning message, of the next step he should take to ensure correct use of the course.

Student Module

The Student Module needs to be easy to construct and modify and should accurately reflect the characteristics of different students.

It has been divided into two sections: Student Model and Student History. The first section is independent of the subject of the domain and describes the student's learning characteristics. The system classifies three types of student: novice, intermediate and expert. In addition, this section represents the domain concepts acquired by the student during his learning process. Student History includes information about how the student's instructional process has developed, and in particular the progress he has made, which exercises have been proposed and how he got on with each exercise.

Domain Module

The domain module represents the knowledge which should be transferred to the student. In our system, this is constituted by basic anatomical and physiological concepts belonging to the field of medicine. It is represented using links and nodes; there are various types of node according to their function:

- ordinary nodes contain only static information to be presented (e.g. text, images, sound, animation);
- navigational nodes contain the tools for activating links to other nodes (e.g.menu, index, information cross-links, etc.). The student can access the voice glossary of medical terms which contains the significant keywords: on selecting the relative term, he will hear it pronounced in English and the theory card which deals with the given concept will then be automatically accessed;
- exercise nodes contain different types of exercises to be solved by the student.

For example, he must insert the answers to an exercise in a visualized field, or solve a comprehension exercise by selecting the right answer among multiple choices, or place the words in the correct order to form meaningful sentences with the mouse drag and drop technique.

Implementation Choices

Although there are many tools now available for managing the student model in stand-alone didactic systems, this management is more problematic for didactic systems on the Web. Memorization of the data on the server is very expensive and complex, because it is necessary to keep track of each student who has access to the course and to obtain the relative information from the server, involving a continual exchange of data between client and server.

One solution which seems to be satisfactory is memorizing this information on the client, because in this way several learners can have access to the same client system, while the tracks of their instructional paths are kept distinct. This solution could be adopted thanks to the use of Javascript. Using cookies.txt files it is possible to memorize the student model, and then call up such information as the pages visited, the number of times each page has been accessed, the exercises carried out and their outcome. This use of cookies avoided the need for server-side solutions, like the CGI script or applet written in Java, to be able to act on the database. Javascript allows access to these cookies to save information on the situation as regards previous sessions using the courseware. A cookie cannot of course replace a database on the server but it is very useful for such applications as the student model.

Conclusion

This new dimension for the provision of courseware is of great interest. It can certainly stimulate learning but the freedom of navigating in the WWW hyperspace raises the risk of exacerbating the disorientation and cognitive overhead drawbacks that had already been observed in standalone systems. Integration of an individual adaptation mechanism can help to guide the student and contain him within paths promoting effective learning.

The NetMedEnglish hypermedial system proposed in this paper is an interactive educational environment on WWW which embodies a tutoring component aiming to help solve the above problems and exploits the Javascript platform to overcome the limitations of the World Wide Web.

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"DreamTeam" - a Synchronous CSCW Environment for Distance Education

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Abstract: This paper presents a platform for the development and execution of synchronous co-operative shared applications in a distributed education environment. Even though several co-operative environments are existing nowadays, specific problems in real student environments are not treated satisfactorily. Students often have to deal with unstable network connections and low bandwidths; they are using different hardware and software platforms; their computers are off-line most of the time.
The DreamTeam platform addresses the special needs of distance education environments. It comprises a development environment, a runtime environment and a simulation environment; it is based upon the concept of a de-centralised architecture. It minimises the development cycle for co-operative applications and encourages rapid prototyping.
DreamView, a co-operative Web browser developed in the DreamTeam environment, demonstrates the strengths of the DreamTeam environment.

1 Introduction

Co-operative (CSCW) applications are playing a major role in distance education, e.g. for group discussions, jointly working on electronic courses, jointly visiting Web pages, remote laboratories, video conferencing, joint program development, co-operative publishing, etc. To develop such a co-operative application is a difficult and time-consuming task.
Dommel et al. [Dommel et al. 97] distinguish three types of co-operative applications:

- *Collaboration unaware applications* offer no collaboration services themselves; they are single user applications, running in a shared environment.
- *Collaboration aware applications* are developed for co-operative environments, but their services for collaboration are hard-coded.
- *Collaboration transparent applications* provide their services for collaboration by using high level services of a standard collaboration environment.

Taking the last approach, a developer can concentrate on the application specific details of his application and can use the collaboration oriented services from the standard collaboration environment.
In the following, we describe DreamTeam, a Java oriented development and runtime environment for synchronous, collaboration transparent applications for distance education. As an example for such an application we further describe DreamView, a co-operative Web browser, which has been developed within the DreamTeam environment. In the following, the terms co-operative application or groupware are used as shorthands for a collaboration transparent application running in a shared distributed environment.

2 Co-operative Applications for Distance Education

Co-operative applications for distance education have to take into account our students' special needs and requirements.
User interface: Especially for remote students it should be as easy as possible to install and run a co-operative application. Different applications should provide consistent interfaces, at least for all aspects of installation and general collaboration.

System platforms: Most of our students are using PCs with a variety of different operating systems. A co-operative application should make as few assumptions as possible about the system platform with regard to hardware requirements (screen resolution, system performance etc.) and software requirements (operating system, version, installed software etc.). PCs tend to be unstable. A co-operative application should be tolerant against local breakdowns and should easily allow to restart a system and rejoin an existing group.
Network: Most of our students are using the Internet for communication, mainly through dial-up modem connections, connecting them to the university either directly or via a service provider. These connections are exposed to network delays, bandwidth degradations, as well as sudden, unexpected disconnections. A co-operative application should handle such situations itself without requesting any additional actions from the user, e.g. by reconnecting to the active group. Usually, students are off-line most of the time and their Internet addresses may change between consecutive dial-ins. It is the task of a rendezvous component to find out which students are actually available for a meeting and how they can be reached via the Internet.

3 The DreamTeam Environment

The DreamTeam environment allows the developer to develop co-operative applications like single user applications, without struggling with network details, synchronisation algorithms, etc. The environment consists of three components, a development environment, a runtime environment and a simulation environment. In the following, the basic DreamTeam concept as well as the three components are described in more detail.

3.1 The Concept

Architecture: Co-operative applications can either be implemented in a centralised or in a de-centralised way. In a centralised architecture, all messages are routed via a single group server, thus group events and data accesses can easily be synchronised. On the other hand, group servers often are performance bottlenecks, a shut down of a group server shuts down the session; all messages, even those between clients residing in the same host, have to be sent through the group server.
In a de-centralised architecture, availability and bandwidth problems can be avoided, but synchronisation and serialisation have to be handled by higher level protocols. On the other hand, a de-centralised architecture allows different kinds of communication channels, e.g. via ISDN connections.
The actual version of DreamTeam supports de-centralised architectures without the need for any central server.
Session management: In a de-centralised architecture, session management has to be handled in a de-centralised way too. The originator of a session defines a session profile and generates the session. As soon as he has started the session, other users can join and leave the session. When the originator himself leaves the session, the session can continue with the remaining members but no new members can join in.
Information distribution: To distribute information among session members, DreamTeam uses a special kind of Multicast Remote Procedure Calls, through which a local system can call a procedure at all participating remote systems. Complex data structures can be serialised, transferred as procedure parameters and rebuilt at the target site. All objects defining a DreamTeam session can be serialised; thus even for a late-comer the actual session state can easily be generated.

3.2 The Development Environment

The development environment provides a big object oriented class library based upon the standard Java library. It contains 190 classes with more than 2500 methods and is steadily expanded for new kinds of co-operative applications. It is structured into three layers.
The *base layer* offers general classes for user interface design, general data structures, general network services and other utilities, which are not groupware specific but are missing in the standard Java library.
The *service layer* contains groupware-specific classes. For, e.g., session management, data sharing, file transfer, distributed dialogues and special groupware widgets (telepointers, tracking of document views etc.).

The *application service layer* defines the only access to the service layer for application programmers. It includes security checks for all method calls, and thus protects the runtime system. Invalid calls are documented in a message log file. Details can be found in [Roth 97] and [Roth 98].
Using this class library, the DreamTeam front-end (see [The Runtime Environment]) as well as several co-operative applications have been developed so far, a co-operative Web browser will be described in more detail in [„DreamView" - a Co-operative Web Browser].

3.3 The Runtime Environment

Besides providing services to shared applications, the runtime environment offers a set of functions to the end user. [Fig. 1] shows a typical DreamTeam desktop.

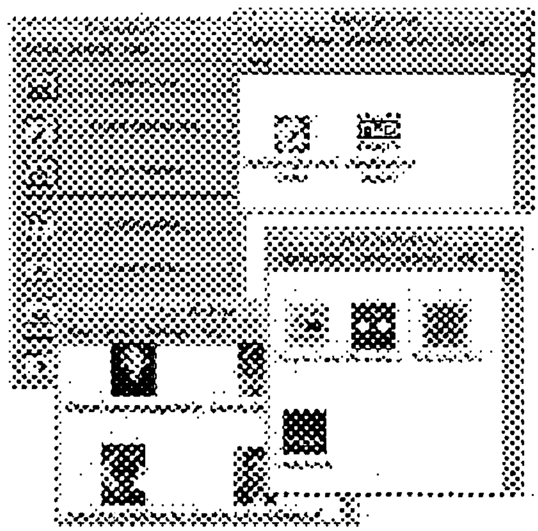

Figure 1. The DreamTeam working environment

The upper left main window allows to

- configure host and user profiles;
- retrieve user profiles of participants of previous sessions (lower left window);
- define and edit session profiles;
- start and stop sessions (icons representing open sessions are shown in the upper right window);
- start private applications (icons are shown in the lower right window);
- view users currently connected to a session.

3.4 The Simulation Environment

The DreamTeam simulation system allows the developer to test his distributed application on a single computer, and to simulate network effects like delays, reduced bandwidths, network failures, etc. To simulate the network, the participating applications are connected to each other via a special program (network simulator) rather than a real network. The simulator transmits every data block to the corresponding receiver. To produce delays and bandwidth effects, data blocks can be stored inside the simulator for a specified time before they are delivered to the receivers. To simulate network failures, the simulation can interrupt the data traffic for a certain time. A user can interactively control the simulator by a user interface, which also provides statistical functions.

4 „DreamView" - a Co-operative Web Browser

4.1 The Concept

DreamView is the first substantial co-operative application developed in the DreamTeam environment. Beside providing a useful tool for distributed education, DreamView has been developed to test and validate the DreamTeam design concept.

DreamView allows a group of users to co-operatively browse the World-Wide Web. The reasons for implementing a co-operative Web browser are manifold. In addition to browsing remote documents, Web browsers can be used to browse local HTML documents; manuals and course materials can be published as HTML trees and distributed on CD-ROMs. In the following, three possible usage scenarios for DreamView are sketched:

A co-operative Web browser as a background tool: In a group session, it would be helpful to have a Web browser as a background tool. For example, a group is developing a program with a shared editor. Suddenly, a specific algorithm is needed. A Web browser is activated and the group visits a site with the corresponding course material. The participants read the specific chapter, find the algorithm, and continue working on their main task.

A co-operative Web browser as a document presentation tool: A Web browser can present formatted documents. In this case, the Web browser is the main tool in a co-operative session. It can be used, for example, to discuss software design documents, graphs and sketches etc. In contrast to the first scenario, internal group documents rather than external documents are discussed and can be annotated by all group members.

A browser as a presentation tool for computer mediated lectures: A co-operative Web browser can be used to give lectures to a student group. The teacher prepares a set of HTML pages. The students put their browsers into tracking mode. Each page and section is synchronised with the teacher's view. In addition, the teacher can use a telepointer to point to relevant items.

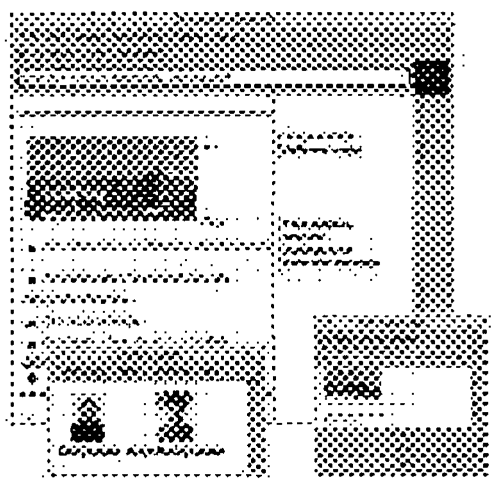

Figure 2. The DreamView browser environment

The browser represents itself as a normal Web browser [Fig. 2]. The largest area is used by the page contents. In contrast to other Web browsers, DreamView provides a separate area for annotations. In the annotation area, textual comments which can be anchored to the page items, can be stored. If necessary, it is possible to hide the annotation area in order to enlarge the page area.

4.2 Group-specific Services

To observe the activities of other users, a special window can be opened (see right bottom window in [Fig. 2]). It presents a radar view of the page area of another user. Each group member can open such a window for each other group member. If desired, a user can jump immediately to the shown page location. In addition, two views can be synchronised (follow mode) in order to follow the same page sections. This mode is helpful for lectures.

To point to specific page elements, a telepointer can be installed. Every user can make his mouse cursor public to other participants.

A problem arises when transferring position information between users: because each user has his or her own workspace settings (e.g. screen resolution, window sizes or fonts), it is not meaningful to transfer platform dependent absolute co-ordinates (e.g. pixel positions). In the case of telepointers, e.g., a textual mapping is more useful than a mapping based upon carthesian co-ordinates. For each mouse position, the browser determines the referenced item (e.g. a word or image). Then it transfers a reference to this item as well as the relative position of the telepointer inside the bounding box of this item to other users. The recipient can now restore the corresponding position, relative to his individual screen settings. If someone points to a specific word, a letter inside a word, or a detail inside an image, on every participant's desktop the telepointer points to the same corresponding item.

4.3 Development Costs

DreamView consists of the following parts:

- the main program, providing the browser window and configuration services;
- classes for the administration of annotations;
- classes for the HTTP connection, for parsing HTML pages and for loading images;
- classes for processing page contents and generating graphical output.

The following tables show the amount of code produced for each of these parts:

Area	Classes	Lines
Main program, user interface	5	1568
Annotations	3	685
HTTP and HTML parsing	5	2075
page processing and graphical output	5	2914

Co-operative aspect	Lines	Realised in part
Basic sharing functions, initialisation	297	**Main program**
Telepointers	148	**page processing and graphical output**
following links and page sections	71	**page processing and graphical output**
distributed data processing of annotations	31	**Main program**

Table 1. Development costs

The right table shows the amount of code related to collaboration aspects.
As a result,

7,6% of the source code is used to realise co-operative functions;

92,4% of the source code is used to realise functions of a single user browser.

This result 'proves' that the uncompromising usage of the DreamTeam platform allows a developer of shared applications to concentrate on the application itself rather than on re-implementing co-operative services.

5 Related Work

This section relates DreamTeam to other synchronous co-operative platforms.

The *Groupkit* system [Roseman et al. 96] is a package for implementing shared applications under TCL-TK. A library offers services for session management, communication and shared dialogue management. It is mostly based upon a de-centralised architecture, only for the group rendezvous a central server is needed. A co-operative Web server called *Groupweb* is built on the Groupkit platform. In addition to telepointers and co-operative browsing, it allows the annotation of Web pages. In contrast to DreamView, a page can only be annotated as a whole. Annotations cannot be anchored to page items.

Habanero [NCSAa] has completely been implemented in Java. Its architecture is centralised, i.e. requires a Habanero server application in order to enable group activities. A co-operative Web browser is available, called *WWW shared session* [NCSAb]. Actually, this browser is the Mosaic browser, which is controlled via a data channel. Thus, group specific services (e.g. telepointers) are not available.

The *Rendezvous* system [Hill et al. 93] provides a distribution mechanism based upon X-windows events. This approach is completely different to our approach, since its emphasis lies on distributing windows contents and user events via the X-protocol. It is difficult to apply this approach to non-X-windows environments.
Share-Kit [Edlich 93] is a Unix-based platform which provides multicast RPC for C programs. Neither session management nor group specific widgets are included in this platform.
Dolphin [Streiz et al. 94] is a co-operative hypermedia system. The emphasis lies on the co-operative editing of hypermedia documents. It is written in Smalltalk and provides one hardcoded application, a shared hypermedia editor.
Compared to other platforms, DreamTeam offers a straight forward implementation of shared application and encourages rapid prototyping. A simulation environment helps to find out weak points and ensures stability before delivering applications to the end users. The de-centralised structure of DreamTeam avoids bottleneck problems with central servers.

6 Conclusion and Future Work

DreamTeam is a platform for synchronous co-operative applications. It consists of a runtime environment, a development environment and a simulation environment. The platform is designed to minimise the development cycle for co-operative applications and to encourage rapid prototyping. The implementation of the co-operative Web browser DreamView indicates the validity of our approach. Only small code segments had to be added to the code for a single user browser to make the application available in a co-operative environment.
The development of the DreamTeam environment is an ongoing process. Each new kind of shared applications requires new services in the service or base layer. In order to define a 'complete' set of services, we are planning to realise a variety of different co-operative applications. In addition to the co-operative Web browser, a chat tool, a drawing tool, a two player game and a co-operative, object oriented graphical editor have been implemented so far. Presently, a sophisticated, co-operative text editor is being implemented.
In order to reduce the time for implementing new co-operative applications, we are working on the definition of a high-level programming language for co-operative application, which supports the development of fully collaboration transparent applications with a minimum of extra source code.

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Impact of Computer Mediated Communication (CMC) on Distance Tutoring

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Abstract: This paper explores how computer mediated communication (CMC) impacts on distance tutoring. It describes the experiences of tutors undertaking staff development in the form of the On-Line Tutors Module (OLTM) to equip them with the necessary skills to deliver innovative programmes employing CMC It focuses its discussion on some of the issues and concepts that we believe significantly alters the nature and role of distance tutoring within a CMC context.

The Context

In the UK there is growing demand from adult learners for education programmes that are flexible in terms of curriculum, modes of delivery and attendance requirements. Many professional bodies are introducing regulations demanding evidence of Continuing Professional Development (CPD) in order to maintain a licence to practice and professionals are looking to Universities to provide innovative and adaptable programmes which will enable them to fulfil these requirements.

Distance learning is of particular appeal to the autonomous self-directed, intrinsically motivated student and would seem to provide the right environment in which the academic, vocational and social demands of busy professionals may be met. However, distance learners often experience feelings of isolation, difficulties in networking with peers and perceived lack of support. Research suggests that communication technologies in the form of computer conferencing and electronic mail have the potential to address some of these problems [Mason, 1994].

Based on earlier, successful pilot projects [Ryan, 1994; Lewis, et.al. 1997] the School of Health at the University of Greenwich in London has recently embarked on an international masters programme which employs Computer Mediated Communication (CMC) at the core of the curriculum process. The philosophy underlying the programme is that learning is a life-long process of active enquiry in which reflection, questioning and re-evaluation are key components [Knowles, 1983]. Adults learn most effectively when they are in control of the process, are encouraged to value, reflect and build on their experiences and are able to interact in a collaborative environment which fosters self esteem and supports both personal and professional growth.

An asynchronous conferencing medium facilitates reflection in a spirit of co-operative enquiry [Heron, 1985] enabling students to apply the skills of critical thinking because there is time to consider the implication of ideas and suggestions in the messages received before a response has to be made. In this way knowledge emerges from the active dialogue through which participants share ideas and information [Gundry, 1992]. Peer-to-peer collaborative interactions have been shown to increase learner satisfaction and involvement in the development of theories of professionalism and professional practice [Tornebohm, 1993]. Geographically dispersed students are thus given the unique opportunity of collaborating in order to develop their professional practice. For the purposes of clarity we define CMC as, *"The use of computers, telephone lines and specialist software to facilitate interaction between students and tutors irrespective of geographical location or time zone."* [Ryan, 1997]

On-Line Tutors Module (OLTM)

OLTM was a curriculum rather than technology led initiative based on a perceived need by tutors that they should acquire new skills if they were going to employ CMC to deliver a new Masters programme. The students in this module were colleagues from Health, Education, Learning Resources and Academic Development, because the innovative nature of this MSc demands a broad range of skills and expertise. Many were novice I.T. users with little experience of distance education and most only had computers at work .

The module aimed to facilitate experiential, on-line learning and tutoring, and the development of CMC skills and concepts over a period of 20 weeks. It included face to face sessions and structured activities delivered and supported by computer conferencing and mirrored how we anticipated the tutors would deliver the MSc. programme. The topics chosen were relevant to the role of tutoring as well as the nature and function of CMC. The activities moved the students progressively from the known (tutoring) to the unknown (the application of CMC).

OLTM has been evaluated by monitoring inputs to the conference topics, and student reflection on the skills and concepts acquired and their feelings and views as participants [Woodward & Ryan, 1996]. This evaluation will lead to guidelines being formulated to help tutors organise and deliver CMC based units. Reflection on the curriculum processes of this module has raised issues and concerns about the potential impact of CMC on tutoring skills and styles [Davie, 1989] as we now discuss.

Practicalities of CMC Tutoring

When devising on-line activities it was found desirable, as with face-to-face (F2F) teaching, to produce an overall plan of a module/unit and to publish it to students - a bit like a scheme of work. It is very important to write clear instructions when composing activities as unlike F2F encounters, students do not have non-verbal cues such as tone of voice or intonation to help them understand the nuances and vagaries of written language. To maintain the dynamic of conferencing it is also advisable to set deadlines. Students engaged in CMC should always be encouraged to make regular and frequent connection to the system and deadlines help to guide them towards the meeting of outcomes and the maintaining of pace which is essential to effective conferencing. We believe that the dynamic and pace of the conference (as in F2F classes) may affect motivation.

A conference may consist of activities very like those encountered in the physical classroom. It is useful to design activities so that they begin with individual and reflective student inputs based on existing experience, moving through pair to small then whole group activities. Such a developmental approach results in a rich store of information that can be used by students and can be a valuable aid to further reflection.

In F2F modes it is perhaps easier to interpret student inputs and to ask supplemental questions to aid understanding. Misinterpretation of virtual speech or *say-writing* is a common problem encountered in CMC environments and tutors must learn to respond appropriately, seek clarification and use the written word unambiguously. It has become evident that both tutors and students use a range of different styles when responding to conference inputs.

At the end of an activity it is good practice for the tutor to summarise, refer back to overall plan and then move on to next activity. Whilst this is equally true of F2F teaching, in CMC everything is on display for future reference as a sort of visual reminder. This can be a very valuable resource but needs to be fairly tightly structured to be of maximum benefit [Harasim, 1989].

The need for tutors to log on regularly and frequently to the system to monitor student activity, respond to and re-inforce points made is fundamental to a successful virtual environment. Students need encouragement and support to enable them to participate fully and effectively in using e-mail and the conference areas. It is helpful if tutors provide clear guidelines for use of all virtual areas.

A CMC environment is possibly more learner-centred because students, especially within a CPD context, are more likely to focus on personally meaningful issues and will keep the topic moving. This to some extent empowers the student to take an active role in their learning process but also means that they must accept the responsibility for that learning.

Impact of CMC on Tutors

CMC tutoring requires a complex, inter-related set of skills to be employed if relationships with students are to be effective and productive. In a CMC environment the absence of non-verbal communication, the potential for mis-interpretation of textual messages and the asynchronous nature of conferencing in combination provide the inexperienced tutor with further complications. Additional skills are required to address these new complexities. Devices employed to provide a form of non-verbal substitute include the use of 'smileys' or emoticons (faces made up of punctuation marks that denote smiles, sadness, anger, etc.) and placing qualifying words and phrases in brackets such as, *what I really mean by that remark is . . .*

Unlike many traditional distance programmes, when using CMC the tutor has an ongoing responsibility for managing a group (as in F2F teaching) as well as individuals. This may also impact on the distance experience and in particular on the quality of relationships between students and tutors engaged in the programme. Indeed, opportunities for interaction between tutors and students are potentially greater in CMC environments, where better access to tutors raises student expectations, may increase contact time, and become more resource-intensive.

CMC facilitates team teaching which is perhaps one of the most innovative features of the application of this new technology to distance education. This can be achieved in a relatively seamless manner and without the same financial implications of traditional team teaching. The technology may also be used effectively for aspects of the planning, administering and managing of a programme and can be seen to be effective in promoting collaboration with other colleagues using CMC. Tutors need to be effective time managers and should develop or adopt strategies and working practices which make the most effective use of the system.

Timetabling of distance education by CMC is both desirable and a problem! The nature of distance programmes, whilst facilitating a flexible use of time may lead to insufficient note being taken of a tutor's overall work load and make it difficult for them to make sufficient time available on a regular basis for the necessary preparation and *virtual contact*. Whilst distance tutoring using CMC allows for considerable flexibility in terms of time and place of the interaction, in our view it is still necessary that the tutor be available to carry out these tasks on a regular basis and not be overloaded with other duties. It is too easy for the apparent flexibility of distance tutoring to become completely dominated and then submerged in the realities of day to day, F2F teaching and administration. This may result in such tutoring being accorded a lower priority than other forms of timetabled contact and lead to less than satisfactory use of CMC which may ultimately impact negatively on students.

Issues and Challenges

An issue which remains unresolved is how one deals with non-participants (lurkers) in the virtual classroom. It is suggested that CMC environments generate an intense need to respond and that any unusual delay is interpreted as rejection. This may be one reason why lurkers are not popular with other participants. We need to design and explore appropriate strategies to address *lurking* as well as discovering what effect, if any, non-participants have on the rest of the cohort.

There is a tension between the suggested practice of regular and frequent connection to a CMC system and deadlines and the more flexible use of time often associated with distance learning. A further tension exists between structured activities with deadlines v more flexible, free-flowing discourse.

In Britain, and we suspect across the world, the issue of copyright and electronic delivery of resources remains a problem. Until publishers allow the use of their materials within secure, virtual communities, other ways of providing resources at an appropriate level and in sufficient quantity will remain a problem.

The nature, quality and extent of technical support may vary according to the institution. The development and maintenance of CMC environments require a blend of skills. A partnership approach embracing technical, networking, curriculum and subject specialist knowledge is more likely to result in an environment conducive to quality learning and teaching.

One of our concerns is to what extent staff need to be trained and experienced in both distance education and CMC? In our view any tutor who is going to operate within a virtual community needs to experience being in such an environment. This was one of the principles underlying the original OLTM which has now been developed into a validated Computer Mediated Tutoring Unit (CMT).

Some Observations

Our experience suggests that employing CMC actually changes the nature of distance education and that those who tutor using this medium need to operate differently from either face to face or traditional distance tutors. As well as the development of new skills, aspects of managing and teaching a group of students remotely have been identified. The issues raised may impact not only on the tutors who employ this technology but also on the students, the curriculum and the institution. This confirms our belief that to become effective on-line tutors, staff need to have the opportunity to acquire, develop and reflect on these skills in order to recognise and appreciate the impact of CMC on the role of the tutor.

An area for future study would be the extent to which CMC impacts on different teaching and learning styles. It is also evident from our work with tutors and a number of students on a range of programmes that a series of new concepts are emerging including *virtual attendance, listening, socialising* and *speaking* amongst others. Further research into these phenomena and the precise nature of the interaction that occurs may help us to understand and exploit this technology more fully.

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Distance Learning Courses on the Web: the Authoring Approach

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Abstract: Emerging educational scenarios propose to try together new forms of distance learning and networking capabilities. Moreover, these scenarios are only sketched, suggesting that soundest conceptual frameworks must be designed for improving available networking tools. In this paper, we propose a framework for distance learning courses, which current focus is the authoring process. Educational applications embrace pedagogical specifies and goals, needing strong support for the authoring process. Aiming to test a design methodology behavior face an educational application to be delivered on the WEB, we modeled a distance learning course about "OO Technology".

1. Introduction

Evolving information technology demands new knowledge and skills. Distributed educational hypermedia delivered via WWW can become effective way to access education resources. The rapid expansion of the Web makes people on the need of continuing education. Moreover, organizations are becoming geographically dispersed and networked. Training is turning financially impractical to bring participants together in the same classroom. All these factors accent the need of deliver education material in a distributed way.

Distance learning has always taken advantage from the development of communication technologies. In the past, post service and new forms of mail delivery have allowed a rise of courses by mail. Today the networking technologies are playing the same role: in developed countries, the technological development already available or currently under development will result in a useful and friendly desktop computer in every home. This development will be available on a mass scale within the next 10 years. The networking technologies are becoming the main focus point of a distance learning system. Facing the networking technologies' growth, innovative distance learning scenarios must be drawn.

Emerging educational propose to try together new forms of distance learning and networking capabilities. Moreover, these scenarios are only sketched, suggesting that soundest conceptual frameworks must be designed, for improving available networking tools and services.

In this work, we propose a framework for supporting the authoring process of distance learning courses. The paper is organized as follow: section 2 presents briefly Web-based distance learning courses; in the section 3, the proposed framework is presented and details about how to design a course are shown. We also present the use of the design methodology OOHDM adapted to model this kind of courses. A course, about Object Oriented Technology, is modeled, aiming to illustrate how pedagogical strategies can be related with design decision. Section 4 offers our conclusions and further works.

2. Distance learning Courses and the Web

The Web is an effective tool for providing information to individuals, teachers, administrators and others. Access to learning resources has never been as easy as it is today. Participants could acquire material from whatever place by clicking on the screen. Internet today provides a wide set of tools like, web browsers, ftp clients, emails clients that become easier the learning process in a distance learning environment. Nowadays, there are millions of users sharing experiences, products and projects on the Web and a lot of them are accessing distance learning materials.

The Web provides a set of standards for handling a wide variety of media types, browser software and server environments that can be integrated fruitfully into a framework that allows a collaborative learning process among students. However, building these kinds of interactive WWW application requires Web browser powered. From a distance learning point of view WWW environment must be more flexible and dynamic and enable one to customize if it is necessary. Java opens up these possibilities by allowing programs to be sent over the Web [Hardlin & Ziebarth, 1995].

Besides the delivering of instructional material, Web-based courses allow asynchronous and synchronous collaboration among peers, real communication among teacher-students and students-students; and a wide access to complementary instructional materials on-line. These features make the Web a rich and powerful learning environment. A critical aspect for developing distance courses seems to be what we can and what we can not simulate of the real classrooms, but overcoming their conventional approach. The Internet provides tools and software applications that enable us to mimic remotely important components of real classes, in addition to features provided by the Web.

Moreover, the success of distance learning courses lays on an effective authoring design. Distance courses must present well-organized contents and clarify the user's pre-requirements, the kinds of student assessments, the ways of interaction among peers, answer-judging procedures and safe and clear manners of communication with the teachers. As result, the design of web-based courses has to be carried out by domain experts, hypermedia experts and skilled instructional designers. During the whole design process it is important keep in mind that students will be working remotely, so they will be alone.

Educational applications embrace pedagogical specifications and goals, needing strong support in the authoring process. Hypermedia models can provide a convenient approach for accessing educational resources and bring us the ability to customize courses, according to customer needs. The diffusing Web brings to the users the opportunity to access to the educational material when and where they want. Therefore, there are striking authoring features that must be improved, but using hypermedia models, the authoring process becomes better.

3. Framework for Distance Learning Course on the Web

Designing and developing web applications is a complex task that involves a variety of activities, either at the storage level, access level and presentation level. As result, the constituencies participating in hypermedia projects differ from those of traditional software development environments. Hypermedia projects involve content-authors, musicians and graphic designers, as well as programmers, software managers, and users. Moreover, aesthetic and cognitive aspects, so important for hypermedia applications, are foreign to existing software engineering environments. Thus, there is a need for special methodologies and tools to support the software development process of hypermedia applications [Díaz et al., 1996].

On the other hand, building an educational hypermedia has differences with conventional ones. Conventional hypermedia systems have a definable structure to be modeled. Educational ones have to deal with abstract concepts and have a high grade of interaction.

To minimize this complexity, frameworks and authoring systems for helping the developing and delivering of distance learning courses have being presented, such as [site Habanero], [site Web Course in a Box], [site Top Class] and [site WebCT]. Therefore, both frameworks and authoring systems neglect the courses authoring process. We propose a framework for distance learning, which core is the authoring process of courses [Fig. 1]. The framework is composed of:

- a hypermedia design methodology for authoring the course which help the building of the nodes and links network;
- links to related Web sites;
- a set of Internet tools;
- a site specifying the students kinds of assessment;

- a site for indicating the students tasks; and
- links to a set of software and other executable resources needed for students work.

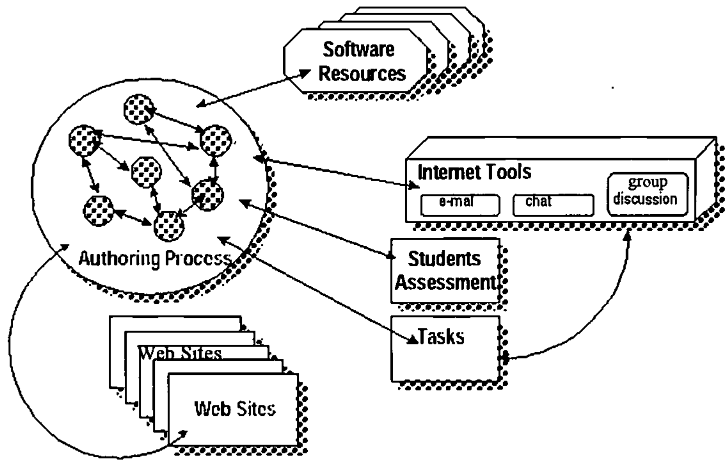

Figure 1: Distance Learning Course Framework

In this work, we detail the authoring process and offer an overview of the other components of the framework. In order to model distributed educational hypermedia, we also propose to use a flexible hypermedia design model - OOHDM [Schwabe & Rossi, 1995]. To show how OOHDM works we designed an Object Oriented Technology course.

3.1 The Educational Hypermedia Design Process

Authoring educational hypermedia application is a critical point. The author must follow the educational goals and an instructional approach for creating associative and meaningful links among nodes. Nodes could support individuals knowledge webs. The complexity of the authoring process demands effective design models. Considering the complexity of developing Web-based applications and the pedagogical specifies of educational hypermedia, we include in the framework a well known and reported model - Object-Oriented Hypermedia Design Method. The OOHDM - Object-Oriented Hypermedia Design Method, is a model-based approach for building hypermedia applications. It comprises four different activities: conceptual design, navigational design, abstract interface design and implementation.

Conceptual Design: during this activity, a model of the application domain is built using well known object-oriented modeling principles, augmented with some primitives such as attributes, perspectives and sub-systems.

Navigational Design: in OOHDM, an application is seen as a navigational view over the conceptual domain. This reflects the point of view that one of the keys distinguishing features of hypermedia applications is the notion of navigation. Different navigational models may be built for the same conceptual schema thus expressing different views (applications) on the same domain. In OOHDM, there is a set of pre-defined types of navigational classes: nodes, links and access structures. The semantics of nodes and links are the usual in hypermedia applications while access structures may represent alternative ways of accessing nodes.

Abstract Interface Design: once the navigational structure has been defined, it must be made perceptible to the user through the application's interface, which is done in this step by defining an abstract interface model. This means defining which interface objects the user will perceive, and in particular the way in which different navigational objects will look like, which interface objects will activate navigation, the way in which multimedia interface objects will be synchronized and which interface transformations will take place. A clean separation between both concerns, navigational and abstract interface designs.

Implementation: to obtain a running implementation, the designer has to map the navigational and abstract interface models into concrete objects available in the chosen implementation environment.

OO Technology: An Example Design: In the first step, we define a conceptual design. The output is illustrated in [Fig. 2]. We can see entities of the application domain and relationship between them. In our example, appear entities such as *class*, object, method, polymorphism and others that would be studied by the learner. Domain specialist is involved in this step.

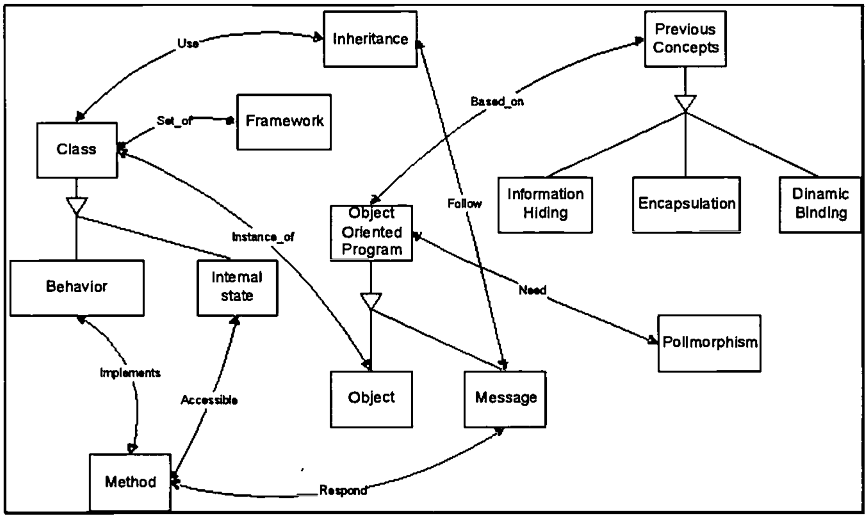

Figure 2: OOHDM - Conceptual Model

Conceptual classes may also be built using aggregation, for example node class *Class* is composed by *Behavior* and *Internal State*. Notice that it is a simplified version of the conceptual model, in a complete version, attributes for each node class we must be added. In the second step, the information represented in the conceptual model is reorganized to achieve the navigational model. We define the intended users establishing a set of operations for each of them. In OOHDM this is accomplished defining views of the conceptual model.

In our example we have two kinds of user: Initial Learner and Advanced Learner. Every node class shown in the [Fig. 3] has two views, one to be used when the learner is an initial student and the other to be used when it is an advanced one. Figure 3 shows a subschema taken from the model of [Fig. 2], and it represent the navigational space experimented by a initial learner.

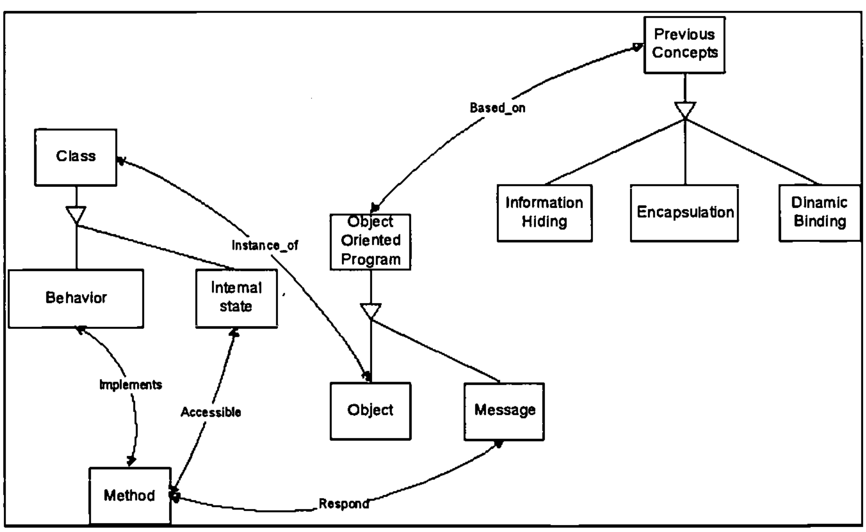

Figure 3: OOHDM- Node classViews

In [Fig. 4] we illustrate the navigational schema for the course of Object Oriented Programming. Next, we define the navigational contexts, and the navigational classes related to these contexts. It allows us to see each class of the conceptual design.

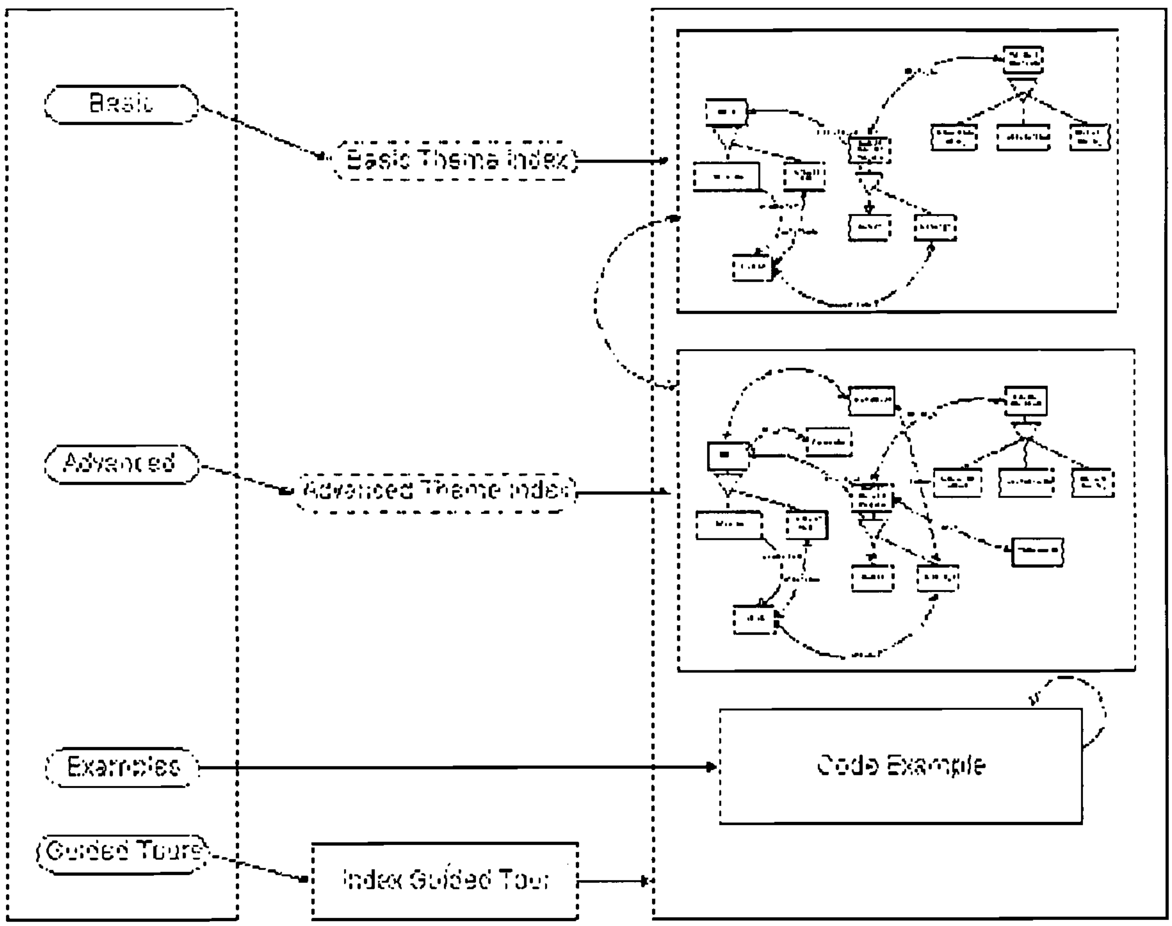

Figure 4: OOHDM - Navigational Scheme

3.2 Implementation Issues

Until a few years ago, software developing in the Internet was a hard task. The improvement of programming language, such as JavaScript, and some ease-to-use new features, such as available plug ins and applets Java, have turned the WEB environment more stable and robust.

The proposed framework runs over a Web browser, and integrates available communication and collaboration tools via Internet protocols such as: FTP (File Transfer Protocol) for downloading files, NNTP (Network News Transfer Protocol) for accessing discussion groups, POP 3 (Post Office Protocol) for accessing electronic mail and IRC (Internet Relay Chat) for conducting multi-user meetings (chat).

For helping the authoring process of distance learning courses, the framework provides a Web link to the OOHDM site and, in a near future, we are intending to integrate an automated tool - the RMCase [Diaz et al. 1995]. Other features of the framework are being implemented as HTML pages and forms.

Distance learning courses in the framework are Web sites composed of HTML pages and forms, added to some synchronous and asynchronous cooperative tools available in the Internet. Since it is already hard to reach real interaction in the Internet, the interaction was been placed in cooperative virtual spaces. A set of cooperation and communication tools was integrated to applications via Internet protocols. In the framework, distance learning courses include improving students learning process, giving them an active participation and letting to maintain contact with teachers and other students through electronic mail, discussion groups and chat sessions for questions or comments about the instruction.

Our first distance learning course - OO Technology, is just modeled. Then, we do not know the students' aptitudes face the distance learning approach and some questions arise:

- Will the users learn better with this approach?
- Will they work cooperatively?
- Will distance learning improve their autonomy?
- How to assess their performance?
- How to avoid the disorientation and cognitive overhead when they are exposed to the WEB?
- How much time professors will must to spend logged in the Internet to supervise and help users?

4. Conclusions and Further Works

The Internet expanding and the need for distance learning are bringing new educational challenges. We are facing this challenge and have started the developing and delivering of distance learning courses in hypermedia format.

The emphasis of our work is the belief that a strong authoring process can result in well-designed distance learning courses. The modeling of OO Technology course shows how pedagogical strategies are related to design process. OOHDM gives the necessary support for the process of designing the OO Technology course. The chosen methodology supports pedagogical specifies found in educational hypermedia and performs well in networking environment, since all its modeling steps keep independence from hardware and software platform.

Further works are related to:

- refine, implement and evaluate all framework features;
- test the distance learning course effectiveness and consistency, both in pedagogical and computational points of view; and
- verify the reuse level of the OOHDM conceptual design for developing other similar courses.

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Creating a Psychological Foundation for the Evaluation of Pre-Packaged Software in Second Language Learning

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Abstract

For over three decades, scholars have been struggling to determine whether computers truly enhance foreign language learning and, more recently, specifically how. In this paper, we attempt to merge specific psychological theories of knowledge acquisition, the impact of pictures on cognitive processes, and theories of effective pedagogical approaches to foreign language learning in order to assess commercially available software for its effectiveness, specific impact on learning, and classroom uses. Within a psychological paradigm which includes an awareness of how mental models are formed, how domain knowledge enhances the process, and how images can impact upon learning against the backdrop of dual-code processing, an adherence to doctrinaire beliefs in one methodology can be broken down, leaving room for progressive pedagogical approaches which attempt to integrate what is valuable from cognitivist, behaviorist, and communicative approaches. Having made selection of method our first priority, we look at a variety of software packages currently available and consider how they may be impacting upon the learner.

I. Theoretical Framework

The research in the psychology of language learning is staggering in its quantity and approaches. On top of this, for over three decades, scholars have been struggling to determine whether computers truly enhance foreign language learning and, more recently, specifically how. The clash of hyperbolic positivism versus dogmatic skepticism about whether or not computers are effective tools makes it imperative that scholars and teachers accurately and thoughtfully start to articulate goals and methodologies when multimedia, hypermedia or any media is integrated into any curricula. Carol Chapelle writes: "Advancements in the design and use of computer-assisted language learning (CALL) activities require that key questions about CALL be identified and effective research methods be used to answer them…[Second language] classroom research suggests the need for descriptive research documenting the nature of the interaction that learners engage in within various CALL contexts [Chapelle 97]." In this paper, we attempt to merge specific psychological theories of knowledge acquisition, the impact of pictures on cognitive processes, and theories of effective pedagogical approaches to foreign language learning in order to then assess commercially available software for its effectiveness, specific impact on learning, and classroom uses. Three questions are key to such an exploration:

1) Can the potential effectiveness or use of these software programs be systematically evaluated based upon a psychology of language learning?
2) What is the psychological impact of the linking of text, sound, and pictures? Does the ability to do so through the use of multimedia somehow make the computer a more potent tool for learning than ever before? And does the *way* the program links these elements further determine how they impact the learner?
3) Is it possible to articulate an integrated use of these tools within a curriculum based upon the answers to these questions?

The process of learning alone and the shifting terrain in our approaches to teaching are complex even without the complicating factor of selection of medium. It has been pointed out that in recent years, emphasis in language instruction has shifted to process, rather than product and to attaining communicative competence over and above learning structure [Puscak & Otto 97; Littlewood 92]. Language learning is increasingly considered to be a process in which set of habits or automatized skills are created which then become imbedded as mental models in the mind [Littlewood 92]. More and more studies of computers in learning are implicitly or explicitly based upon the understanding from cognitivist theories that the computer creates, acts upon and reacts from mental models [Seel et al. 89; Cousins & Ross 93; Mayer & Sims 94; Mayer & Gallini 90; Bernhardt 84; Snow 84; Masny 84]. A mental model can be loosely defined as a "construction of an internal model of the world" which is "persistent and stable" [Seel et al. 89]. On top of the layer of mental modes, there is the level of skill and control, according to Ellen Bialystok. "Language processing…is based on a set of two interacting subskills, or skill components. The skill components are called analysis of linguistic knowledge and control of linguistic processing. These skill components are part of the cognitive mechanisms for learning, organising [sic] information, and solving problems [Bialystok 91]."

In order to impact upon pre-existing mental models or to create a new mental model, domain-knowledge has been found to be important. Domain knowledge has been defined as pre-existing knowledge of a particular subject matter. In a study of how learners processed pictures of katagana and hiragana through observation of eye movements, it was demonstrated that when learners were exposed to the characters without any prior introduction, eye movements were random and processing apparently shallow. However, when they were given a general introduction to how characters are formed and read, their eye movements showed regular patterns which indicated perception of meaning and content within form [Koga & Groner 89]. This study again emphasizes an integrated approach to learning, in which lower-level and higher-level processes in learning can be accessed depending upon the learning context.

Karen Swan and Carla Meskill have postulated that a computer represents cognitive processes so habits of thought are internalized [Swan & Meskill 96]. The use of a computer program can build new mental habits and plans of lower- to higher-levels of complexity throughout an overall class plan, as well as doing so cyclically, depending upon areas where students may hit a plateau or need to regroup to focus on particulate skills rather than communicative competencies. This is consistent with Littlewood's holistic view of how language use works: "When we use language, we are constantly having to create new higher-level plans at the level of ideas, meanings, and conversational strategies. The effective execution of these plans depends upon a high degree of automaticity at the lower levels [Littlewood 93]." A common complaint among language teachers is how difficult it is to adapt materials developed independently of textbooks. However, if the goal is to bundle a variety of different types of exercises in order to immerse the learner in varied contexts and to provide varied and targeted communicative input, then any tool such as software, video, or an audiotape can enhance what is offered in a textbook. Modality must suit the method. "Sometimes the question arises whether a specific medium, as a result of its mode of presentation, may create certain symbols and codes in the domain of knowledge representation by favoring the storage of information in a format which is congruent to the modality of presentation [Seel 89]."

How do images enhance language acquisition or affect mental modes? This is particularly crucial in light of the capacity of digital media to provide more direct, varied, easily controlled and mediated visual input to support and enhance aural comprehension and use of the target language. It is illuminating to reflect on the fact that in the evolution of cognition, writing developed from sketches [Molitor et al. 89]. In a sense then, it could be said that as digital media infiltrate more and more of our communication and learning processes, we are returning to a dependence upon a cognitive tool predating writing. Innumerable studies have proven conclusively that pictures enhance learning, especially in high-ability learners. Stephen Krashen, who developed the natural learning theory of language acquisition, notes "whatever helps comprehension is important. This is why visual aids are so useful. Pictures and other visuals ...supply the extra-linguistic context that helps the acquirer to understand and thereby to acquire [Krashen 83]."

Articulating a psychological theory of how pictures affect learning, Sylvie Molitor and her colleagues echo Krashen's view: "Texts and pictures...visualize parts of reality which are not immediately present or accessible in one's direct experience" and are "mental models" in which "reality is represented in an analogous, predominantly imaginative form...Corresponding to their prior knowledge and their cognitive strategies, learners build up a specific knowledge structure based on the information obtained from texts and pictures [Molitor et al. 89]." This view is shared by G. Salomon who notes that when texts and pictures are combined, "they often determine how stimuli are perceived and processed [Salomon 89]." When studying a new language, a learner starts with very little, if any, prior knowledge. In the process of acquiring this knowledge, according to Krashen's theories of natural learning, the learner must "acquire...language by understanding input that is a little beyond [his] current level of (acquired) competence [Krashen 83]." Just as a child's knowledge base is increased by external stimuli, so images as teaching tools can push this envelope in direct and indirect ways.

One of the most obvious ways in which pictures interact with text is through modeling. Just as a learner might use a grammatical model to understand personal pronouns, so she might depend upon a picture to illuminate the content of a conversation in German. In the former example, modeling is being used as a skill-based or non-communicative learning exercise, while in the latter example, the modeling as exhibited by the picture can be used either for a task-oriented or communicative practice. Ultimately, both modalities serve to build up and reinforce increasingly complex layers of knowledge that can be tapped into when needed, consciously or unconsciously. But more than the function of images as models or for spurring language production by giving the students something to talk about using new forms, what seems particularly significant is the concept that pictures "activate schemata" and support comprehension. The implication may be that if a learner has built up a body of knowledge through a variety of skill-based and communicative practices, that images will lower what Krashen calls the affective filter or break down learner resistance to acquisition and production of new forms on a *neurological* basis.

This theory essentially postulates that the more modalities properly targeted, as is suggested in theories of dual-coding, the capacity for learning is expanded. According to dual-code theory, the learner uses two distinct information-processing systems—one that represents information verbally and one that represents information visually. For learning to be meaningful, there must be a connection constructed between the two [Mayer & Sims 94]. This means that it is better if material is presented in two or more formats to construct knowledge models promoting visual, verbal, and referential connections. When this is done, studies have shown that learning is likely to be more successful [Mayer & Gallini 90]. This idea is similar to Chun and Plass' speculation that text "represents information in symbolic structures of a language and is processed sequentially, that is, word by word or sentence by sentence. Pictures, on the other hand, convey their information by means of a visuo-spatial structure...and thus represent the subject matter by employing an analogy based on common structure properties and encode information parallel or simultaneously [Chun & Plass 97].

Dual-code theories make clear how and why images can enhance learning. The next question is how pictures work specifically so that the appropriate modality can be selected. Molitor provides four functions of pictures in learning useful in discussing the impact of foreign language software on learning.

- In the representation function, "the picture overlaps the contents of a text...the picture is a redundant source of information to constantly check text comprehension by offering...a second opportunity for learning.
- The organization function of a picture "provides an organized, coherent, reductive macrostructure of the text content."
- The interpretation function "illustrates text contents which are difficult to understand (e.g. by analogies, visual metaphors, etc.)."
- The transformation function "offer a mnemonically useful form of recoding, being a kind of visual mnemonic. This is the function pictures often have in the 'keyword' or 'hook' technique for learning vocabulary in foreign language instruction [Molitar 89]."

Other studies have shown that visual and verbal processes can also compete with one another. It is therefore important to determine that the pedagogical motivation behind the combination of text and visuals is not creating conflicts in processing and retention of materials [Loew 95]. Robert Kozma theorizes that computers primarily have transformational capabilities, or the ability to make connections between symbolic learning and real world situations. "First, an important attribute of the computer is its ability to symbolically represent entities in ways that might inform mental models. They can graphically represent not only concrete objects but also formal, abstract entities that novices do not normally include in their models. Second, the computer has the important capability of being able to proceduralize the relationships among these symbols [Kozma 91]."

In a study researching the effectiveness of a program called *Thinker Tools* which teaches Newtonian mechanics, students who used the program scored significantly higher than the control group. In another study, students using a software program called the *Jasper Woodbury Series* also scored higher than the control group. According to Kozma, it was the computer's ability to model objects in motion in the *Thinker Tools* program Which enabled student to construct complex and dynamic mental models of the materials. In the case of the *Jasper Woodbury Series*, Kozma states that "the visual and social nature of the story, as presented with video [was] more likely to activate relevant situation-based prior knowledge so that students can use this to solve the problem. They are also more likely to connect their new learning to representations of situations as it is stored in memory. This will increase the likelihood that when similar problem situations are encountered, they will evoke an appropriate solution response. "By repeating the same kinds of analyses and solutions in multiple contexts or situations with very different surface characteristics but common underlying task demands, these learned solution strategies are connected to a variety of situation schemas in memory and this promotes transfer across a variety of subsequently encountered problem situations [Kozma 95]." Kozma concludes in another discussion on learning with media that these effects would be particularly true in foreign language learning [Kozma 91].

Vitor Duarte Teodoro reflects this emphasis on targeting a cluster of learning modalities. He calls for computer environments which "demand cognitive and metacognitive skills." Cognitive skills are defined as the ability "to manipulate and integrate information" and metacognitive skills as the ability "to regulate and control their actions and knowledge in order to build new knowledge." Extrapolating from this idea, Teodoro is interested in the development of exploratory programs which "allow students to get a strong degree of familiarization with an idea. With exploratory software, students can see many situations, explore what happens in different conditions, discuss what happens if they change conditions...When they become more familiar with new ideas, they can establish more meaningful relations with ideas they already have [Teodoro 1994]."

Within a psychological paradigm which includes an awareness of how mental models are formed, how domain knowledge enhances the process, and how images can impact upon learning against the backdrop of dual-code processing, an adherence to doctrinaire beliefs in one methodology can be broken down, leaving room for progressive pedagogical approaches which attempt to integrate what is valuable from cognitivist, behaviorist, and communicative approaches. Having made selection of method our first priority, the medium can complement the learner and facilitate operations the learner is capable of performing and perform those which the learner cannot [Kozma 91 & 95]. Our view of media in learning can then be similarly integrated, holistic, and flexible as Robert Kozma notes:

> Specifically, to understand the role of media in learning, we must ground a theory of media in the cognitive and social processed by which knowledge is constructed, we must define media in ways that are compatible and complementary with these processes, we must conduct research on the mechanisms by which characteristics of media might interact with and influence these processes, and we must design our interventions in ways that embed media in these processes [Kozma 95].

II. Putting Theory to Work: Evaluating Commercially Available Software

Software currently available on the market for educational or mass-market use stretches across a wide spectrum of quality and thoughtfulness in design. When initially considering the use of any type of media which uses video or pictures, it is important to know that studies have shown that audio support has no positive effect on *retention* of words [Puscak & Otto 97]. This is probably true because it is postulated that processing of spoken and written text involves similar cognitive processes because they are symbolic representations of information [Chun & Plass 97]. On the other hand, as we have already said, other studies have shown conclusively that pictures increase recall if they illustrate information central to the text [Kozma 91 & Weidenmann 89]. The most basic computer programs developed now in foreign languages mainly differ from traditional audiocassettes in their attempt to provide moving or repetitively appearing pictures to model the text and act as a visual hook for memorization. Therefore, even when the capability of multimedia is used only at this basic level, it follows from the research that these programs might be slightly more successful than a similar audiocassette exercise with only oral input. Since such programs are generally designed for beginning learners who have little domain knowledge of the subject matter, they will be more successful if they focus on smaller units of sound and speech.

Programs such as *Talk Now!* and *Learnware* fall into this category and explicitly work on lower-level processes such as pronunciation and aural recognition of words. In *Talk Now!* multiple exercises around the same content in which the same pictures appear and reappear seem to be an attempt to reinforce and stabilize a learner's basic knowledge base of pronunciation and intonation, and, in the case of the less-commonly-taught languages, such as Russian, of recognition of the non-Latin alphabet, a huge cognitive leap in and of itself for which a whole new mental model must be created. Especially in the case of *Learnware*, which provides eight "Teaching" segments on pronunciation (and character writing for the non-Latin scripts) and eight "Games" where the student works with the knowledge acquired through teaching, the learner is being immersed in varied contexts, thus providing varied communicative input. The fact that studies have also shown that learners adjust their behavior according to the amount of instruction they receive would lean in the favor of programs providing many exercises [Hannafin 95 and Vosniadou 94]. Additionally, in the case of *Learnware Chinese*, the learner is guided into a study of pronunciation with an introduction to the Chinese tonal system. The intention is clearly to acclimatize the learner to listening with a different intent at the outset by creating the minimal needed level of domain knowledge.

Other visual hooks used in pronunciation exercises are included in *Learnware* and *The Rhythm of French*. The movement of lips, tongue, and breath are modeled through moving diagrams and can be clicked on repeatedly so that the learner can attempt to imitate the action of the model. In *The Rhythm of French*, focus on pronunciation is robust, with extensive explanatory text used to create domain knowledge, audio to allow learners to hear the differences as the text is read aloud to them, and multiple exercises involving the diagrams and other mnemonic hooks to reinforce aural recognition and production. Indeed, *The Rhythm of French*, a three-volume CD set, uses the benefits of multimedia to complete advantage with probable high learner success in this area high, even with low-ability learners. What is the most powerful about this program is how much control the learner has over all the material and the pace of instruction. In this sense, it is capitalizing on the fact that "Hypermedia supports constructionist views of learning, which hold that learning takes place when students actively and collectively build internal knowledge structures." In the case of *The Rhythm of French*, as Swan points out, this process has been made "explicit, thus increasing the likelihood that students will internalize what they learn [Swan 96]."

Many programs at various levels of difficulty use audio waveforms to graphically illustrate the audio pattern of speech. The program *Transparent Language* calls this feature the "sound palette." The learner is expected to record her own voice and attempt to match the wave form of the native speaker's voice, an example of the organization function in which the image provides summary of the content. In addition, by providing additional visual input to match the aural input, these programs are conceivably creating "additive effects in recall" by coding the information through the verbal and nonverbal systems. As Chun and Plass point out, "Information in a symbolic representation is stored in the verbal system; information in a nonverbal, analog representation is stored in the nonverbal system [Chun & Plass 97]."

One of the few software programs designed with an awareness of how multimedia can capitalize on the psychological processes of language learning is *The Rosetta Stone*. Indeed, because of this fact, *The Rosetta Stone* is perhaps one of the more powerful learning tools on the market today. Its developers explicitly based their methodology on Krashen's theories of natural learning. In their promotional flyer, they write: "the best model for learning a new language is the natural way in which we learned our native language. This idea has been espoused by a school of thought that emphasizes comprehension of spoken language as the first step to acquiring fluency. This is called 'the comprehension approach' or 'the natural approach'." *The Rosetta Stone* provides the learner with gradated comprehensible input, always pushing the envelope of the learner's knowledge just a little above what they have just acquired. Their flyer reads: "The native language is learned by hearing simplified speech in a context which provides the cues that make this speech comprehensible. This context also provides immediate reinforcement to the child...[*The Rosetta Stone*] works in the same way. It uses thousands of carefully selected pictures to create contexts where the meaning is clear. The program elicits the student's response and gives instantaneous feedback, confirming the comprehension that takes place."

The Rosetta Stone is designed directly from the concept that media can be a mediator of information or is an 'external model' of reality. This program could be said to be "activating subjective knowledge about the significant facts and the available modes of presentation...Thus external and mental modeling...is intended to produce a plausible (subjective) explanation of a particular appearance existing in the external world. External modeling is intended to evoke cognitive processes in itself in another (known) recipient of information, to facilitate or to cause mental modeling [Seel and Strittmatter 89]." For instance, in the first unit of the Russian version, students are exposed to individual words. Then each lesson increases in grammatical and syntactical complexity. Each unit can be worked with in a variety of different formats: sound with pictures, sound and text with pictures, text and pictures, and so on. In other words, the learner or teacher can select the modality to be emphasized depending upon the skill to be acquired and activated: aural, oral or reading comprehension. A selection of emphasis can also be based upon learning styles: Is the learner visually oriented? Does text help them understand spoken language at the outset? Do they want to work on becoming more accustomed to the new alphabet and spelling rules?

The language in *The Rosetta Stone* is consciously decontextualized or disembedded in an external context in order to affect deeply the internal model. By gradually wearing away the affective filter, or lowering the learner's resistance to the activation of new knowledge structures in communicative contexts, new communicative plans are replaced and created. With the new schemata in place, the learner can then extrapolate grammar in similar structures. For instance, *The Rosetta Stone* for Russian provides a series of exercises on the genitive declension using a small selection of adjectives and nouns. The material, presented amodally with increasing levels of complexity in each segment, gradually allows the learner to build lower- to higher-level skills. "Identifying needed information and disembedding it from a context is an important component of learning to solve problems and this ability contributes to successful transfer and performance in subsequent real-world situations [Kozma 95]." Eventually, when the new case is needed, having been disembedded for the purpose of creating an internal model in relationship to other structures and forms, it can be activated in communicative scenarios in direct relationship to other components of language structure relevant to meaning.

This process occurs because of the unconscious associations established through the use of text, sound, and pictures. The pictures in *The Rosetta Stone* fulfill a "representational function": they support the initial process of comprehension by helping the student link text and sound with a picture. Once the necessary connection is made between sound, text, and picture, then the image acts in a transformational way, becoming a mnemonic or hook leading the student repeatedly back to the previously imprinted knowledge. The active involvement of the learner in selecting pictures to match text and sound also successfully hooks especially the low-spatial ability learner who has been shown to "only be able to keep referential connections when visual and verbal information are presented simultaneously [Mayer 94]."

Such an active and complex engagement of the picture in the learning process in these programs is unusual. In many programs, pictures serve no purpose other than to illustrate the overall content of a dialogue, much as a picture in a book might do, and seem to be thrown in as an afterthought to the pedagogy, rather than as central to it. In a program called *French Your Way*, each "Study Conversation" has a picture illustrating the action in the dialogue. Although the picture technically serves an organization function, learning at the level of internal models are not being significantly helped or hindered by the pictures because the dialogues are relatively complex. In a Spanish program developed by Holt, Rinehart, and Winston called *Encuentros*, the pictorial backdrop is clever, but seems to be more illustrative than interpretive or transformational. In short, the power of multimedia is in its ability to use images, whether static or in motion, as a recoding device, as illustrative of difficult to understand content, or as representative of unknown content. What is lacking in *Encuentros* and *French Your Way* when considering what multimedia is capable of doing is that the pictures are not focusing the reader's attention on certain aspects of the information, thus improving the chance that the information is processed. Nor are they supporting the reader's building an internal connection among units of information presented or building connections through the images between the ideas in the text into existing mental models [Chun & Plass 97].

However, the strength of *French Your Way* and *Encuentros* is the degree of control given to the learner to determine different outcomes within established scenarios, such as "Dining Out" in the former [Vosniadou 94 & Snow 96]. They are attempting to use the computer to provide as real a communicative scenario as possible where higher-level processes are completely engaged. Another very popular and pedagogically successful program called, *A la rencontre de Philippe*, also does this by allowing learners to accompany the protagonist, Philippe, on a journey through Paris to find a new apartment. The story is videotaped and learners can determine the outcome of the story depending upon their choices from a multiple-choice menu offered at each juncture in the story. It is in *Philippe* that we see the power of digital media to provide as complete an immersion experience as possible through the use of video and random access leading to use of higher-level processes. It is exemplary of how "the visual and social nature of the story, as presented with video, is more likely to activate relevant situation-based prior knowledge so that students can use this to solve the problem...By repeating the same kinds of analyses and solutions in multiple contexts or situations with very different surface characteristics but common underlying task demands, these learned solution strategies are connected to a variety of situation schemed in memory and this promotes transfer across a variety of subsequently encountered problem situations [Kozma 95]."

We are all aware that the best way for learners to acquire a second language is visit a country where that language is spoken and to experience the stress of needing to communicate actively. Most of our students who return from overseas come back far more fluent in all or some of the four basic skills depending upon their individual strengths and weaknesses: aural and oral comprehension, reading and writing. In *Philippe*, the images presented not only enhance or support comprehension, but in fact engage the learner in as real-life a conversation as possible. Learners are able to read and interpret various non-verbal and sociolinguistic clues to extrapolate meaning, just as they would in a real-world conversation. Vosniadou wrote that approaches in computer-assisted-language-learning were needed which would "emphasize the need to construct learning environments that engage students in culturally meaningful, purposeful and authentic activities that make deliberate use of the physical and social context... and which allow them to experience higher-level processes [Vosnaidu 94]." *Philippe*, *Encuentros*, and *French Your Way* attempt to do this with relative success.

Other features found to be empowering in the learning process include interactive pages, construction tools, note-taking capabilities, nonlinear access to background information, and open-ended questioning [Swan 96]. Programs like *Transparent Language*, *CineInteractive*, *French Your Way*, and *CyberBuch*, a CD on German literature, provide some combination of the above elements. In *French Your Way*, in addition, learners can also control the speed of speech in addition to having access to textual help when something is not understood. This latter feature is consistent with studies suggesting "that annotating lexical items with different modes of information presentation has positive effects on vocabulary acquisition [Chun & Plass 97]." *Transparent Language* which provides authentic literary texts replete with grammatical and cultural notes, annotations, translations of the entire text, a dictionary, various games emphasizing grammar, vocabulary, and pronunciation, and either a slide show or a video accompanying each text, is a very successful program probably because of its multi-layered design. When learners can approach material in a variety of different ways depending upon individual preferences and needs, it has been shown the deeper the level of knowledge acquired [Hannafin 95].

III. Conclusion

It is striking that even in the past six years, research on the effectiveness of computer-assisted learning has increased dramatically. Whereas studies in the seventies and eighties were largely inconclusive as to the effectiveness of computer assisted learning, as the technologies have become more powerful, so has their potential *and* proven impact on learning in many disciplines. As Puscak and Otto point out, current technologies have created a "paradigm shift" that "will challenge traditional definitions and assumptions about the role of the student, the teacher, and the print textbook in language study. The basis for such a challenge is anchored in the prospect that multimedia can provide self-contained instructional experiences in a way that non-interactive media cannot [Puscak & Otto 97]."

Many of these software programs can be used independently or as a supplement to regular classroom instruction, giving the learner more control over the learning process than ever before. In addition, the wide array of modalities used to impact upon knowledge acquisition through a variety of different means promises to make more multidimensional what can be done in an ordinary classroom with just a textbook and a single speaker of the target language. These analyses of software are only meant to be suggestive; the next step would be to initiate studies testing these theories. We anticipate that such focused research methods will show that these tools are even more powerful than we had originally hoped and will dramatically change the ongoing dialogue about the effectiveness of the new technologies.

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Education Direct - Entering the World Beyond the Web

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Abstract: This paper reports on a major and innovative project called Education Direct, where the next generation Internet technology, based on IP multicasting, has been used in practice over large geographic distances involving a wide variety of students and teachers. Education Direct utilizes the mStar tool suite, which exploits IP multicasting to provide fully symmetric use of audio, video, group-synchronized web-browsers,whiteboards, chat, voting, recording, replay, annotation and editing. All integrated into the end users regular desktop computer, making education both more available, independent of place and to some extent time, as well as of higher perceived quality.

While many observers would judge the large scale application of this rather advanced technology less realistic, we can hereby report the contrary. The experience has been surprisingly positive, and the resulting environment is, by many people, considered to give better quality than the alternative of physically attending a lecture. The paper reports on the methodology, context, technology, and experiences gained over a year of practical use.

1.0 Background and Context

Education Direct is part of a larger effort to deploy new technology to better support all kinds of cooperation, interaction and information access. The goal is to create an environment where people can work, learn, do business, socialize and be entertained, with less regard for their geographic location. While this paper is about education, we believe it is important not to isolate this aspect from all other parts of life, but to integrate it. As a consequence of this philosophy, the tools used in this project have been designed to be equally useful in other contexts, such as distributed projects, marketing and support, and even media and entertainment.

The project is part of an ambitious effort of making the County of Norrbotten a pilot example of an electronic marketplace in a wide sense, where many of the everyday tasks should be possible to carry out over the network. This includes governmental and community services, marketing, purchase, and other business interactions, distributed work and consultation, medical support, education, media and entertainment.

The basic communication infrastructure consists of 155 mbit/s ATM links going to all communinty centers, which may be small villages down to a few thousand people. More important is however that multicast capable IP is run on top of this transport network, enabling the use of realtime streams of audio, video and data events to large audiences as part of the regular Internet connection. The Norrbotten County Network is actually just a segment of the Internet that happens to be unusually well equipped with quality of bandwidth and information contents.

Education Direct is part of this, and represents significant progress towards the vision of the electronic presentation and education environment, according to which most courses at the Luleå University of Technology and CDT will be possible to attend independent of physical location. While this would be enough of a challenge, the goal was in fact even broader than so: to transfer not only courses but the use of the technology itself to regional high-shools, secondary schools, small and medium sized companies.

The county of Norrbotten consists of the northernmost fourth of Sweden and covers an area of 400x400 kilometers. The population is sparse, with about 260.000 people. This has meant that many high-schools cannot gather the critical mass and competence to offer the courses and subjects that are possible at other places. The Education Direct project is part of the solution to this problem, because it allows schools to specialize in a subject and amortize its cost over more students than otherwise would be possible. By giving the courses over the network, a sufficient critical mass is generated,creating a county-wide virtual high-school with a breatdh and quality of subjects that would otherwise not be possible. The effects on society are evident.

2.0 Participant profiles and usage patterns

The Education Direct involves, in various ways, several hundred people. It was initiated during the spring of 1996, and spent significant effort on getting a firm rooting among end-users outside the already knowledgeable kernel of technologists. The operational phase started during the fall of 1996. The project involves four kinds of people:

- *Technicians*, who must be able to manage computers and communication equipment to ensure continuous operation.
- *Advanced Users*, who should be able to utilize the technology for doing own productions, presentations, and information searches.
- *End Users*, who need to be able to use the technology to benefit from the information provided by others.
- *Technologists*, who in addition should have an overview of how the technology works, ongoing trends, and principles of the area.

In the first phase of the project an undergraduate course in Internet and distributed multimedia was distributed. The participants came from all over the county, many of which weresecondary-school teachers, (as those will act as local technology transfer persons) and local under-graduate students. The local students had the choice of following the course by attending the lectures physically or virtually using the mStar environment. By choosing the technology itself as the subject for the first main course, the transfer and introduction became much smoother. Explanation of technology, tools, and network became part of the subject rather than a distracting element. The students were in many cases high school teachers, which have become local competence centers and advocates for further deployment of the technology.

Since this first course, during the winter and spring 1996, dozens of courses and seminars have been distributed. All computer science graduate courses, and a growing number of underegraduate courses at the University of Luleå, have been carried out this way. Many seminars have been carried out between high schools, and the usage has even found its way down to rather exotic examples like sixth class students learning spanish in remote villages.

The mStar system allows for many different patterns of use. The initial, and most straightforward, approach was however been to mimic the traditional lecture where a teacher presents her view of the material to the students, using various forms of presentation material. As a basic measure, all material used is made available in WWW accessible form. The traditional overhead-slide projector is replaced by computers and screen projection equipment, (the latter for those who wish to attend the presentations physically), which also run the communication and distribution software. The presenter and the local audience has, therefore, continuous contact with all remote participants.

3.0 Technology

IP-multicast has been used for several years with success on a world global scale under the label of MBone, (www.mbone.com). In addition, it has proven its maturity in a multitude of local contexts, within regions, universities, and company Intranets. It is by most observers judged to be the best, (maybe only), way of providing large scale distribution of interactive multimedia. It tigthly integrates with other existing Internet technologies, including the World Wide Web. At an international level, the IP Multicast Initiative, (http://www.ipmulticast.com/), is a consortia of major industrial players promoting its deployment. Both the MBone and IP Multicast site include good tutorials on the subject. At the most basic level, multicasting ensures efficiency by duplicating data packets at distribution branching points, rather than using todays extremely inefficient and non-scalable use of duplicate streams of the same material for each viewer involved. Multicasting is however much more than so, but represents a rich body of standards on how to define, join, and leave distribution channels, and how to construct tools that utilize it. Because multicasting is inherently two-way, it also bears in it a new depth of meaning for the word "interactive" that has not been provided by previous technologies. The mStar environment, (http://www.cdt.luth.se/mstar) exploits this potential, and currently includes the following components:

- Audio. mAudio for telephone level quality audio, mRadio for high quality mono, and mIR for distribution of CD quality stereo, (using MPEG audio).
- Whiteboard. mWB for shared whiteboard, documents, and pictures. Distributed Presentations. mWeb is used for distributing web-pages and synchronizing audiences web-browsers on common pages.

- Chat. mChat for textual group intercations. Voting. mVote for definition, issuing, and immediate graphical visualization of voting alternatives.
- Video. mStar is reusing the well known "vic" application for low to medium quality video, (such as H.261).
- Floor control and attention getting. mWave allows for people to electronically "wave their hand" and maintain the order among multiple wavers.
- Application sharing. mShare for integration of application sharing system.
- Media Recording and Replay. mMOD records and replays multicast sessions, (not only audio/video, but all tools involved).
- Session/channel information. mSD is web-based application for presentation and joining of multicast channels.
- Session Editing. mEdit allows for Indexing, editing, and annotation of recorded sessions.
- Presentation authoring. SlideBurster allows for easy creation of Web based material for distributed presentations (as is used for mWeb above).
- Network adaptions. mTunnel is used for transfer and scaling of multicast traffic over unicast links, which is important for deployment in areas where multicasting is not completely settled.

While the usage scenario described here is distributed education, mStar is in fact largely developed within the ongoing Esprit project Mates (Esprit 20.598, http://mates.cdt.luth.se/), with the original purpose of supporting distributed engineering projects. Being written completely in Java, mStar is an example of the emergence of another important technology, the dynamically platform independent and mobile code approach. While Java has been a big step forward, we have not yet seen the arrival of its potentially most important aspect: the on-demand delivery of software in modular components. This is a property of utmost importance in a groupware context, where penetration and success depends on fast growth of a user community, and where the value of a service increases, (and cost decreases), with audience size.

The applications above, (as well as many other tools), are running on top of a rich set of protocol standards at many levels. The Realtime Transport Protocol, [RTP] , is a well known foundation, as well as implementations of reliable multicast based on extensions of SRM, [SRM, RMP]. Recent ITU standards such as H.323 have directly adopted multicasting and RTP, and are therefore inherently compatible to a large extent.

4.0 Network and Preparations

To ensure that the rather extensive software and networking technology would work at all sites, there has been several intensive courses given to local system administrators. The largest part of the prepartion work was however in ensuring the existence of a network with a quality sufficient to carry out the tasks. In this section, we describe the basiccommunication platform.

The Norrbotten county network is a TCP/IP broadband backbone network based on ATM. It is operational today, but has an extensive plan for further extending its capacity. Late 1997, 155 Mbit/s ATM links were established to 15 major connection points. This will support all 14 community centers, and the hospital areas, with broadband services. The backbone will be used for private networks and an open regional network with connection to Internet. Using connections to the open region network is preferred to get connectivity to other organizations as well as locally, regionally and globally through the Internet.

Connections to the open region network, (that is Internet), are universally available at very low prices. Connection speeds are ranging from ISDN up to 100 Mbit/s over optical fibercables and can quickly be upgraded in convenient steps. As part of this project every school, (down to first year), have at least an ISDN connection. This ensures an extremely wide coverage, giving potential for an unusually wide impact on society. During 1998, a major programme for launching ADSL/ADSL Lite technology is under deployment, which utilizes standard telephone copper wire for communication speeds in the order of 1-10 Mbit/s (downstream) and 256-800 kbit/s upstream. The early pilot network, in use from 1995 - 1997 was a TCP/IP leased line router network with 2 Mbit/s connections, with a 2 Mbit/s connection to the Internet. There were about 9000 connected systems in the region. Surrounding the University of Luleå, (where CDT is located), are 2000 appartments connected by 10 Mbit/s through LAN technology.

In many places IP-Multicast has been, and still is, regarded an area of research and experimental usage. Not so in this case, where it has been in native and productive use since 1995. As the pilot network has been a large network with local administration it has been perfect for testing different ways of distributing multimedia with IP-Multicast. It should be noted that while the underlying transport technology is ATM, that is not really a concern of end user nor of applications. IP, (Internet Protocols), is run on top of the ATM transport and is the interface of concern - a pattern we believe is here to stay. Therefore speaking about "ATM networks" is less relevant.

5.0 Experiences and observations

While initial focus usually is on video distribution, our experince is that this medium is not the most important. Rather, most users regard it, after a while, as somewhat fun to have but not essential. Its most important role is actually as a "state-indicator", telling others that a person is actually in place, and maybe what he is doing, (listening, speaking in telephone or talking to someone else).

The reason for the decreased focus on video is probably the rich availability of other media, of which the "*mWeb*" application has proven to be essential. mWeb fulfills the role of the distributed slide projector, ensuring that all remote participants get to see exactly the slides/Web-pages that the presenter shows. It works by catching all Web-page requests at the presenters Web-browser, multicasting those to all participants, where the same pages are given to the local Web-browser. In this way, all participants get a high quality picture of what the presenter is referring to. This approach generates a surprisingly large number of extra benefits: Since the "slides" are now actually HTML pages presented by a local browser, every user can tune the font size and other layout details to his own preferences. For the same reason, the listener can easily browse back and forth in the teachers material, to further consider some part that was especially interesting, even while the teacher proceeds.

Furthermore, since the slides are regular Web pages, including links and Applets, each participant has the freedom to explore those individually. As a conseuqence of moving all presentation material to HTML, we have also noticed a sharp increase of quality of slides. Teachers now tend to include pointers to background material directly in their presentations.

The quality achieved is far outperforming any alternative known, like document cameras and the previously much used Internet whiteboard tool wb. It may sound impossible to some readers, but fact is that many people, including the authors, mostly prefer to attend lectures over the network. The reason is simple: the perceived quality is better than attending live sessions. It has also been observed that the other media, like Chat and Whiteboard, are creating an orthogonal communication pattern, where comments and questions are circulating, and being answered, during presentations.

Another component which has become especially essential is the multicast Media on Demand server, *mMOD*, which allows for recording and replay of any presentation session. This has created a freedom in the time-dimension that was not possible before, and has been used extensively. Collisions of events and lectures become less serious, and many students go through selected parts after initial presentations, and can directly mail the teacher any questions. *mMOD* also allows for indexes, (comparable to bookmarks), to be inserted at any place in the presentation, and later be used for quick jumping between various places. This facility also adds another view on the concept of annotations. Besides using indexes for giving the presentation an overall structure, (such as a table of contents), it can be used as a link between a point in a presentation and a comment of any kind, (which in principle can be another multimedia presentation). From an educational point of view, the mStar offers support for many aspects of the educational process. The table below shows examples of it's possible usage.

Teacher activities	**Student activities**	**Support**
Planning and cooperation with other teatchers	Cooperation with other students	Technical support
Lecturing	Participating in lectures	
Tutoring	Participating in tutoring sessions	
Creation of learning resources (recorded lectures, html documents with links, etc.)	Time independent usage of learning resources	
Creating group work sessions for students	Participation in group work	

An important aspect of the mStar system is that although it's most prominent feature is the possibility to work in a synchronous mode, the possibility to record and review lectures and sessions adds an asynchronous mode of usage. This means that although the system has been built on the metaphor of the traditional lecture with slides, the teacher using thesystem, must take the possible asynchronous use into account while planning his lectures. Furthermore, the practical use of the mStar system indicates the need of a knowledge of methods for distance teaching involving a more active behaviour on the teacher's part towards remote students. The system has already in it's development phase shown a remarkable reliability, which together with user-friendliness is of high importance in educational use. Regarding user friendliness, experiences from the use of mStar by secondary school teachers indicate that it takes some learning to master the system and that more development work needs to be done in this area.

Searching for negative aspects, it is clear that the current tools create an disadvantage for teachers who like to improvise, emphasize their points by drawing on the whiteboard, or depend on a dynamic body language. The reason is obvious from the above, which emphasize well and in advance prepared material. While it is certainly possible to use the distributed whiteboard for all written presentations, it requires more investments in peripheral equipment like large electronic whiteboards and electronic pens.

6.0 The mStar system as an Educational Innovation

An innovation, according to [Rogers, EM, 1995] is an idea, practice or object percieved as new by the adopting unit whether it is an individual or an organization. A technolgy as the mStar system has a hardware aspect consisting of the tool that embodies the technology as a material or physical object and a software aspect consisting of the knowledge base for the tool. The software aspects also contain the underlying ideas on how the technology can be used and on the possible social embedding of the technology. Innovations are also related to some kind of change in the practices of the adoption unit. An educational innovation is something that is new to adopting units in the educational system. Some educational innovations consist of ideas and theories, other educational innovations also contain some kind of technology. In the Swedish educational system, innovations and change have been closely related, though research results [Ekholm &Sandström 1984] indicate that the process of adoption and change is slower than in business and industry.

While the underlying metaphor for the design of mStar has been the traditional lecture, which most of it's tools support, it is a distributed and distance bridging system that can be used in an synchronous as well as an asynchronous mode. It is therefore no doubt regarded as an educational innovation, or as an innovation capable of strongly sponsoring educational innovations.

Diffusion is a process by which an innovation is communicated through certain channels over time among the members of a social system. Results from research on the diffusion of innovations have shown that the diffusion process follows a certain pattern resulting in a S-shaped curve, if time is plotted along the x-axis and the number of adopters on the y-axis. It has also been noted that adopters can be grouped according to their innovativeness (the degree to which a unit of adoption is relatively earlier in adopting new ideas compared to other members of a social system). It is also familiar that adopter distributions follow a bell-shaped curve over time and approach normality.

During the process of adoption, adopters in a social system can be placed in five major categories based on their innovativeness, which in time order are named innovators (who sometimes fulfill the role och change agents), early adopters,early majority, late majority and laggards. Individuals in the categories differ in innovativeness, but it is also known that other important differences can be found between categories in patterns of communication, search for information, and the degree of homophily (to what extent a persons that interact are similar in background, values, patterns of communication, etc.). These differences are important for the development of the process of adoption. When it comes to an innovation with a high technological content information on software aspects embodied in the technology and innovation-evaluation information are regarded as of central importance. It has been found that interpersonal communication is very important for information on an innovation and that a higher degree of homophily between members of a social system is important for the diffusion process. Information from a peer is given higher credibilty than information from someone whith a lower degree of homophily. Thus, results form research in the duffusion of innovations show that early adopters are generally more important for the development of the diffusion process than innovators or change agents.

In the project Utbildning Direct where 17 upper secondary schools from 13 municipalities in the county of Norrbotten participate, we can find a hard kernel of roughly 10 indiviuals that we can call innovators or change agents. These individuals have been more actively involved in the project and combine a relatively high competence in using the mStar system with an interest in educational development. Outside this hard kernel we can find a larger number of what can be characterized as belonging to the early adopters. This indicates that the process of adoption of the mStar system is still in an early stage, though the process of diffusion has lead to a spread of the technology to all municipalities in the county.

The adoption of an innovation is dependent on previous practice, experienced neeeds and problems, the degree of innovativeness and the norms of the unit of adoption. Inside the project Education Direct, there is a tendency that sparsely populated inland municipalities regard the mStar system as a solution for needs to keep schools in villages with a diminishing population, and as a means to offer courses to these schools in subjects, that would otherwise be impossible to offer.

Reinvention is the degree to which an innovation is changed or modified by a user in the process of adoption or implementation. While mStar is starting from the lecturing metaphor, t has however been observed that a secondary school teacher has used the system in a way characterized by a much richer interaction between teacher and students, than is normally the case in a lecture. This and other cases indicates that although the system is based on the lecture metaphor, it is flexible enough to allow for other forms of interactions. At the same time it is important for the further development of the mStar system to note and evaluate occuring tendences of reinvention among educational users.

7.0 Related Work

The MBone [MBone] has been used for distributed presentations for several years, and is rather well described in many references. What distinguishes this project is however the broad use in less specialized education environments together with the novel tool-suite of mStar. Reference [Parnes 1997] describes the mStar environment in more detail, and its usage from the distributed project scenario. Concerning the use of WWW as a distributed and synchronized presentation medium, there have been at least two earlier attempts:

In 1995, Ed Burns presented his work on Web-Cast [WebCast], a platform for sharing WWW documents over the MBone by either multicasting URLs or HTML-documents. It interfaced the WWW browser XMosaic [Mosaic] through the Common Client Interface (CCI) and distributed WWW pages and corresponding inline images using the Reliable Multicast Protocol [RMP]. Tests were conducted during the spring of 1995 which showed that the multicast distribution model used by that version of RMP was not suitable for wide-area-networks, because only the original sender of the data could do a repair of lost packets. In more recent versions of RMP the distribution problems have been solved.

mMosaic [mMosaic] is another tool for sharing WWW-documents over the MBone and is an extended version of the WWW browser XMosaic. Initial tests show that mMosaic works well with HTML-pages and smaller images, but the distribution delay gets too large with bigger images. A drawback is that it is very tightly coupled to XMosaic. Both these tools and other earlier Web-distribution tools are all tightly connected to the XMosaic browser. One of the main design-constraints on the mWeb application is that it should be browser independent.

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A Telelearning Service Based on User-Defined Group Building Mechanisms

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Abstract: Fast changing environments generating new requirements create the demand for „life long learning" - for individuals, groups, as well as for corporations. Therefore there is a growing need to support new ways of learning. This paper describes a Web-based system for the support of cooperative learning which allows for joint learning in a flexible, open environment. In contrast to currently available systems, which mainly focus on maximizing shared information and do rarely support dynamic group interaction, our approach concentrates on three important aspects: (1) awareness of other learners, (2) support of interaction, and (3) dynamic and structured building of groups according to the learner's interest, wish, and will.

1 Introduction

Nowadays the available knowledge is steadily increasing. Fast changing environments generating new tasks, new technologies, new requirements create the demand for „life long learning". People as well as corporations are forced to constantly build up new knowledge, to maintain it, to share it and also to make it accessible for others.

Therefore there is a growing need to provide structured, user-oriented information and learning facilities to support learning besides traditional, school-based education. But also using new technologies, an important and often neglected element of learning is the presence of a social context (i.e. learning in interaction with others) whenever isolated work is not effective or not wished. To support this kind of joint learning some basic requirements have to be fulfilled. In particular there is a need for a shared information space which is easy accessible and easy to use, for awareness of other people in the „virtual learning room" and for adequate ways to communicate with each other.

To meet these requirements we have chosen the World Wide Web (WWW) technology as the basic platform. It is independent of hardware and software platforms, accessible at relatively low costs and therefore in wide spread use. Since it is ideally suited for information browsing it supports the worldwide information exchange in a very efficient manner. Additionally, the Web continues to evolve from its role of being a simple document-based information pool - e.g. as a low-cost electronic advertising medium - to a platform providing more complex services as well. Moreover, we are using the WWW also as distributed and easy-to-use platform to support the interaction within our Telelearning Service.

The paper first describes requirements and a prototypical implementation of the Telelearning Service. Secondly it introduces special mechanisms that allow structured and dynamic building of learning groups. Then available forms of group interaction are presented, before the basic architecture is shortly described. A brief overview of the related work and a conclusion finish the paper.

2 Requirements and Implementation

Learning in the above described environment requires a distributed structure and also implies the support of loosely coupled interaction schemes. The Telelearning Service is not focussed on fixed classes with well-defined roles (teacher, pupils) and tasks. Our emphasis is more on supporting joint learning in a flexible, changing system regarding contents and participants. Resulting questions of this kind of joint learning are for example: Where can I find interesting information ? Who else is interested in this information ? Is there somebody who could give me a help ? Is somebody interested in learning together with me ? Can I help somebody ? How do others learn ?

To support joint learning in this context we have identified three major requirements: (1) the awareness of others, (2) flexible building of learning groups, and (3) different forms of interaction between users.

Awareness serves as a prerequisite for group interaction and group building, and is thus strongly related to the perception of other users. The question is which people in our Telelearning Service should get into contact in which way? It is intended that our system will handle this in a flexible manner by the definition of generic measurement methods, so-called *metrics*. Each user can specify some criteria, e.g. his knowledge, his interests, his intention and so on. They are then used as *group building mechanisms* for clustering learners into groups. In addition to just recognizing related users, group building gives an user a social context for his interactions: The individual turns into a group member. Different group building methods result in different types of learning groups. Depending on group types and user interests different interaction schemes are necessary. *Group interaction support* is oriented on the specific needs of a learning group.

A first prototype for a general group interaction system has been developed to illustrate parts of the abstract concepts and to evaluate the usability and performance of an implementation. The following scenario and prototypical application illustrate the focus of our web-based Telelearning Service (figure 1).

Sreenshot

Areas

(a) Browser Toolbar

(b) System Functional Groups

(c) Map Panel

(d) Chat Panel

(e) Group Panel

(f) Content Area

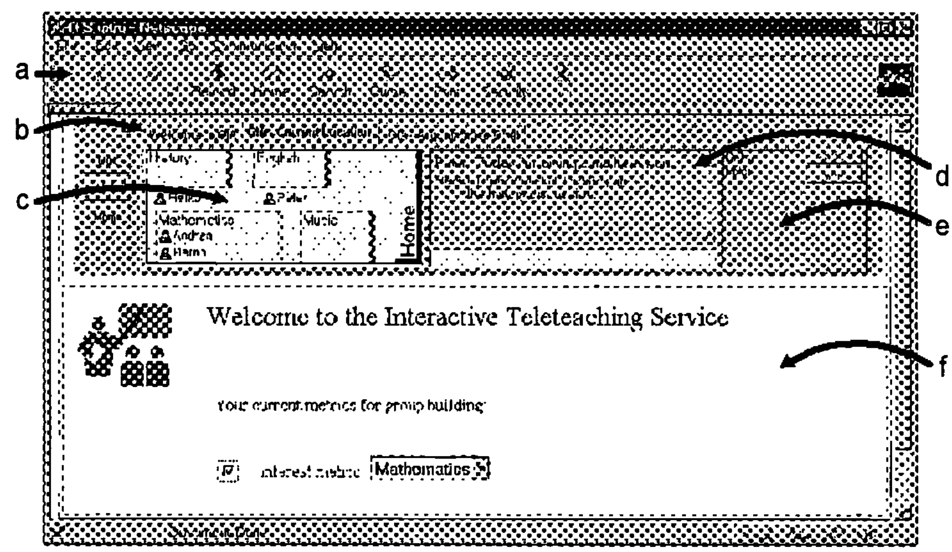

Figure 1: The Telelearning Service for Cooperative Learning

When loading the entry page of the demonstrator the browser splits in two horizontal frames. In the upper frame the Web client runs as a Java applet. In the lower frame the homepage of the web-based interactive telelearning service is loaded (fig. 1 f). A user, called Peter, enters the service. Since the button „current location" (fig. 1.b) is preset, a map (Map Panel, fig. 1.c) provides an overview for Peter. It contains all learning rooms within the service together with Peter's current location. Peter is in a location group with Heiko (fig. 1.e) because he is currently on the same level in the Map Panel. Peter then decides to enter the mathematical room. The system allows him to choose for every room in a pop-up menu between predefined entries, e.g. for the menu mathematics the entries: linear algebra, analysis, stochastic, number theory, numerics, game theory. This set of topics is easily extendable. The user can choose a combination of entries out of one or more menus.

Peter chooses the entry „analysis“ in the mathematics menu and enters the mathematics class room (fig. 2). After a specific evaluation he is grouped with Bernd and Andrea, whose lists of interests match his list. They can start to discuss the topic given in the content area by communication via the chat panel (fig.1 d).
Our support of the application scenario „telelearning“ features an automatic and dynamic grouping by regarding the interests of the participants. This is different to the usual „telelearning“ support where groups are built on the fixed roles of teacher and students.

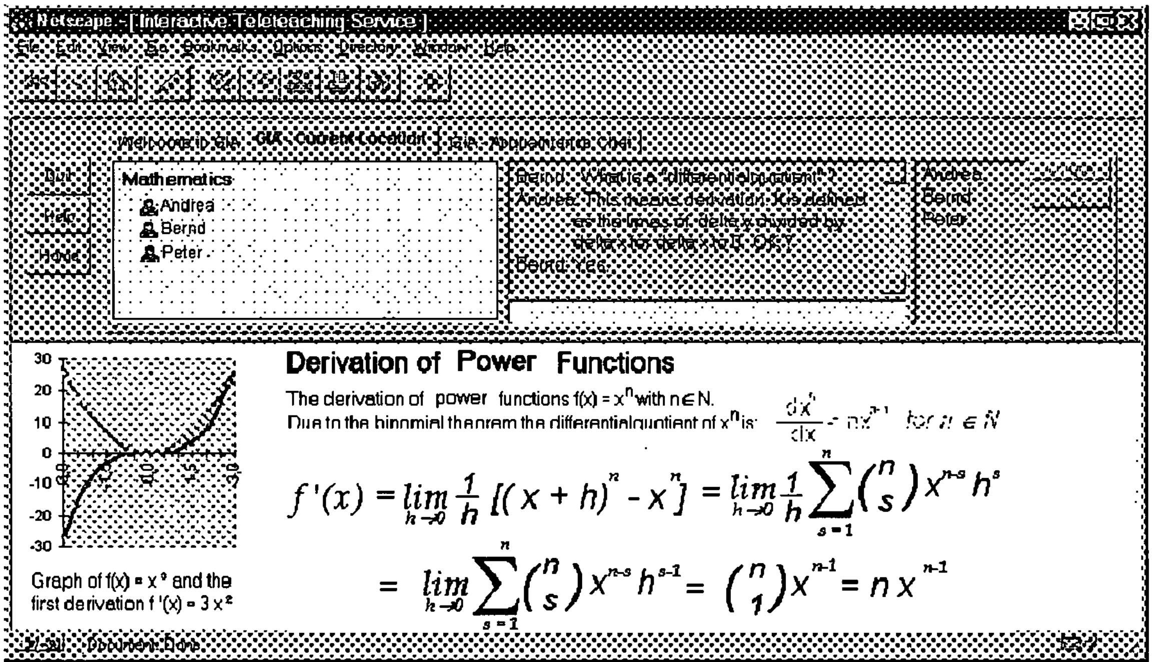

Figure 2: The Virtual Mathematics Room

3 Dynamic Grouping by Metrics

An idea for the grouping process is to bring people together who share the same interest and knowledge or have the same questions. This can be achieved by the introduction of special mechanisms, called *metrics*, which allow a more flexible realization of awareness and grouping. Nevertheless the process of grouping still depends on the users will and wish.
Metrics are defined application-independent and therefore offer advantages for different web-based applications. They help web users to benefit from each other dependent on their intention. Structured group building allows to perform dynamic evaluation based on the learner´s choice of metrics. He can choose just one metric or combine some of them.

3.1 The Space Metric

Like the Web, the Telelearning Service is organized as a mesh of hypermedia-based HTML-documents. This corresponds to a graph represented by arcs and nodes. Structured grouping based on the *space metric* brings people together who request an URL in a certain part of this graph. The part is determined by the definition of the link-distance LD which gives the shortest path between two HTML-documents (spec_URL, URL_i) in the corresponding graph. Mathematically spoken, space grouping means to find coverings in the graph. For this computation several existing graph algorithms can be applied. Two clients (client_1, client_2) are grouped together when the following predicate „Distance“ evaluates to „TRUE“:

```
Distance (spec_URL(client_1), URL_i(client_2))<= LD
```

The space metric groups people browsing in a spatial environment, e.g. the same classroom, defined by the relationship of the documents via the embedded links. This metric can be interpreted both human-centered (in the sense of user behaviour) and document-centered.

3.2 The Semantical Metric

The *semantical metric* is based on the content of a HTML document in the Telelearning Service. The semantical metric is document-centered. This metric is useful to get into contact with people resp. groups who share interest in HTML-documents with similar contents. The semantics can be covered by introducing *weighted hyperlinks* or by extracting *content-based* information from the documents.

For the *weighted links metric*, the links between HTML documents are tagged with weight attributes. This weight expresses the intensity of the relation between both documents as a hint for content correlation. A high weight implies a strong correlation. Given is a threshold value W. Two clients are grouped, when each link on the path from URL_i to URL_j has a weight >= W. Weights can be integrated in the corresponding documents explicitly by the author or semi-automatically by analysis tools based on e.g. keyword matching algorithms.

```
Weight (URL_i(client_1), URL_j(client_2))>= W
```

The *content-based metric* is more challenging to realize. Here People should be grouped, which request documents, that are not necessarily linked but address the same topic. To obtain the relevant content of a document, information retrieval algorithms are necessary. The required search algorithms can be executed as periodical background tasks to generate the correlation information in the Web in a semi-static fashion to moderate the algorithm's NP complexity characteristic. On the other hand heuristics, for instance keyword matching and their statistical evaluation over all requested documents, can be used. The following predicate have to be „TRUE“ to group two clients (client_1, client_2), requesting URL_i and URL_j.

```
Content-match (URL_i (client_1), URL_j (client_2)) = 1
```

3.3 The User Interest Metric

Whereas the previous metrics have been mainly document-centered, the user interest metric is human-centered. Here grouping is defined by a correlation of users according to attributes assigned to them. Attributes can include sharing of interests, speaking the same language, belonging to the same cultural group, having the same knowledge (e.g. mathematics with a special emphasis on linear algebra) and many other definable attributes. Attributes could be collected at the client side and exchanged with servers during browsing. Similar techniques as with the content-based semantical metric can be used on the server side to match user attributes (Attribute-List). The predicate to be evaluated is the following:

```
Int-Match (Attribute-List(client-1), (Attribute-List(client-2)) = 1
```

For an implementation two starting points can be chosen: (1) Constructing the users attributes through user tracking, or (2) get a collection by directly asking the user to select attributes. This can be easily done e.g. by clicking buttons in a predefined table.

Complexity and implementation issues play important roles in the choice of a metric or a combination of metrics. Each metric requires different manipulations at the server side. Combinations of metrics are useful since they considerably reduce the search space and herewith the computational complexity. They also limit the group size, which is necessary to foster synchronous collaboration.

4 Possible Forms of User Interaction

The previous chapter explained how dynamic grouping of different learners might be performed in the Telelearning Service according to the learner's preferences. This chapter now describes four available features of interaction of the current prototype: *User Perception, Location Chat, Acquaintance Chat and Cooperative Navigation:*

The challenge of *User Perception* is to gather the clients URLs and to generate the information needed to visualize the visitors in a 2D environment. Each location, which represents a logical related set of URLs, is represented in a room plan that additionally visualizes all the „learners" residing in the current location or a subordinated place (see fig. 1.c).

The feature *Location Chat* enables an user to communicate with others because they reside in the same environment or have been grouped by the use of the metrics in later versions (fig 1d). If an user navigates to another room in the service the chat members may change since the chat group may dynamically be build from the visitors current locations.

In contrast to the Location Chat, where people normally do not know each other, *Acquaintance Chat* can be used for communication within a closed social group (e.g. class mates, relatives...). The participants of such a chat group are independent from a members current location.

Within the Acquaintance Chat group *Cooperative Navigation* is supported. It enables the members to jump to another ones current page by simply pressing a button. For guided tours or if a person is a non-experienced user of the Telelearning Service it is possible to give navigation support. Each time the leader moves to another page the browsers of all other group members are automatically synchronized.

The above features for grouping are currently „hardwired" and could be enhanced by the application of one or more metric(s).

5 Architecture of the Prototype

As a conceptual basis for the implementation of the basic system named *GIA* a client-server architecture has been designed (figure 3) [Manhart et al. 1998]. The *giaServer* manages all client information, e.g. every student's name, his current location, or information about groups, their members, and the two basic features „user perception" and „acquaintance chat". The server runs as an additional service on an Internet server. The *giaClient* is conceptually structured into two basic building blocks. One is managing the map of the classrooms and implements user awareness, since it visualizes the location of the currently visible users in the room map. The other realizes ASCII chat of each group having been built.

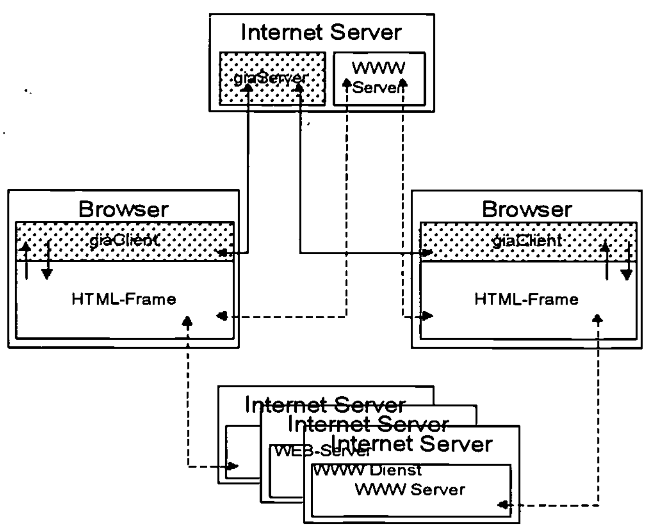

Figure 3: The Client/Server Architecture of the GIA-system

6 Related Work

User awareness is a main criterion to support user interaction in groups [Fitzpatrick et al. 1996]. In [Palfreyman and Rodden 1996] a protocol for "user awareness" in the Web has been presented, but without addressing the group aspect.

Depending on the increasing amount of new knowledge and developments there is growing demand for organizations, groups and persons to augment knowledge and expertise. In the following a few synchronous and asynchronous learning systems are mentioned:

"Answer Garden 2" [Ackerman and McDonald 1996] consists of a 2nd generation system architecture for organizational memory and collaborative help support in an asynchronous fashion. Examples for synchronous learning are: "GestureCam" [Kuzuoka et al. 1994], an approach that supports spatial workspace collaboration via a video-mediated communication system. "CLARE" [Wan and Johnson 1994] represents a collaborative learning system which allows also for knowledge construction. In [Nakabayashi et al. 1995] several advantages of constructing an interactive educational system based on the Web are collected. [Benford et al. 1996] developed "The Internet Foyer", which provides awareness only via the definition of an unified entry point. But it is only a collaborative virtual environment and not dedicated to learning.

Current collaborative learning systems focus more on maximizing shared information and have neither group support (only predefined teacher-pupil) nor dynamic group building support.

7 Conclusions

We have introduced a Web-based Telelearning Service to support joint learning in a flexible and open environment. The implementation is based on existing Web technology to allow wide-spread use. To provide a social context for the users a focus was set on the awareness of other learners. Innovative methods for dynamic and structured group building were introduced. They allow new and effective ways to build up learning groups according to the participants wish, will, and interest. Dependent on the user needs and the learning context different forms of interaction between the users were presented.

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"ADI" — An Empirical Evaluation of a Tutorial Agent

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Abstract: Most efforts concerning the idea of "agents" as human-like interaction modules are concentrated on technical questions, like features which can be implemented, and how. In contrast, this paper describes an attempt to tackle the question: What use is an "agent" for its human counterpart? Do people actually perceive the agent metaphor the way software developers expect them to do? We integrated an adaptive pedagogical agent into a sample tutorial system based on earlier work in the field of adaptive hypermedia courseware [Specht, Weber, Heitmeyer, & Schöch 1997]. The agent developed is supposed to help learners optimize the learning sequence for their individual interests and knowledge. In the study, the agent's "abilities" were varied, students' skills were measured, and it was expected that learning efficiency would significantly increase when the agent was offering more sophisticated support. Results generally matched the expected effects.

1. Introduction

1.1 Why Do People Need Pedagogical Agents?

Becoming increasingly accepted as an ordinary medium just like everybody's TV-set, the WWW is a superb chance for individual training — if taken seriously. Meanwhile, a lot of so called "courseware" is spread all over the net which is often not only based on an ordinary book, but simply reprinted in HTML. This way, possible advantages of hypertext vanish immediately and certain disadvantages become dominant.

Hypertext courseware should be *easy to use*. This obviously is the fact for an ordinary book, because everybody is familiar with using books — so why hypertext? Hypertext courseware can *free the learner* from the static structure of the material given by the author, an aspect that cannot be provided with an ordinary book [cf. Dillon 1996]. But freedom must not end up in a loss. To avoid the effect Hammond and Allison called "lost in hyperspace" [Hammond 1992] there is a compelling need for a mediating instance such as a personal teacher. In the best case, a personal teacher knows the domain, knows the student, has some didactic experience, and thus provides the student with learning material individually selected and structured for him or her. Moreover, a personal teacher keeps close interactive contact to the student, always regarding his or her personal goals and preferences. Altogether, the personal teacher's tasks are to optimize learning efficiency and motivation. And exactly these are a tutorial agent's tasks, too. But is it possible to achieve sufficient student support through anything else than a human teacher's attendance?

1.2 What is our goal?

We hypothesize that any "agent" equipped with some "intelligence" even far behind the latest technical state-of-the-art would generally raise learners' learning efficiency and motivation in comparison to plain hypertext. Our goal was to verify the hypothesized effects by means of a sample agent. At the same time we wanted to study students' acceptance and perception of this user interface component that was unusual to our subjects.

1.3 Background

Earlier work in the field of computer-based education had led to our *A*daptive *S*tatistics *T*utor "AST" [Specht et al. 1997]. AST is a tutorial system for WWW-based distance learning [1] that integrates several adaptive resp. adaptable features. We decided to add to the adaptivity already implemented in AST and to present certain individually adapted guidance features by a newly invented user interface component: The agent.

In parallel with the AST implementation, the tutorial system described in this paper is based on dynamically generated HTML enhanced by a handful of illustrations. As a TCP/IP server platform we again chose the Common Lisp Hypermedia Server [2] described in [Mallery 1994] that proved to be an efficient development tool for these purposes.

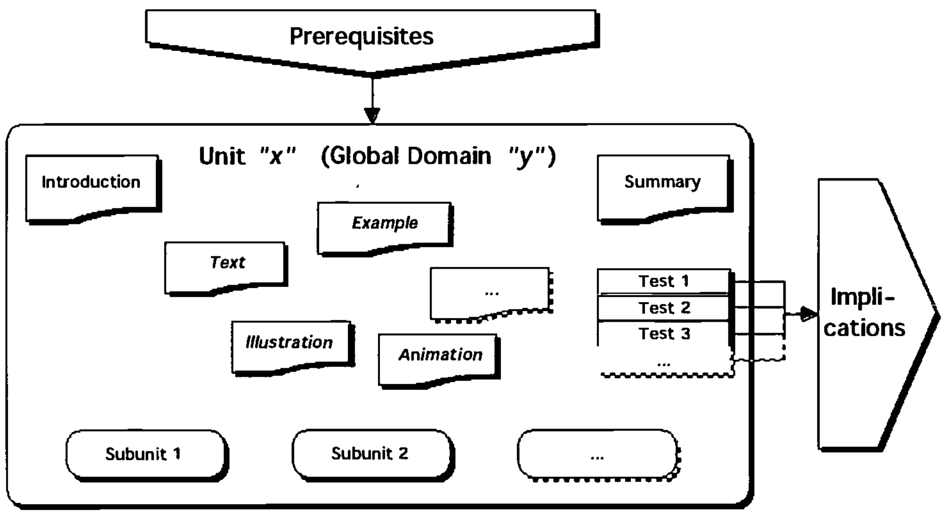

Figure 1: Schematic structure of a *Unit*. There is information on the subject matter (teaching materials, printed in *italics*) as well as features relevant for presentation (introduction and summary), in-depth-information (subunits), features relevant for evaluation (tests) and meta information aimed at an adaptive presentation (global domain, prerequisites, and implications).

2. System Architecture

Essentially, there are two different types of databases that provide the basis for adaptivity in a tutorial system: A "Domain Knowledge Base" and a "Learner/User Model". While [Murray 1996], among others, stresses the necessity to clearly distinguish two aspects of a tutorial's knowledge base — *what to teach* vs. *how to teach* —, our system represents an alternative point of view: We implemented static procedures that derive the suitable presentation ("*how*") from the implications arising when the knowledge base data ("*what*") is incorporated with the learner model data. For reasons of the evaluation we had in mind, besides the agent's recommendations the learner is free to decide which item to learn next and to choose convenient learning media.

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[1] as well as some other ITSs, AST is fully WWW-accessible at
http://specht.gmd.de/ or *http://cogpsy.uni-trier.de:8000/TLServ-e.html*

[2] you may find more detailed information on this LISP programmable TCP/IP server software at
http://www.ai.mit.edu/projects/iiip/doc/cl-http/home-page.html

2.1 Knowledge Base

We denote our knowledge base *curriculum*. It contains the teaching material and meta information aimed at a flexible presentation. The curriculum is built up from *units* representing narrow pieces of subject matter information. Subject matter information is stored by means of *teaching materials*. The number and kind of teaching materials depends on the information to teach. It may vary significantly between different units. [cf. Fig. 1]

The units are structured in three ways:

- The *subunit* principle results in a hierarchy, as it can be found in an ordinary book. This hierarchy serves for a "red thread" and for the presentation of a table of contents.
- The *prerequisites/implications* paradigm as thoroughly described in [Dannenberg, et al. 1990] allows for adaptive recommendations based on learner model information.
- The *global domain* meta information serves for cross-reference generation and for sequencing recommendations based on the learner's special interests.

2.2 Learner Model

Each student is assigned a personal *learner model*. It is initialized by means of one demographic and one subject oriented questionnaire at a learner's first login procedure. This model is kept and continuously updated while the student works on the curriculum. A learner model includes the following data:

- *static data*, e.g., name and password. This data is only of formal interest and does not influence adaptation.
- *adaptable data*, like special interests and preferred learning strategy. This data is taken into account for adaptational features and can be changed whenever the student feels like.
- *dynamic data*, i.e., past learning episodes and their implications on the presumed knowledge level on a certain topic. Adaptive features are based on this data.

3. The Agent

3.1 Interactive Personal Teacher

One of our agent's learner support features is the ability to calculate advisable units to proceed with from a given learner state. The implicitly given teaching goals are promoting and retaining learner motivation and evoking students' interest even in lessons they otherwise might have avoided. More precisely, the goal is to present the lessons of a curriculum in such a way to promote a structured and well balanced learning process.

Several propositions can be calculated, each according to one set of priorities. Any of these findings are presented, for it is our philosophy not to force students to a sequence that is postulated to be ideal. In contrast, the idea is to help the students find their own sensible way through the curriculum. This position is both supported by considerations concerning the effects of (at least perceived) learner control and by the purpose of our implementation designed for collecting empirical data and finding out what precisely determines individually ideal sequencing. A controversial discussion on learner control and its impacts is drawn up in [Schulmeister 1996].

When a student asks for help, an appropriate subset of the following recommendations on how to proceed is presented together with short comments:

- *a learning material of the current unit, corresponding with the student's preferences.* Following this proposal, the student may acquire the current unit by means of a type of learning material that he or she claimed to be especially convenient.
- *a learning material of the current unit, to complete knowledge about this unit.* This proposal draws the student's attention to a learning material of the current unit that has not yet been seen.
- *a unit related to the current unit and corresponding with the student's preferences.* This proposition may attract the student's interest because it shows the idea of the current concept in the light of a global domain the student has claimed to be especially interested in.
- *a unit to complete most recently acquired knowledge.* The student's attention is drawn to another unit within the current subunit.
- *a completely new, unrelated, unvisited chapter.* A student who is bored or annoyed by the section he or she is just working at, may like to follow this link.

- *proceed with the current unit*. In case, none of the above is considered convenient the student may simply continue where he or she interrupted to ask the agent for advice.

The calculation tasks include comparing the learner model data with the data in the knowledge base, selecting possible units, bringing them into an appropriate order and presenting the one which fits best. Duplicate findings and units already presented are filtered out.

3.2 Student Interaction with the Learner Model

In addition to these *adaptive* features, we decided to implement some *adaptable* features. This was another aspect we wanted to test in our study that had its roots in a discussion on learner control [cf. Schulmeister 1996]. Therefore our agent cannot only be asked, but also be told:

- The student's preferences for global domains such as "biology" or "history" as well as preferred types of learning material can be adjusted whenever the student feels like.
- The student may inspect parts of the learner model by means of a "knowledge barometer". This serves as feedback for the learner and, at the same time, gives the learner the chance to improve the model through direct interaction. [Fig. 2]

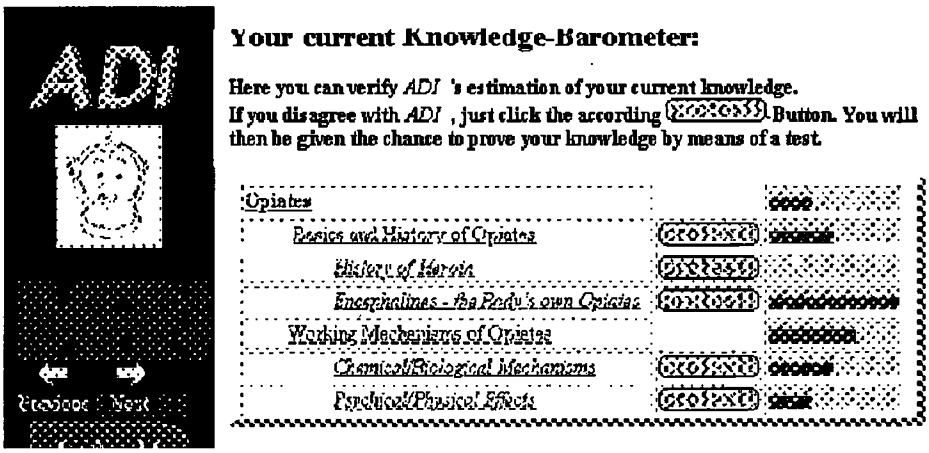

Figure 2: Inspecting the *Learner Model*. The student may decide to visit a topic of low knowledge valuation (e.g., "History of Heroin") or to "protest" against the agent's estimation. In case of a protest, after the student performed some tests, the model will be updated.

4. The Empirical Study

The idea of the study was to clarify implications our agent might have on learning. We wanted to investigate on the acceptance, motivational effects, and learning efficiency both of (a) adaptive guidance by proposals and (b) learner model adaptability. On the basis of the technology described above we decided to put up a small curriculum on narcotics we called "*A*daptives *D*rogen *I*nformationssystem" (*ADI*). The acronym "ADI" became a synonym for our implementation of an agent and will be used as such from now on.

4.1 Method

Subjects had to visit every concept of the curriculum at least once. The curriculum consisted of three chapters, each chapter containing two or three subunits with a total of 23 units. It could usually be completed within less than one hour. A total of $N = 40$ students took part in the experiment. Subjects were randomly assigned to the following treatments:

- *ADIproposal*: Students could ask ADI for proposals, but were neither allowed to change preferences once they had started the course, nor to inspect their learner model.
- *ADIproposal+model*: Students were given ADI's full functionality, i.e., ask for proposals and inspect/adjust the learner model.

- *NoADI* (control): Students had to complete the course with plain ordinary navigation tools, i.e., without having any of ADI's features at their disposals.

To realize the control group and for reasons of a realistic setting, in addition to the agent our system was equipped with standard navigation tools such as *next*, *previous*, *table of contents*, and *next unvisited*. As we will see later, this revealed to be a problem for our evaluation.

We evaluated performance differences in a questionnaire on the curriculum's contents that had to be completed before and after the learning phase. Moreover, before the learning phase students could select special interest domains and preferred types of learning material. At the very end, subjects completed a questionnaire concerned with demographical features, possible side effects such as computer experiences, and acceptance of ADI's presence and assistance, as far as appropriate to the subject's treatment.

4.2 Results

Evaluation of the final questionnaires indicated no problems with the interface (91%) and high acceptance of adaptive support in general (94%). Another general finding was that learning with ADI's assistance takes some extra time, an effect we consider to be an impact of such a small curriculum.

Condition	*First Questionnaire*	*Second Questionnaire*	*Learning Performance*
ADIproposal	9,6	12,0	+2,4
ADIproposal+model	9,9	12,8	+2,9
NoADI	9,8	13,0	+3,4

Table 1: Correct answers. Comparing performance before and after completing the course.

A first evaluation of the questionnaires concerned with learning performance did not show any significant difference between the three conditions [Tab. 1]. Moreover, the *inspect learner model* option was almost never used, so we combined the conditions *ADIproposal* and *ADIproposal+model* into condition *ADIavailable*.

Learning Performance	*FewADIrequests*	*ManyADIrequests*
FewInformationRequests	0,50	3,43
ManyInformationRequests	3,14	4,71

Table 2: Performance increase after course completion inside treatment *ADIavailable*.
Post hoc split by *InformationRequests* and *ADIrequests*.

We post hoc split data into *FewInformationRequests* and *ManyInformationRequests*. This split could explain large portions of the observed deviation ($F_{(1,39)} = 5{,}06$; $p < 0{,}05$). A closer look revealed some correlation between the quantity of information requests and the quantity of ADI requests which could be explained by splitting *ADIavailable* into *FewADIrequests* and *ManyADIrequests* [Tab. 2]. This explained another large part of deviation ($F_{(1,29)} = 7{,}26$; $p < 0{,}05$) and reveals clear positive effects of ADI's assistance on learning performance, if requested by the student. However, these findings have to be interpreted with care, for they are based on two post hoc splits. Nonetheless, they can be taken seriously: There is no correlation between the post hoc variables and computer experience or WWW experience measured by means of the final questionnaire.

4.3 Discussion

The presence of various navigation tools combined with such a small curriculum exceeded the effects of ADI's features. Therefore, this design was not ideal to find effects of treatments *ADIavailable* vs. *NoADI*. Subjects had to browse some 23 concepts, so they did it just in order and did not mind any features which just seemed to cost some extra time. In addition, an average student is not used to the idea of being helped by an agent, but is definitely used to browse books in a given static order. Thus, to make everybody profit from support by an agent, one has to consider aspects of salience and training.

Nonetheless there is remarkable evidence, that the actual use of ADI as a personal mediator to individual sequencing has positive effects on learning performance. This partly may be due to motivational effects when interacting with "someone" in contrast to just being left with a stupid machine.

Regrettably enough, due to the fact that most students just ignored this feature, we cannot state any results concerning the effects of *learner model inspection*. To clarify this point, another experiment is required that makes students stumble across this feature and try it out.

5. Conclusions and Future Prospects

ADI is a prototypical implementation of a pedagogical agent integrated into the previously developed WWW-courseware AST. The way our agent supports the learner is both *adaptive* to the learner's knowledge state and learning history and *adaptable* to the learner's personal interests and preferred learning strategies. Equipped with a small curriculum on narcotics, we used this design for an empirical study.

The results of our study indicate that students do not always ask ADI for advice, though they might profit from some assistance. From this emerges the idea to equip ADI with a "self activation feature" that might increase learning efficiency for students who otherwise would not make use of adaptive support. At the same time, a certain "autonomy" may improve the perception of ADI as a "personal teacher".

Our idea is to analyze the sequence chosen by the student and to intervene

- if a student jumps from one unit to another in an inefficient manner, e.g., without looking at any learning materials.
- if a student gets stuck in one particular section of the curriculum and simply ignores the rest.

To make recognition of these situations possible, it is necessary to take down the student's path from login up to the presence and to find ways to animate the ADI-figure. For learner control reasons, the student's attention should be drawn to ADI and help should be offered, but the student should not be irrevocably interrupted in the sequence he or she chose.

However, results of our study gave evidence of positive efficacy of our onset of an agent. These findings are encouraging enough for us to go on investigating this field from an empirical point of view. The idea of an "agent" in general, i.e., a user adaptive tool presented as a mannikin inside the computer and perceived as a personal contact for the user, definitely has a great potential. This is demonstrated by several promising onsets of adaptive tutorial agents, often presented by means of latest multimedia techniques [e.g., André, T., & Müller 1997; Rickel & Johnson 1997]. Future versions of ADI and his colleagues are not to be considered as yet another weird sprout of IT but as useful tools that may become common in the near future.

A version of ADI with an enlarged curriculum, and some other experimental ITSs may be tried out at *http://specht.gmd.de/* or *http://cogpsy.uni-trier.de:8000/TLServ-e.html*.

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The Internet and Equality of Educational Opportunity

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Abstract: One benefit often expected to flow from Internet use in schools is an increase in equality of educational opportunity as all kinds of schools gain access to the same extraordinary set of resources. Yet, prior research suggests that patterns of technology access often mirror existing inequalities rather than mitigate them. This paper discusses the issues pertinent to equality that arose in a project bringing Internet access to a large urban school district. It concludes that even though this project strongly valued equality, competing considerations led to some inequality of Internet access between schools serving different kinds of students. Furthermore, within given schools numerous factors, including the perception of Internet use as an optional privilege and many teachers' lack of familiarity with the Internet and computing more generally, resulted in greater access for students who were already ahead of their peers academically and/or with regard to knowledge of computing.

In recent years there have been many calls to connect teachers and students to the Internet [Carlitz 1991; Hunter 1992; Newman 1992]. Among the many benefits predicted are increased communication and collaboration between teachers, increased connection of the schools to the outside world, and increased equality of educational opportunity as students from schools of all types gain access to the same extraordinary set of informational resources. This emphasis on increased equality of opportunity as a potentially important outcome of school-based Internet use is epitomized in President Clinton's belief that the Internet will "revolutionize" education since "for the first time in the history of America...we can make available the same learning from all over the world at the same level of quality and the same time to all our children" [Clinton 1996].

There is no doubt that the Internet has the potential to help equalize educational opportunity by making the information resources available to students in all schools more similar than has been the case before. However, prior research on computer use in schools suggests that patterns of technology access and use often mirror and reinforce existing inequalities rather than mitigate them. For example, affluent schools provide their students with more computers on a per pupil basis than do poorer ones [Becker & Sterling 1987; Heaviside et al. 1996]. Furthermore, the amount and kind of computer use within a given district often vary in ways that reflect and sometimes reinforce existing social differences [Becker & Sterling 1987; Schofield 1995; Sutton 1991].

The goal of this paper is to shed light on the complex relation between the use of computer technology in schools and equality of educational opportunity by describing and analyzing the issues that arose pertinent to this topic in a project designed to bring Internet access to a major urban school district. Specifically, this paper will focus on two important aspects of equality -- equality of inputs and of processes [Good & Brophy 1986; Harvey & Klein 1989]. Educational inputs are the physical, financial, and human resources a school starts with. The input of interest here is Internet access. For the purposes of this paper, equality of Internet access is defined as there being no relationship between the kind and amount of Internet access in a given school (or program within a school) and the characteristics of the students that school (or program within the school) serves. An input, however, may be differentially available to or differentially utilized by different kinds of students within a school or even within a subsection of that school. Thus, educational processes -- what happens within the school -- are also very relevant to actual equality of opportunity. Before turning to our findings, we briefly describe the project studied, the district in which it was located, and the methods used in this research.

Common Knowledge: Pittsburgh and Its Setting

This paper is based on a four-year study of a NSF funded project called Common Knowledge: Pittsburgh (CK:P) -- one of four national testbeds in the United States designed to explore the Internet's potential for improving education. CK:P's goal, at the most general level, was to bring Internet access to teachers in the Pittsburgh public schools for use in instruction. During its first four years (mid-1993 to mid-97), CK:P provided a substantial amount of training and support, as well as hardware and Internet connections, to teams of educators at 20 schools.

Like many other urban school districts in the U.S., Pittsburgh has a substantial minority group population, with roughly 55% of its students being African American. Many of its students also face problems of familial poverty, with almost two-thirds receiving free or reduced-price school lunches because of low family income. In addition, there are major differences in the average socioeconomic status of white and African American students, with an accompanying marked achievement gap between the two groups overall. Addressing this gap is one of the district's prominently stated goals. Given this, it should come as no surprise that, as a project, CK:P placed an emphasis on enhancing equality of educational opportunity. To give just two very different examples, the proposal CK:P submitted to the NSF prominently featured promoting equality as one of the opportunities potentially provided by Internet access in the schools, and project staff commonly strove to achieve gender and racial balance when selecting students for Internet-related projects.

Methods

The major data-gathering methods used in this research were qualitative observations, semi-structured interviews, and the collection of archival material. Since the project began in 1993, we have conducted repeated observations in a wide variety of settings. This includes over 160 hours of observation in over 40 classrooms in which the Internet was being used. It also includes observation of over 125 meetings between different groups of teachers who have been involved with the project, and dozens of meetings of CK:P's educational and technical support staff. Trained observers used the "full field note" method of data collection [Olson 1976] which involves taking extensive hand-written notes during the events being observed. All notes were made as factual and as concretely descriptive as possible.

To gain insight into participants' perspectives, over 300 semi-structured open-ended interviews were conducted with a wide variety of individuals including over 100 teachers, 30 school district personnel, 14 CK:P staff, and 130 students. Archival materials, especially e-mail, were another important source of information pertinent to the issues discussed here. With participants' permission, the research team's address was added to virtually all group mailing lists connected with the project. This permitted collection of most normal e-mail between members of the various groups working on this project.

Both field notes and interviews were audiotaped, transcribed, coded and then analyzed using established qualitative methods [Miles & Huberman 1984; Strauss & Corbin 1990]. In the data analysis, our primary emphasis was on the development and systematic application of thematic categories to all data. Further, we paid close attention to triangulating data from the different kinds of sources.

Results

Equality of Inputs: Distribution of Internet Access Across the School System

CK:P did not have enough funds to provide Internet access and extensive support to every school and classroom in the district, although it did have a budget of over five million dollars. Thus, the issue of how this potentially valuable educational input should be allocated arose early in the project, just as it is likely to arise in any school district that must decide how to spend limited tax dollars. Since lead time was short during the project's first year, the first three projects to be supported by CK:P were selected by weighing considerations such as which schools had teachers knowledgeable and enthusiastic enough to successfully carry out Internet projects with little lead time and where the district already had decided to place new computer equipment and/or local area networks.

However, during CK:P's second year the project staff decided to select future schools based on an annual competition to which teams made up of small groups of interested teachers could submit proposals. The staff saw the development and successful implementation of this process as a major achievement, since they felt that the competition would encourage teachers to develop high quality curriculum projects and that support of the strongest of these would further CK:P's goal of stimulating creative and productive uses of the Internet in education. For a variety of reasons, including the desire to build political support for CK:P, the staff did not select these projects themselves. Rather, this task was left to a broadly representative and racially-mixed group that included individuals ranging from school board members to central administrators to community members.

In spite of the diversity of the group making the selection, the issue of equality of inputs arose almost immediately at the end of the first competition when a prominent African American member of the school board charged that the competitive process built in a bias against the very schools where the need was greatest. Critics of the process argued that teachers working in the schools facing the greatest social and academic challenges would have less time and energy to devote to writing proposals and developing new curricular approaches employing the Internet than their peers working in less difficult situations. In addition, since schools with higher achieving students, or with special programs likely to attract such students, were generally seen as more desirable places to work, teachers who were experienced or reputed to be unusually energetic and skilled were more likely to be able to secure positions there than their peers. It seemed reasonable to expect that such teachers would be more likely to write proposals, and to propose projects strong enough to win. Given this, it seemed plausible that district-wide competitions would end up favoring the schools with the higher achieving students. Since socioeconomic status and race were clearly connected to academic achievement in the district, as they are nationally, this would tend to work to the disadvantage of the students who were already disadvantaged by minority status or their relative poverty.

Examination of the seven schools selected in the first competition held by CK:P suggested that there was some basis for this concern. The one high school selected was only 20% African American, although almost 50% of the students in the district's high schools were African American. Students in this school were also somewhat, although not strikingly, better off economically than the average student. For example, 18% of them, as opposed to 25% of high school students district wide, came from families receiving public assistance. Similarly, the one middle school selected was a magnet school which had a somewhat lower percentage of African Americans than middle schools in the district in general (48% vs. 56%) and which served fewer students from families receiving public assistance than middle schools did on the average (17% vs. 40%).

The five elementary schools selected presented a somewhat more mixed picture. However, taken as a group, they did appear to enroll children who were somewhat more advantaged than the average child in the district. For example, two of the district's five most affluent elementary schools were selected, giving them a remarkably high success rate given that only three elementary schools were selected from the remaining forty-four. One of the three other schools selected was one of the few in the district with a student body containing less than 10% African Americans. (However, its students' socioeconomic status was somewhat below the district average since 52% of its students came from families receiving public assistance compared to 46% of elementary school families district wide). Only one of the elementary schools selected had a substantially higher proportion of African American students than average. Its student body had a socioeconomic status very similar to that of the heavily white school just described. Finally, although the district had 12 elementary schools that were 80% or more African American, all but one of which were characterized by higher than average levels of poverty, none of these schools ended up with CK:P projects through this competition.

The issue of which schools got access to the Internet through CK:P, and what the implications of this were for educational equality and equity, received a substantial amount of attention from policy makers. However, even if access were equal across schools enrolling different kinds of students, the possibility remained that the Internet projects might be focused in niches in the schools which served non-representative samples of students since small teams of educators, ranging in size from 5-12 people from within a given school, served as the CK:P Internet teams and their students typically had greater access than others. This did occur and, when it did so, the students served were generally advantaged in one way or another compared to their peers. So, for example, one project in a school which was 99% African American and which had a student body characterized by high poverty rates was located in the honors track, which by definition served the most academically able students. As a group, these students tended to come from somewhat less poverty stricken families than their peers. Similarly, another CK:P team in a different high school which was 57% African American ended up using the Internet heavily in their smaller advanced language classes, which generally speaking had a lower proportion of African American students than the school.

As a project, CK:P made strong efforts to be inclusive and to mitigate the impact of existing inequalities on Internet access. For example, it secured additional funding targeted for schools serving the most disadvantaged populations. Also, project staff provided extensive training covering topics ranging from Internet use to proposal writing so that teachers from all schools could receive the help they needed to write strong proposals. In addition, CK:P provided modest levels of Internet access and support to sites that were not selected for more intensive focus, so that by the end of CK:P's fourth year over two-thirds of the schools in the district, including many of those serving the most disadvantaged students, had some form of access. However, the problems that arose regarding equality of access in this project, in spite of the relatively high priority this issue held in the minds of those responsible for implementing it, suggest just how complicated it may be to achieve. Furthermore, they highlight the fact that hard tradeoffs may need to be made between equality, equity, and maximizing the likely impact of any given dollar invested in educational technology.

Equality of Educational Processes: Distribution of Internet Access Inside Classrooms

Even if there is no relationship between the demographic characteristics of the students in a school or classroom and the likelihood that resources such as Internet access are located there, the question of whether or not students actually end up with equal access remains. At the classroom level we saw few if any cases where teachers blatantly used student characteristics such as race, gender, or socioeconomic status in a way that systematically denied or minimized access to any particular group. In fact, when such criteria were explicitly considered it was virtually always in a way that promoted equality of access across groups -- such as a teacher's consciously deciding to select one boy and one girl to engage in a particular Internet activity even though more boys than girls had volunteered. However, several educational process issues did lead to advantaged students often obtaining more Internet access than their peers. Ironically, this occurred in spite of the fact that many teachers believed that Internet access was particularly valuable for at-risk students.

First, teachers, especially those working in noncomputer lab settings, tended to see Internet access as an optional privilege rather than as a basic resource, such as textbooks or library materials, to which all students should have access. This view stemmed from several sources, including the fact that even in classes receiving full CK:P support teachers generally had many more students than Internet access points, which meant that Internet access was a scarce good. As such, it was most easily dealt with as a privilege, rather than something to which every student should or could have equal access. The view of Internet access as a privilege was also connected to a positive view of it on the part of teachers who went to the trouble to write a proposal to bring it to their classrooms. Students' generally very positive reactions to access reinforced the image of access as a privilege.

Another factor contributing to this view of Internet use was that work done on the Internet was often not part of the core curriculum upon which students were tested, so that teachers did not feel a responsibility to assure that all students got to use it in order to do the work expected of them. Although this situation was partly due to the relative scarcity of Internet-linked computers, it did not appear to be completely due to this. Rather, teachers had curriculum materials and accompanying tests that reflected the core of what they expected students to learn.

Internet work tended to be added on to this as enrichment, rather than integrated into the core curriculum. Since class time was limited, time spent on the Internet was sometimes seen as time not available for more pressing work.

Since Internet work was often seen as an optional privilege, the question of which students would gain access arose. Teachers frequently used access as a reward for good behavior, especially strong academic performance. Similarly, behavior of which the teachers' disapproved, especially social behavior of this nature, was seen as reason for removal of this privilege or for failure to bestow it. This tendency was exacerbated by teachers' concerns about students' inappropriate use of the Internet and by their concerns regarding the possibility that students might intentionally or unintentionally damage the computers to which they had access. Taken together, these factors tended to increase usage by students who were academically strong and to decrease use by those who were either weaker academically or less attuned to the schools' behavioral norms.

Teachers' genuine concern about the academic progress of their weakest students also often contributed to this inequality in access. Since Internet usage was generally not conceptualized as the quickest and clearest route to helping students master the core of the curriculum, some teachers believed that weaker students' time was better spent on more traditional activities. It is certainly possible that the teachers were correct in this assessment. However, to the extent that familiarity with computer use in general, and the Internet in particular, is useful in today's world, inequality in Internet access for weaker students created yet another potentially important dimension on which they were behind others. Furthermore, the stronger students' greater access to the Internet had the potential to increase any pre-existing motivational differences between them and their academically weaker peers since there was widespread agreement on the part of teachers and students that Internet use was motivating.

Another factor that contributed to disparity in access was that many teachers' lacked highly developed knowledge about the Internet and about computers in general. This led them to give greater access to students who were already knowledgeable in these areas rather than to spread access more broadly, since such students could use this resource most effectively and in a way that made the least demands on the teachers' already heavily obligated time. Such students were disproportionately white, male, and from relatively privileged socioeconomic backgrounds. Enhanced access, in turn, increased and highlighted the knowledge gap between them and their peers. One factor that appeared to contribute to creating the initial gap in expertise was home access. Previous research suggests that both males and relatively affluent students are more likely to have home computers and to engage in other activities such as attending computer camps than their female and less affluent counterparts [Hess & Miura 1965; Kraut et al. 1995; Sutton 1991]. Such appeared to be the case here as well.

Students' behavior sometime tended to reinforce the disproportionate access created by the kinds of process issues discussed above. For example, males and students of somewhat higher socioeconomic status than their peers sometimes made disproportionate voluntary use of the Internet in the school library before or after school. Similarly, teachers noted that girls were sometimes less assertive than boys in laying claim to computers when both they and others wanted to use them.

Conclusions

This study suggests that bringing the Internet to schools in a way that enhances educational equity is likely to be a complex process. First, there is the issue of whether this educational input will be distributed across schools and classrooms in ways that exacerbate or mitigate existing inequalities. In prior research, the association between access and advantage has usually been understood to reflect the differential tax base in poor and affluent communities. In CK:P's case, the inequality stemmed from something else entirely -- a desire to deploy scarce resources where they were most likely to be well utilized. Yet other considerations could also be weighed, and might lead to different kinds of inequalities. For example, there were those who suggested that CK:P should place more emphasis on concentrating resources where the need was greatest -- a strategy intended to enhance equity, although not necessarily equality of inputs. Furthermore, this study highlights the fact that distributing access equally across different kinds of schools and classrooms does not insure equality of use. Numerous educational process issues, from the way that teachers think about Internet use to differential pre-existing expertise on the part of different kinds of students, also shape usage patterns in ways that often reinforce existing inequalities.

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Teaching Shakespeare: Materials and Outcomes for Web-based Instruction and Class Adjunct

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Abstract: Multi-media hypertext materials have instructional advantages when used as adjuncts in traditional classes and as the primary means of instruction, as illustrated in this case study of college level Shakespeare classes. Plays become more accessible through use of audio and video resources, including video clips from play productions. Student work can be included as models, and updating or expansion of texts is as easy as changing html files. With over 40 hours of instruction per play module, assignments can be individualized to student needs and used repeatedly--for instruction, clarification, make-up on missed classes or review for exams. Materials for each play include three lectures and seven topics for exploration (Issues, Character, Plotting, Genre, Critics, Staging and Background); instructional aids on cast, story-line, literary terms, and references, as well as access to a searchable text of Shakespeare's works, are included. Results over five years of development and revision are reported.

How can hypertext help teach an academic subject such as Shakespeare's plays? Can a class be taught completely on the Web or should Web materials simply serve as adjuncts to class-room presentations and homework sessions? Over the past five years I've experimented with the interface of hypertexts to teach nine Shakespearean plays (including sound, pictures and video clips as well as text in the instructional material) and have modified the ways these hypertexts were used in face-to-face classes and in Web-based courses. This paper reports on the philosophy and pedagogy underlying the design of materials as well as the results.

At first, the Shakespeare Hypertext Guides (SHG) were used as resources for classroom presentation and for student use in making up missed classes, reviewing students' knowledge of plays and supplementing classroom instruction. After using the SHGs in three face-to-face classes, I initiated a hypertext-based course in Fall 1995. Initially the hypertexts were HyperCard stacks with delivery of course assignments through the campus network and email. In Fall 1996, four of the seven plays were delivered on the World Wide Web, again with email as an adjunct. In Spring 1998, an upper-level version of the course was offered that is completely Web-based, including the delivery of student work to the instructor, the posting on a class bulletin board and posting of grades (with the course management presented through WebCT, a Web-based teaching environment developed at the University of British Columbia: http://homebrew.cs.ubc.ca/webct/.

Structure

The Web-based SHGs call for student response while providing guidance and learning aids in the form of texts, sound clips of speeches, relevant pictures and comparative video clips. Each play has its own Web site. Each play provides instruction with

- "Lectures" (usually three per play) that provide a coherent interpretation of the play while suggesting alternate interpretations
- "Explorations": seven per play on Issues of Interpretation, Characterization, Plotting, Genre, Critics, Staging and Background (use of sources and textual variation). These Explorations provide material to help students with more open-ended questions. They also contain samples of student response, whenever such work is available.

Each "Lecture" or "Exploration" segment has a form by which the student can send a response to the instructor. It is the instructor's job to select how many or which forms will be required and at what pace. For example, in Spring 1998 I required on-line students to respond to one "Lecture" and one "Exploration" of their choice, as well as working on a group-paper in response to another Lecture. But after the first exam I recommended which "Exploration" is recommended for a particular student based on their exam results--with the Explorations on Genre, Critics, Staging and Background usually suggested only for students who have earned at least a B on the essays and identification of quotations on the exam. In Fall 1998, with a different instructor, on-line students will generally respond to a Lecture or Exploration of their choice, work on a group-paper and fill out a more factually oriented short-answer form. (An additional paper requiring use of critical sources is also required, but independent of the course materials described in this paper.)

Additional aids to instruction (as shown in Figure 1) are given in the header for each Lecture or Exploration. A student can review a scene-by-scene summary of the play, an interactive graphic of the cast of characters, a glossary, references to secondary sources or Shakespeare's playtext (with the opportunity to search or copy the text at MIT's Shakespeare Web site at http://the-tech.mit.edu/Shakespeare/works.html).

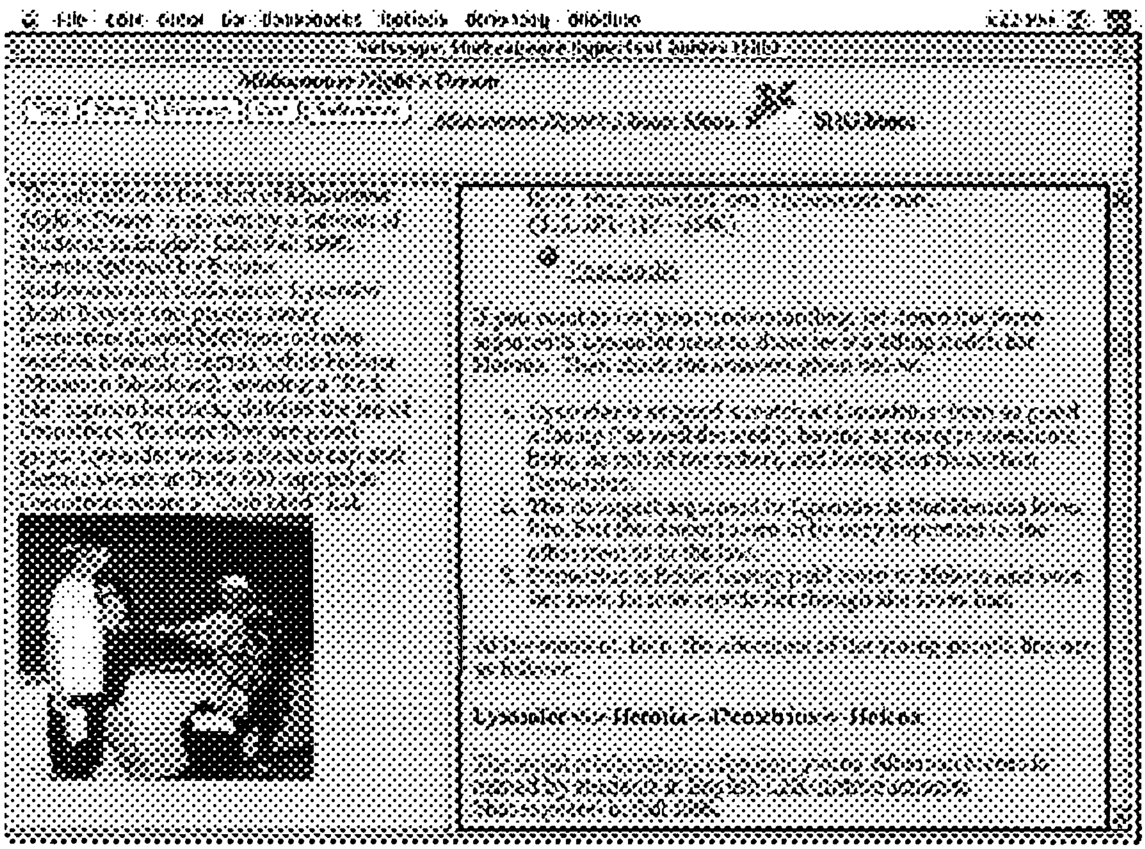

Figure 1: Sample page for Web-based instructional delivery on Shakespeare's *A Midsummer Night's Dream*

Advantages:

Hypertextual instructional materials provide several important pedagogical advantages:

1) Hypertexts use audio and video resources that make Shakespearean drama more "accessible" to students.

2) Students see different versions of actual productions juxtaposed to show the range of interpretation possible and the necessity to explain quotations.
3) Student work can be included in the stacks as samples and videos of scene production.
4) In individual sessions, students control the pace of their learning, with the ability to print most text resources, to answer questions in one or several sittings.
5) The range of topics (with over 40 hours of instruction possible per play) allows supplemental activities geared to individual learning needs (on the basis of an early diagnostic exam) and allows inclusion of challenging materials (such as discussion of historical adaptations or textual variants) that are not normally covered in class.
6) Frequent writing supports learning when students process what they are learning in a mode in addition to reading and listening.

Advantages for the logistics of teaching in various contexts are:

7) The random-access of hypertext makes it easy for teachers to have flexible control of audio and video resources without excessive equipment.
8) Coordination of the syllabus with hypertextual activities allows commuter students to make up missed class sessions and keeps students responsible for their learning, despite missed classes.
9) The teacher can use stacks repeatedly, but can also change text as easily as modifying an html textfile.

Process: From Theory to Prototype to Evaluation to Revision

The SHGs have evolved over time as I learned from practice about problems and opportunities. The first prototype, created using HyperCard, was designed to achieve advantages of random access to audio, graphic and video resources, especially different productions of the same scene (Advantages 1, 2 and 7 above). In Spring 1994, the prototype on *A Midsummer Night's Dream* established the basic structure for the SHGs (Lectures and Explorations, Cast graphic, Story summary, Glossary, References, Playtext access and Samples), used in English L315: Major Plays of Shakespeare. A year later (Spring 1995), I had HyperCard versions of 4 plays (*Taming of the Shrew, Midsummer Night's Dream, Hamlet,* and *Macbeth*) available for use in class and as an adjunct for out-of-class student use. Bugs in scripting and limit to use on Macintoshes on campus were very restrictive, but student response in class and on questionnaires encouraged me to continue development to test the SHGs as an adjunct to a traditional section of the class and as the primary means of instruction in an on-line class. Before a full-scale test in Fall 1995, however, one student worked on the stacks for an independent study in the summer. (She had been taking a Shakespeare course by correspondence and had earned an A on her first paper, but she had not worked further for several months. Although this student earned a B in the hypertext course, she finished in eight weeks.)

The comparative sections of the course in Fall 1995 established that the on-line course was logistically possible and academically sound. Students had the opportunity to switch sections at the beginning of the semester, and transfers in both directions occurred, though mainly from the on-line section to the face-to-face section. I was the instructor for both classes: most educational studies show that the greatest variable between classes is the teacher. Besides, I was the only person prepared to deal with both the subject matter and the technology, even with the help of a student technician from my Spring 1994 class. In Fall 1995, the sophomore-level class (L220: Introduction to Shakespeare) used the same hypertext materials as earlier 300-level classes, but set the work in a different set of goals and requirements. The section of the course which met face-to-face employed the SHGs for classroom presentation and to provide makeup for missed classes. The other section used HyperCard hypertexts for seven plays, with students required to use the campus broadband network on-campus and only on a Macintosh platform, but with automatic sending of work to the instructor and automatic printout of student work. On-line students were also required to post at least once per play on a class listserv. On the hypertext materials, questions (some optional and some required) were interspersed in the Lecture and Exploration materials, usually with about eight required responses per play--a great deal of writing and a great deal of responding required from the instructor. (Students in the on-line section averaged four single-spaced pages of writing per play.)

Table 1 summarizes the mode of instructional delivery and course requirements for these sections--shown in boldface for paired sections-- (as well as earlier and later sections that used the SHGs in any way), along with a summary of completion rates, grades and student evaluations of the course. Since students in the two sections took the same exams, the only significant difference was the mode of instructional delivery. The grades and student evaluations in the two sections were comparable, suggesting that the on-line students had as academically sound a learning experience as the students in the traditional classroom. However, there were important problems, in my estimation, with both sections. In the face-to-face class, I felt that I was being pushed away from discussion or class activities and toward traditional lecturing because the make-up assignments covered certain lectures and explorations; that is, the supplementary material was organizing the

Crs/Sem	Logistics	Grading	Retention	Grades	Stdt Evals
L315 C042 Sp93	2x75 min. per wk for 14 wks.	10% paper1 15% ppr2 15% attendance 25% ppr3 10% rev.*Hamlet* 25% grp projt	(35-7Wx=28) 28-4W, 2F, 1lnc=21=25%non-com 75% success	6A 25% 12B 50% 3C 13% 2F 8% 1lnc 4%	3.4
L315 C136 Sp94	1x150min.per wk for 14 wk	15% ppr1 20% ppr2 20% exam 20% fin projt 20%cps* 5% attdnce *class prep. sheets	(29-2Wx=27) 27-8F, =19=33%non-com [horrible weather] 67% success	4A 20% 12B 60% 3C 15% 8F 40%	4.6
L315 C207 Sp95	2x75 min. per wk for 14 wks.	15% ppr1 20% ppr2 20% exam 25% grp proj 15%cps(4of7) 5% attndnce	(34-2Wx=32) 32-1lnc=3% 97% success	9A 28% 17B 53% 5C 16% 1lnc 3%	4.6
L220 C304 F95f	**2x75 min. per wk for 14 wks.**	**30%ppr 35%exm 25%cps (4of7) 10%att**	**30-1w=29 = 3% non-com 97% success**	**9A 31% 15B 52% 5C 17%**	**4.6**
L220 C305 F95c	**6x75 min. total for 14 wks.**	**30%ppr 35%exm 25%response-ol (7plays) 10% listserv**	**(24-5WX =19) 2W of 19 = 11% non-com 89% success**	**5A 29% 10B 59% 2C 12%**	**4.4**
L220 C200 F96f	**2x75 min. per wk for 14 wks.**	**30%ppr 35%exm 20%resp (4of 7) 10%cps (5of7) 5%attdnce**	**(31 -2Wx=29) 6w,1Fe =24% non-compltn 76% success**	**10A 43% 5B 22% 4C 17% 3D 13% 1F 4%**	**4.6**
L220 C201 F96c	**11 f2f mtgs (75 min) req. in 14 wks.**	**20%ppr 35%exm 30%resp-ol (7 of 7plays) 10%listserv**	**(30-6WX, WZ =24) 5w, 1Fe= 25% non-com 75% success**	**7A 37% 9B 47% 2C 11% 1F 5%**	**4.8**
L315 C279 Sp97f	2x75 min. per wk for 14 wks.	10% exam1 30% 2 sh ppr 10% att&quiz 25% fin projt 25% fin exam	(44-5Wx=39) 1w, 3Fe=10% 90% success	11A 29% 21B 55% 4C 11% 1D 3% 3F 8%	4.2

Table 1: Logistics and Evaluation of Shakespeare courses using SHGs 1993-1997

main instructional activity. In the on-line class, students complained that they worked harder than in a traditional class, and as a teacher I certainly worked harder. Although I knew the minds of my on-line students better, I felt less satisfaction as a teacher, compared to the affect from a traditional class.

Transferring materials from HyperCard to the Web has made the instructional material more accessible to students and has given the opportunity to revise the way opportunities for response are included in the materials. In Fall 1996, I offered the two sections of the class again, but with some instructional material available in HyperCard and some as Web materials (with greater access). In Spring 1998, all materials were on the Web, with one or more questions available for each Lecture and Exploration. The administrative part of the class, separate from (though linked to) the SHGs and on a different server, included: posting of assignments and information as well as a class bulletin board (including separate forums for sub-groups), a grade book and a chat room. The syllabi of the two sections are now significantly different, with activities in the face-to-face class that require in-person group work, and with a group-paper in the on-line class that would be logistically difficult except on-line. Instead of 8-12 short responses, on-line students are asked to give two substantial responses and one group response for each play. The group paper cuts the grading to 20% for the third assignment, since there are five people in each group: one paper to grade per group instead of five individual responses.

I have been willing to cut the number of responses once it became clear to me that simply asking students to write a great deal was not necessarily improving their writing skills. The group project, which called for faith and good will in the first semester of use, is an attempt to include some metacognitive analysis with the writing. Each person in the group gets a slightly different part of the assignment to write about--due at the end of the first week of study (after the posting of the first individual assignment). Two days later the Writer for the group (a job that rotates throughout the group from play to play) posts a coherent draft incorporating the work of all group members; two days later the Editor posts revisions. Others in the group have the possibility of sending their comments via the Bulletin Board, by email, by meeting in a chat room or by meeting in person--before the Writer posts the final draft to the Main Bulletin Board for the class at the end of the second week of study on the play. In this way, students compare their work to that of others who are "on their side"; it is to their advantage to try to strengthen the work of the Writer. All students get the same grade for the response, except for group members who post too late for their work to be used (and they get a D).

It's clear to me now that there is no ideal form, though some are better than others. The SHGs are instructionally sound (according to an outside review I commissioned as part of project evaluation and available on request). Creation of the SHGs is labor intensive. Once the interface was established, it took me about 50 hours per play to write the instructional material and about 100 hours for a trained student assistant to create machine-readable resources; in addition there was debugging of the text. At this point I'm more interested in designing different course matrixes than in producing additional SHGs. The html code is easy to adapt or add to (although SHGs will now be available on CD-ROM to cut the time students are required to spend on-line). Perhaps the best use of the SHGs is as modules within a course structure that can be designed by many different teachers to serve different students. The next test therefore involves use of the materials by other teachers: are they willing to adopt the SHGs? are they able to adapt them into their own course goals, student needs and pedagogical philosophy?

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Co-constructing Learning Environments and Learner Identities-Language Learning in Virtual Reality

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Abstract: This paper describes the changing roles of language learners in a collaborative learning environment (MOO). The role of the learner is defined within the concept of learner autonomy, and we use both Kelly's theory of personal constructs and Vygotsky's concept of the zone of proximal development to explore it. These theoretical notions, especially regarding learner identities, are supported by some concepts of virtual reality that emphasise its communicative and participatory nature. Finally, I will look at organisational issues that need to be considered when implementing learner autonomy, on the one hand the Tandem network, on the other hand the integration of MOO activities within an inter-curricular framework between Trinity College, Dublin, and the University of Bochum, Germany.

Introduction

Although the recent past has provided numerous computer resources for students, the underlying concepts and aims of language learning software and general notions of how to use a computer in the language classroom have not always had the effect teachers and learners would have wished for. Language learning CD ROMs have been produced at a rapidly increasing rate, and with the increased accessibility of the Internet many Internet resources have adopted the technical and pedagogical limitations of that static medium.

Personal Constructs and Collaborative Learning

The underlying framework for a collaborative learning environment as an alternative to the traditional classroom is partly based on George Kelly's theory of personal constructs. The second major string of thought is derived from the work of the Russian psychologist Vygotsky and his view that mental abilities are determined by social relationships. Both were used in language learning theories to explore the concept of learner autonomy, developed particularly by David Little [Little 1991].

Kelly emphasises that each individual has different personal constructs that he uses to deal with a learning task: "Different men construe [the universe] in different ways (...) Some of the alternative ways of construing are better adapted to man's purposes than are others. Thus, man comes to understand his world through an infinite series of successive approximations" [Kelly 1963]. The learner's view of the world is characterised by a "continuous process of hypothesis-testing and theory-revision" [Little 1991] to make sense of the world around him. When this view of the world requires little or no adjustments of the underlying hypotheses and theories, learning will take place without great difficulty, when it requires substantial changes, learning will be difficult or even painful [Little 1991]. One of the strongest points Kelly makes is that these diverse personal constructs need to be explored and laid open. In language learning terms, learners need to become more aware of their personal constructs and thus of their personal learning process. Another important consequence of this approach is the need for the creation of personally meaningful learning environments and materials, private spaces that can be constructed by each learner. This idea can also be found in Seymour Papert's theory of constructionism [Papert 1993]. Papert adopted Jean Piaget's idea that people construct new knowledge from their experiences in the world and added that they do so "with particular effectiveness when they are engaged in constructing personally-meaningful products"[Bruckman & Resnick 1995].

The other major influence on learner autonomy arises from the work by the Soviet psychologist Vygotsky. His emphasis on social relationships in the development of mental abilities and thus also learning underlines the importance of peer support for any form of learning. Central to his theory is the idea of "the zone of proximal development. It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers"[Vygotsky 1978]. David Little mentions that "[t]he developmental learning that unimpaired small children undergo takes place in interaction with parents, brothers and sisters, grandparents, family friends, neighbours and so on. Education, whether institutionalised or not, is likewise an interactive, social process. For most of us, important learning experiences are likely to be remembered at least partly in terms of our relationships with one or more other learners or with a teacher"[Little 1991]. The Vygotskian approach, then, emphasises the need for a collaborative learning environment where learners are enabled and encouraged to interact and give each other support with their language learning, a public space characterised by interaction and scaffolding.

The concept of learner autonomy integrates these approaches: "Essentially, autonomy is a *capacity* - for detachment, critical reflection, decision-making, and independent action. It presupposes, but also entails, that the learner will develop a particular kind of psychological relation to the process and content of his learning. The capacity for autonomy will be displayed both in the way the learner learns and in the way he or she transfers what has been learned to wider contexts"[Little 1991].

Virtual reality could realise some of these goals, in particular the kind of virtual reality that is presented in the following chapter.

The Framework of Virtual Reality

At the grassroots level, and indeed subconsciously by most users, the Internet has developed a number of communication modes, one of which- e-mail- is probably the one Internet tool that is used most extensively. For reasons of limited bandwidth and computer power, it was not feasible until now to use other communication modes, or so it seems. Unnoticed by many, a number of communities have formed over the last 15 years that have been communicating and collaborating "live" via the Internet.

Using at first only asynchronous modes like Bulletin Board Services, mailing lists, and newsgroups, they soon discovered Multiple User Dungeons (MUDs), first developed by Richard Bartle and others in 1979 [Bartle 1990]. Within MUDs, people create characters and engage mostly in adventure role plays, many of which still exist today. Those games were and still are solely text-based, and messages are exchanged by typing them on the keyboard. In the early 1990's, thanks to Pavel Curtis and others, the MOO (MUD object-oriented) programming language was created. This allowed for the creation of text-based virtual realities where every user with little or no programming knowledge could participate in creating new spaces, "rooms", and new and sometimes quite diverse social identities. Within these worlds, they could meet and communicate with each other.

Many of these MOO-based worlds were and are quite different from the adventure MOOs. Some MOOs started as social worlds, were people collaborated and worked together rather than slay dragons and monsters or "kill" each other in adventure scenarios. Quite recently a number of educational MOOs were created, where people are encouraged to learn and study together and where teachers and educators can experiment with new teaching tools and/ or implement recent learning theories. In addition, the MOO language has constantly been revised and updated. Recent developments include the BioGate interface [Mercer 1997], an Internet-based access system to MOOs where the usual text description of virtual worlds is supplemented by WWW-based hypertext and a VRML interface, all of these as an add-on, not as a replacement of text-based virtual reality. This increased redundancy in mirroring object presentations in three separate programs may sound superfluous, but is a feature that compared to sophisticated 3D chat systems [Roehl 1996] allows for impaired users and different access systems and bandwidths. For language learning these recent developments have led to the creation of a number of foreign language MOOs, where students can meet with target language speakers to improve their proficiency.

I consider the framework of virtual reality very important in the context of language learning. Right from the beginning, the element of communication between participants has always been emphasised to create the impression of VR. Chip Morningstar, one of the co-founders of Habitat, today maybe the biggest commercial text-based community, stated that "a cyberspace is defined more by the interactions among the (users) than by the technology with which it is implemented" [Hamit 1993]. Another important element that can be found in several definitions of VR is the active collaboration between participants, the in principle open and extendible nature of VR and its intuitive nature as an interface. This applies to text-based VR as well as VRML that is still evolving as a standard for 3D walkthrough VR.

In contrast to most proprietary systems that use 3D walkthrough systems and allow for chat facilities, the modular nature of the MOO interface (including increased redundancy of representation), its wide distribution and reliability, its participatory nature even for students, and its recent option to integrate all other interactive Internet development tools within a common interface, makes it a powerful tool for any subject area.

Two aspects that I mentioned earlier are vital for language learning. First, the MOO allows for asynchronous communication modes via a built-in system of email and mailing lists, but first and foremost for synchronous communication via the keyboard. As these "live" conversations between two or more participants can be recorded to a so-called log file (an ordinary text file) or to a virtual tape on a virtual tape recorder, they can form a powerful future learning resource. One of the first impressions in the MOO environment, namely that people do not exist on screen unless they act or speak, leads to much higher participation in larger groups. The basis of MOO is, after all, text, or, for language learners, language. Participants can only define themselves in terms of language. Live communication becomes measurable and occupies a vast majority of the textual space compared to object descriptions. In a vital sense, most of the virtual environment that participants experience is built through the use of their own language. This also means that learner identities are created only through written language; personas are created and recreated in collaboration and interaction with their partners Sherry Turkle describes in detail the sociological processes that take place in MOOs [see Turkle 1995]. The permanence of the written medium also allows for another important feature. Compared to modes like audio conferencing or video conferencing, which may provide more natural ways of communicating live, the conversations in MOO are not lost, transcripts can be retrieved and printed out straight after the event. A ten minute bilingual conversation can thus provide a vast learning resource, where both learners will end up having a wealth of personally meaningful material, partly own efforts in the target language that can be reviewed and analysed alone or with their partner and partly authentic target language input by a native speaker, their partner. This shift from an interactively constructed corpus of learning material towards intrapersonal learning reflects Vygotsky's theory of learning a foreign language: "In one's native language, the primitive aspects of speech are required before the more complex ones. The latter presupposes more awareness of phonetic, grammatical and syntactical forms. With a foreign language, the higher forms develop before spontaneous fluent speech" [Vygotsky 1986]. By constant analysis of his own performance in the target language and his native speaker's input, the learner approaches the fluency that only arises from external processes having been internalised.

Secondly, the participatory nature of the MOO makes it easy for teachers and even learners to create their ideal learning environment. Creating a room in the MOO is as easy as editing a text in an old DOS word processor. Linking up WWW resources to objects is just as easy, and the extensive help system within the MOO helps any newcomer with obstacles they may encounter. The increasing availability of WYSIWYG-editors for HTML and VRML simplifies the use of more advanced technologies.

For the Tandem language learning project between the universities of Bochum, Germany, and Trinity College Dublin, Ireland, I decided to develop language learning environments in Diversity University MOO (*http://moo.du.org:8888*), one of the pioneering MOOs and (together with BioMOO) origin of the BioGate interface. Although the MOO is written completely in English (a German alternative is currently being prepared), it provides a rich campus-like environment and features a number of very useful teaching tools that were not yet available elsewhere at the planning stage of the project. I also installed links to foreign language resources in German, French, Italian, and English and a variety of task templates that tandem pairs can adapt to their own needs and work on in self-access time. These facilities only serve as a starting point for students to explore the virtual campus and select their favourite areas for collaboration. If they want to build their own environments, they can quite easily do so, either as private spaces or as public spaces, for example for class projects or presentations. However, it is not sufficient to simply provide these tools for language learners. Maybe the most important factor within a successful language learning partnership is a solid organisational framework based on learner autonomy, such as the concept of tandem learning developed within the Tandem Network in Bochum, Germany.

The Dublin Bochum Tandem Project

In 1995, we joined the Tandem Network. The organisation of the Tandem Network is divided into an ever increasing number of bilingual sub nets that on the one hand provide tandem partners through a central agency, and on the other hand allow for group work via bilingual discussion lists. The agency would pair for example an Irish student of German with a German student of English. The major principles behind tandem learning are reciprocity, which implies the commitment to a partnership and the use of both languages involved in equal amounts, and the previously mentioned concept of learner autonomy. For more information on tandem learning, see [Little & Brammerts 1996].

However, during a pilot phase with our students we discovered a number of organisational drawbacks. As a mere add-on to a course, a tandem partnership was only pursued by a small minority of our students. Partners did not respond, and when even a second or third attempt to get a reliable partner failed, students simply got frustrated. Furthermore, traffic from the mailing lists, at least the English-French and especially the English-German lists had become so big that they were receiving from 5 to 15 messages a day, many of which the students considered overwhelming and irrelevant to their own course work.

The Dublin Bochum project grew out of the dissatisfaction with our efforts at implementing the principles of tandem learning. While a few tandem partnerships remained, these took on the form of no more than penpalships. Sometimes one language took over (the target language of the more proficient learner), in most cases the exchanges were highly irregular in their use of bilingualism. Learners did not relate the exchange to their language courses and the projects and course work they were involved in. The tandem principle of reciprocity was in most cases not followed.

For the 1997/98 project year we implemented a number of changes. Thus we created our own mailing list, dealing only with a number of around 160 students on each side of the project. We also took over the dating of students ourselves, and we started the project by double dating students. Thus every student starts off with two partners, as we expect a fairly high attrition rate (due to the language courses being an add-on course for students of Arts, Science, and Engineering). Students are repeatedly trained not only in the technical know how of email and MOO commands, but also the principles of tandem learning. In particular this means training in error correction and using the authentic target language input from their partner to create a future learning resource for their own needs. All four courses now have a project oriented structure, and the year 2 courses (1 course on each side) have the same four project frameworks. Email and MOO work is an essential part of course work and assessment. Because of the different term structure in Germany and Ireland, only two projects are used for assessment. The first of these, initiating a debate, can be particularly well planned and exercised in the MOO environment, while the second, the project web site, will probably more likely use email exchanges. Throughout, however, students are encouraged to use both facilities to improve their written and oral proficiency.

Conclusion

The MOO environment as presented here offers an ideal solution to the drawbacks of the traditional language learning classroom. According to their individual personal constructs, learners are enabled to create their own learning environments, either by actively participating in the object-oriented virtual reality or by redefining their identity as learners through interpersonal contact with the target language culture and its speakers and analysing their new place within this relationship. The double role as learner and expert in an environment characterised by learner autonomy allows them to take part in the immediate and personally meaningful creation of collaborative learning material that is by definition also meaningful for their partners.

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A Discussion of Pedagogical Strategies and Resources Associated with Software Engineering Training over the Intranet

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Abstract: The Internet infrastructure is presented as an ideal training medium distributing self-directed, just-in-time, information waiting to be transformed into newly-constructed knowledge. This training environment becomes viable when pedagogical strategies supporting learning outcomes are explicitly implemented. In this paper, we present various strategies associated with on-the-job software engineering training over the Intranet. We believe that this particular Internet infrastructure has the possibility of not only developing new individual knowledge skill sets but also creating and identifying new communities of Web-based learners, regardless of domains.
Keywords: pedagogical strategies, Internet Technology, Web-Based Training, Software Engineering Education and Training, Just-in-Time training, Collaborative Training, Learning by Doing.

Introduction

According to [Davis 94], knowledge is doubling every seven years and technical fields that are knowledge dependent are critically affected by this phenomenon. A great part of what students learn in their first year of College is obsolete by the time they graduate [Davis 94]. This justifies not only the incipient existence of continuing education but also the need to design and develop innovative, on-the-job training strategies associated with life-long learning skills. In this context, Internet technology and tools can provide a less costly and more efficient alternative to on- going training and continuous education. We believe that in order to take advantage of this technology one must concurrently adapt existing strategies with new methods of apprenticeship capable of empowering and sustaining the act of learning.

The emergence and ready availability of Internet technology is providing software engineers and educators with new tools and innovative means and ways to communicate and disseminate information as well as develop resourceful, constructive and outcome-driven training strategies. These variables have the potential to either be exploited internally by companies developing their own corporate Intranet or externally within an extranet environment targeted to their client base.

There are many ways of utilizing the Internet's infrastructure to improve the conditions of training and education [Brunner 96, Malay 97]. We list a few, in part:

- Records the level of understanding, prior knowledge and competencies associated with the participating end-users.

- Collectively shares and exchanges one's individual efforts and strategies identified with knowledge acquisition
- Makes available pertinent resources identified with self-directed and just-in-time learning.

Examples of Internet Technology-Based Environments

At its most basic level, the Internet infrastructure is viewed as a platform that distributes information and supports communication. Given these two services, we can develop an effective intranet/extranet environment for distance software engineering training. [Tab.1] presents an example of this basic training environment.

HTML Resources	- Overheads - Syllabus - Objectives - Assigned readings - List of work to accomplish - Exocises - FAQ
Links to WWW sites	- Bibliographic References - Additional information - Other Courses
Discussion Group	- Questions/ Answers - Trainer's Comments - Student Ideas
Electronic Messaging	- List of available experts to consult - Registered students in the course - Personalized Questions/ Answers - Training follow up - Corrected Exams - Training Overview - Personal Information

Table 1. Description of an Online Courseware Environment

This environment allows students to freely browse through different kinds of learning resources used to either achieve a greater understanding of the lesson or receive further information concerning the lesson.

Current plug-ins and middleware extensions facilitate the development of advanced training environments. From a technical perspective, these environments are characterized, in part, by highly interactive and portable learner interfaces and by a gateway that enables a Web browser to access external databases and tools. This technical integration can now lead us to promising learning outcomes supported by a whole range of pedagogical strategies.

As an example, we have developed an advanced learning environment that identifies to object-oriented developers, their training needs. It accomplishes this by classifying the strong and weak areas of their knowledge concerning object-oriented technology. The system addresses questions such as:

- What does a software developer know about an object-oriented environment?
- Which concepts should he/she focus his/her efforts in order to learn effectively and efficiently?
- How does one identify a developer with the best resources in a team in order to accomplish a certain design/development activity?

The GAA [Khuwaja-96] and UKAT [Desmarais-93] tools developed at the Computer Research Institute of Montreal (CRIM) support the environment. UKAT (User Knowledge Assessment Tool) uses a state-of-art user knowledge assessment method to create a user profile of the mastery of a subject domain. GAA is a Web-based learner interface that uses the UKAT to personalize the distribution of resources stored in a database. The various questions used by UKAT are part of the database.

Pedagogical Strategies

Integrating information and resources into an on-line training environment requires an analysis of apprenticeship skills. This analysis helps to define an appropriate training pedagogy [Seffah 97]. Studies have shown that on-line distance training becomes more efficient with end-users engaging in at least one face to face point of contact.

Our opinion is that an Internet-based learning environment must explicitly support a cognitive technology that encourages the student to (1) become a confident individual singularly organizing and retrieving information and data as well as (2) collaborate with other participants in search of common virtual learning outcomes. Cognitive technology (CT) brings together identified cognitive tools with Internet/Intranet Technologies and Tools. We construct cognitive tools to help us negotiate learning transactions to arrive at some kind of meaning and internalized understanding of the proposed content. As mediated devices, cognitive tools also assist the end user in the transfer of knowledge by encouraging and fostering cognitive activity that is the antithesis of rote learning and the passive retention of material. The Web is an ideal medium for this kind of cognitive apprenticeship because it can simultaneously support singular transactions as well as synchronous and asynchronously interactions with other learners. The following principles apply:

- Learning by sharing information and resources
- Synchronous and asynchronous collaborative learning
- Self-directed learning
- Learning by doing
- Self-assessment

Learning by Sharing Information and Resources

It is important to encourage the student to share and compare his/her solutions and problem-solving capabilities with other students. We accomplish this by:

- Presenting the student with contextualized resources and information.
- Extending those resources and information leading to an acquisition of knowledge.
- Communicating this augmented knowledge and understanding with other participants within the course parameters.

As an example, the inclusion of a tree browse applet within our online courseware environment will assist both course developers and students to generate and organize the overall course content as well as add resources.

Synchronous and Asynchronous Collaborative Learning

[Guzdial 96] indicates that collaboration in leaning activities can facilitate both successful performance and reflection for learning:

1- Groups can solve more interesting and complex problems than can individual working alone.
2- Students working in groups need to articulate designs, critiques, and arguments to other group members, encouraging the kind of reflection that lead to learning.

We facilitate both synchronous and asynchronous collaboration, since the former lends itself to planning and brainstorming, and the latter lends itself to reporting experiences and off-line reflection.

Self-Directed Learning

Students should be involved not only in structuring their own learning but also sharing the control of their learning activities through discourse and reflection. In this context, we provide each end-user with the opportunity to make decisions concerning the possible re-organization of the curriculum according to his/her own self-paced understanding of the instructional objectives, access to the materials, demonstrations and problems.

Learning by Doing

It is important to integrate several kinds of resources that can support the requisite training needed to accomplish certain tasks. For object-oriented training, pedagogical design patterns [Manns 96] and scaffolded examples [Rosson 96] are examples of such resources. A pedagogical pattern essentially describes an abstract design template from which specific solutions can be generated, so those later designers don't have to start from scratch when they come across this problem again. Scaffolded examples are sample problems of realistic size whose complexity is gradually revealed in steps that leverage and reinforce the intrinsic structure of the problem-solution process. Scaffolding enables learners to build their understandings through a process of successive elaboration and integration.

Self-Assessment

It is important to understand the outcomes before we design and develop self-assessment strategies. A priori, we need to anticipate and identify the end-user's unique and self-paced exploration of the given learning resources and then situate their need for insight, alternatives and new directions by providing embedded questions, and correct, summative self-evaluation instruments. Once a learner profile has been established, we can confidently design the assessment strategies.

The following illustrates one approach to a test/diagnosis mode related to the advanced environment presented in section 2. It provides opportunities for self-assessment through the administration of multiple choice questions, varies quizzes and Likert style questions. The results of the assessment are available via a histogram applet [Fig.1]. When the student double clicks on his/her particular column, a pop-up menu appears on the screen to display a list of a value added resources that will reinforce the students' apprenticeship.

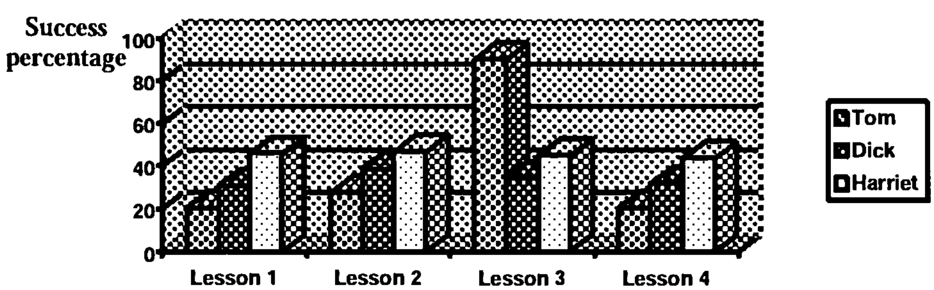

Figure 1. Presentation of Results of an Assessment Process

Conclusion

The pedagogical strategies that we have identified should seriously be considered by corporations and institutions wishing to implement an online training environment. However, identifying and implementing such strategies is a large and complex undertaking requiring many critical milestones. In this paper, we have described several strategies.

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Web-assisted Teaching - A Geomatics Experience and Perspective

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Abstract: This article addresses the experience in the Web-aided geomatics teaching and prospects its potentials. A brief introduction is made to the education background and the environment involved in teaching activities. Experience in Web-aided geomatics teaching is discussed in detail. Creative assignments for publishing geographical information and its 3-D visualization in the Web environment are addressed. Administrative issues, sharing geographical data and establishment of a universal Web site for geomatics education with participation from industrial domains are prospected.

1. Introduction

The advent and world wide proliferation of the Web (World Wide Web) enables teachers and students to be in a common platform to communicate, either on-site, locally or globally, in the whole procedure of education [IJET, 1997]. Through the Web, lectures notes, exercises, lab instructions, reference materials and further readings can be made available to students [Stemler, 1997; IJET, 1997]. In addition to this communication function, the Web is also served as a powerful and unique tool to improve the quality of demonstrations, explore and explain phenomena on-site and simulate the dynamic process of events [Bergeron and Bailin, 1997; Stemler, 1997]. Moreover, the Web can be used as a development platform for undertaking labs, assignments in various teaching subjects.

This article presents the experience and results of Web-assisted teaching in geomatics courses at the University College Gävle, Sweden, and prospects its further development. Section 2 makes a brief introduction to the background of the geomatics education and its implementation. The experience in teaching is then discussed in detail in Section 3. Two creative assignments for students, namely publishing geographical information and visualizing geospatial data in three dimensional (3-D) mode, both in the Web environment, are addressed. Perspectives on further development for effective Web-aided geomatics education are given in Section 4. The concluding remakes are in Section 5.

2. Background

Geomatics is the science, art and technology to acquire, process, analyze, depict and distribute geographical information which may take various multi-media forms. Currently, under the curriculum for geomatics (surveying, mapping and geographical information system) subject at the University, two courses, namely *digital mapping* and *visualization of geospatial data* for undergraduates are designed and given with the assistance of the Web.

In order to make full use of the Web potential, the teaching activity is conducted in the following way. In addition to lecture notes and reading materials, labs and assigned projects in accordance with the courses are also based on the Web. Netscape Communicator™ and VRML (Virtual Reality Modeling Language) are used as application programming interface for the assignments. The publishing of geographical information on certain themes based on clickable maps are conducted with Netscape Communicator™ and Mapedit™. VRML is used for developing 3-D interactive visualization for terrain and urban models. Cosmo Player™, VRwave™ and WorldView™ are chosen as VRML browsers on the Web.

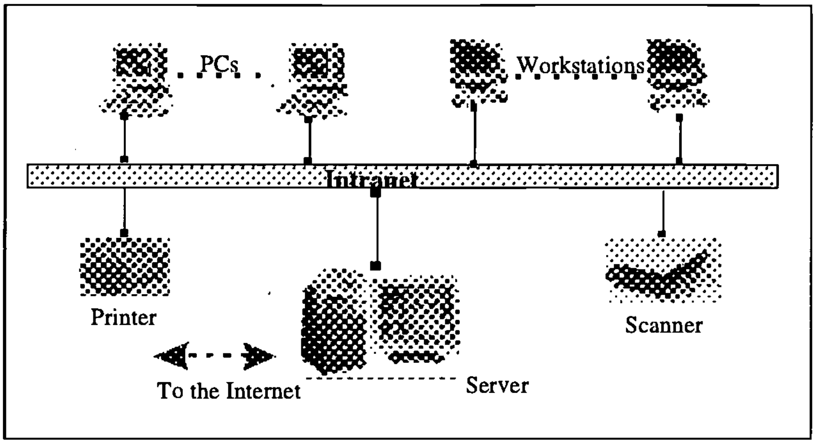

Figure 1: System for Web-aided geomatics education

[Fig.1] shows the system configuration for Web-assisted geomatics teaching. Approximate 25 students for each course have the option to use PC with Windows 95 or Sun Sparc Station 20 in two groups. Support from IT (Information Technology) foundations is granted. National and international cooperation with universities are undertaken and expected to strengthen and expand further. The persistent support and encouragement in using IT for multimedia education from the University initiated the implementation of this program. Without the exceptionally good IT equipment and the well-maintained connection, the entire educational program would not have been of a success. During the courses, students can access to the Internet through PCs or workstations at any time with his unique account.

3. Experiences

3.1 Distributing teaching materials

The Web is firstly used as an effective way to distribute lecture notes. Students can therefore read them on-line. In particular, the Web provides an innovative way showing and accessing geographic maps, images, as well as dynamic pictures. With this tool, the lecture notes can be organized and prepared in a consistent way. Its aesthetic effect is greatly improved comparing to photocopies of books or overhead transparencies. Highlighted points are easily marked by using different fonts, bolded text and distinct colors. Teaching materials collected in the Web environment can be shown on-site directly via screen projector.

All teaching materials are integrated on one site. Just by clicking links the complete documents are then available to readers. Moreover, references and further readings on the Web are also organized and pointed by meta-pages, that provides students with a wide space of free thinking and an opportunity to extend their knowledge on neighboring subjects.

3.2 A self-learning site

In addition to lecture notes and specified reference materials, senior students use the Web as a tool to acquire current status in geomatics. Web sites for similar courses in other universities in the world are requested to visit where students get seminars, summary of historical developments, research reports as well as lecture notes and tutorials. Through the Web, students are also able to visit various products of well-known firms in geomatics industry. It is shown that this function is extremely helpful when students are asked to design and perform their works independently. Surfing the Web has played an essential role in completing creative assignments. In this way, one can search and acquire related geospatial data, information and development tools, such as free- or share-wares.

3.3 A platform for assignments

The innovative field in geomatics where the Web is being successfully used and still has prosperous potential is depicting, distributing and even manipulating geospatial data through the Web. Two types of creative assignments within the courses are conducted in the Web environment.

One assignment is devoted to publish thematic geographical information based on clickable maps in the Web environment. Students have the freedom to choose their own interests though suggested topics are given by the lecturer. Heretofore, topics for this assignment have covered information about tourism, national mapping coverage, national parks, municipality, distribution of universities offering education in geomatics, distribution of world culture heritages. All products are based on a properly designed clickable map. Detailed information will show up when the highlighted spots on the map are clicked. Hyperlinks may further guide the readers to other remote or local sites for more relevant information. Multimedia and hypermedia functions of the Web make this publication compatible in all aspects with conventional thematic maps. Moreover, Web publication is uniquely characterized by human-computer interactivity which is non-trivial without using a Web browser.

Another assignment is to visualize geospatial data in a 3-D mode on the Web. This includes shaded perspective view of digital terrain model, 3-D city model of the local area. VRML is used as the development tool for this purpose. A panoramic view of the virtual reality is displayed by browsing the Web page. Again, this visualization technology is characterized by human-computer interactivity so that the realistic and immersed effect is reached. There are several available tools to browse the VRML file. VRwave™ is chosen as the browser on Sun Workstation. For PC users, Cosmo Player™ and WorldView™ are used.

Since all the workstations and PCs are network connected, various desktop tools for graphics and image processing and editing can be used together with Web editors without troublesome data transfer and format conversion.

A final Web-based on-site demonstration is arranged for students to report their works in the class.

4. Perspectives

4.1 System administration

In order to make the Web-assisted teaching activity possible and effective, the school should be well equipped with sufficient advanced hardware (Workstation and Pentium PC) and software (Windows 95 or later) platforms and have them well connected to the Internet. Moreover, the system server is expected to work reliably in a wide bandwidth access to the Internet. Only in this way can be ensured the access to the local and global documents, especially to a large amount of graphical data, in marginal waiting time. Regular upgrade of system packages and plug-ins are also essential.

Students should be able to print out lecture notes and primary reading materials through the intranet. An administration mechanism is expected to be operational in order to examine the amount of free output printing from each individual account for each course.

In addition, sufficient input and output devices (especially for graphics and images) will be an indispensable part in the environment for geomatics education.

4.2 Geospatial data source

This is a unique issue in the practice of geomatics education. Only with sufficiently available geospatial data can be effectively operational the Web-based geomatics education. So far, only a few sites can supply limited sample data. The lack of consistent and comprehensive geospatial data thus remains a key issue for future practice. A global and regional co-operation is highly expected to provide sample data which will be mainly used for the education in 3-D visualization of geospatial data in the Web environment. For this end, contribution and coordination from industrial domain are mostly demanded. Existing consortium or the one yet to be formed may have university participants as its members so that a close industry-university cooperation can be established.

4.3 A universal Web site

Though geomatics courses are taught in many universities around the world and some excellent sites for individual courses are available, a universal Web site is expected to be established and maintained. In addition to collecting related Web sites, it will be served as a forum for exchanging education experience, publishing assignment and project reports, distributing test data and results. On this Web site, programs developed with platform-neutral languages and running in the Web environment will provide local or global students with a uniform and standard learning environment. Moreover, this will make possible the real-time distance-learning through running the same programs and operating on the same data set simultaneously. For this end, international societies and organizations in various subjects of geomatics are expected to play a substantial role together with the possible participation from industrial sector.

5. Concluding remarks

The advent and world wide proliferation of the Internet technology offer us an innovative tool in the education of geomatics, either on-site, locally or globally. The Web can be used as a platform for teacher-student communication, the access to outside sites, understanding the recent development in academy and industry. Besides, publishing thematic geographical information and 3-D visualization of geospatial data can also be conducted in the Web environment as creative assignments to the students. Primary experience and results indicate a challenging potential for refreshing existing courses and developing relevant courses. Cooperation between academic and industrial sectors are expected to establish a universal Web site for geomatics education, including exchanging experience, distributing test data, publishing project results and real-time distance-leaning.

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Document-Centred Discourse on the Web: A Publishing Tool for Students, Tutors and Researchers

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Abstract: This paper describes how we are exploiting the potential of interactive Web media to support a central part of academic life: the publishing, critiquing, and discussion of documents. We are as interested in supporting school and university students critiquing course texts and publishing their essays, as in professional scholars and researchers engaged in journal peer review and publishing. We question the replication of "papyrocentric" models which do not stop to question whether the new media make possible new forms of document and new modes of working. We then describe the design principles underpinning the environment for reading and critiquing Web documents that the D3E Publishing Toolkit generates, and illustrate its application to an educational multimedia e-journal, and to tutors and students in a distance learning scenario. We conclude by pointing to directions in which future work could develop.

Documents in Academic Life

The emergence of the internet, in particular the World Wide Web, have potentially far reaching implications for academic life, because *documents* mediate the work that students, tutors and researchers do everyday. This observation is at one level banal and not particularly helpful: documents mediate the established work practices of every organisation. However, taking this simple observation as a point of departure, a detailed understanding of the work that documents support, the contexts in which they are embedded, and the processes that give them their true significance in the communities that read and write them, opens up a spectrum of possible uses for new technologies (cf. [Brown & Duguid, 1996]).

In this paper, we use the term "publishing" in the broadest sense of a student, tutor or researcher making a document publically accessible, in this case, on the Web. Our approach to analysing how documents and publishing can change is best illustrated by examining what are arguably the central activities in academic life, namely, *publishing and critiquing documents*. The intellectual 'cut and thrust' of debate between peers as they contest the ideas in a document is a core skill that we seek to foster in students, and which obviously needs to be recognised and supported within professional scholarly communities. As members of these communities become increasingly distributed in time and space, how is this to be facilitated? In conventional teaching situations, such debate normally occurs amongst students when they are brought together in a moderated tutorial context; this is difficult in distance educational contexts. When the object of discussion is a document, we need more elegant environments than an e-mail list in order to easily refer to different parts of a document, and conduct parallel streams of discussion. In the context of a journal, such debate is also missing between authors, reviewers and peers with the exception of the few journals which publish commentaries and replies (albeit after a long delay, and with poor support for continued discussion following publication).

Our particular focus is therefore on *document-centred discourse.* In the following sections, we explain the design principles underlying *D3E (Digital Document Discourse Environment)*, and illustrate how it can support students, tutors and researchers in publishing and debating documents. We conclude by considering promising directions for future work.

Paper-Based Print and Scholarly Work

From surveying the current state of the field, our conclusion is that most e-journals serve only to demonstrate the extent to which thinking is still "papyrocentric" (a term coined by Stevan Harnad). Traditional documents are simply disseminated digitally, and traditional activities are facilitated by established technologies such as e-mail and document/journal management systems. The central processes and products of scholarly work have gone unquestioned. This can be ascribed on the one hand to inertia amongst publishers who fear the loss of markets and are unsure of their role in digital publishing, and on the other to inertia in the paper-based academic culture, where traditional print literacy and genres dominate (understandably), literacy with new media (e.g. HTML, interactive and time-based media) is not yet widespread, and the pressure to publish in established journals is intense.

Papyrocentric deployment of interactive media does not seem to us, therefore, very imaginative. However, for the first time, the dominant influence of print on our conceptions of documents, publishing and associated scholarly processes is being seriously challenged by the convergence of the Web and communications tools. In such transitional times as these, constraints previously taken for granted are recognised as merely contingent on paper, and established modes of working are no longer as natural and obvious as they seemed. Such times provide the opportunity for radical and creative reflection on why we do what we do, offering the opportunity to keep the best properties of paper, but to explore alternative scenarios that transcend papyrocentric practices.

Design Principles Underpinning D3E

D3E is based on extensive research into how hypertext systems can support critical reflection and the analysis of arguments in writing and software design. Over a period of about six years, we have surveyed, prototyped and evaluated the usability and effectiveness of systems designed to support the representation and analysis of arguments to justify decisions, and the smooth switching of attention between building an 'artifact' (whether a written document, CAD design, or program), and reflection on it [Buckingham Shum, *et al.*, 1997][Sumner, *et al.*, 1997].

From this work on pre-Web hypermedia systems, we formulated several design principles to guide the development of D3E:

A: Avoid over-elaborate discussion structuring schemes.

B: Integrate document media with discourse.

C: Redesign work practices to emphasise discourse.

D: Support the new practices with tools.

Principle A: Avoid over-elaborate schemes for structuring comments and discussions. If users classify their document annotations or contributions to an online discussion, greater computer support can be provided. For instance, one can search for all *Theory* comments that have *Contradictory Evidence*, if those categories have been defined and used. Numerous schemes have been proposed for structuring discussions (e.g. [Conklin & Begeman, 1988][Turoff, *et al.*, 1991]. In the systems we have studied, discussion schemes have required users to categorise contributions as *issues*, *positions*, *comments*, *pros*, and *cons*. Schemes of this sort, however, run the risk of burdening people with excessive representational overhead by forcing them to categorise their ideas before they are ready to, or the scheme is too restricted to capture the nature of a subtle comment. Studies from a wide range of work contexts show that at least initially, users are often unable or unwilling to structure ideas in new ways, because the effort is too great for the perceived benefit [Shipman & McCall, 1994][Shipman & Marshall, 1994]. The answer is to allow a user community to evolve a richer scheme from a simple one as *they* deem it worthwhile (this may be in ways that cannot be predicted by an outsider).

Principle B: Computational tools must tightly integrate documents with comments and discussions about them. Many systems place documents in a different application to where discussions about them take place (we see this with e-mail discussion lists for Web e-journals). This separation hinders users from quickly accessing relevant comments when they are most needed and makes it hard to add contextualised comments. Likewise, tools should tightly integrate the textual parts of documents with any computational parts. Research in design support tools has shown that users need to easily bridge the separation between different representations of the design, and between representations and associated rationale [Fischer, *et al.*, 1991].

Principle C: Work practices must be redesigned so that structured annotations and discussions are integral to the task. Studies show that people often do not contribute to discussions because it is perceived as extra work over and above what they are already required to do [Grudin, 1996]. Successful approaches have redesigned work practices to make contributing to a discussion integral to the overall task being performed [Terveen, *et al.*, 1993]. Others also advocate 'seeding' (providing some initial contents), arguing that people find it easier to contribute to a discussion site with content designed to promote debate, rather than starting from scratch [Fischer, *et al.*, 1994]. In a course setting, this means providing the right kind of motivation to students to participate in group debates, and seeding the discussion area with appropriate structures and questions. In a journal online peer review setting, this means redesigning the review process to *require* electronic threading of reviews into a shared space, changing the traditional roles of editor and reviewer, and seeding author-reviewer discussions for readers to build on.

Principle D: Tools are needed to support the new work practices. Many people may lack the technical skills, time, or inclination to engage in hand-crafting new digital document forms. Support is needed for automating the tedious and error-prone parts of the document creation process and to make it accessible to non-technical participants. Tools should be designed to make a good first approximation and then allow for humans to refine and correct the tools' output. The challenge is to create tools that are supportive, yet do not hinder the formation of new practices. Our goal is that the D3E Publisher's Toolkit will enable students, tutors and researchers (as well as professional publishers) to easily publish Web documents in a well-designed discussion environment, without having to worry about the intricacies of HTML.

Publishing and Critiquing Web Documents Using D3E

The D3E Project began through the design and publication of the *Journal of Interactive Media in Education* [JIME], which as we describe elsewhere [Sumner & Buckingham Shum, 1998] is a next generation e-journal that supports web-based peer review and interactive media embedded in articles. It became clear that the HTML mark-up effort that this involved had to be partially automated to make the publishing of such complex Web-sites tractable. It also became clear that there are many contexts where documents need to be discussed in different ways, by different populations. This motivated the requirements for a generic publishing toolkit which could be used to generate different kinds of document-centred discussion sites. The concept of a tailorable environment was conceived, with the project's research goals being to better understand the factors that make discussion and debate about media-rich Web documents intuitive and effective. We are concerned therefore with the whole spectrum of design issues, from Web hypermedia functionality and usability [Buckingham Shum & McKnight, 1997], to the computational, cognitive, and cultural issues that determine the uptake of such novel technologies by professional communities.

The D3E Publisher's Toolkit is the result, which generates an environment for reading and discussing Web documents. The toolkit provides a simple user interface via which the user (who does not need to know any HTML) fills in a form describing their document. First, one selects the style of publication to be generated (e.g. "Paper for student assignment") which determines the look and feel of the site, and then provides the relevant details of the document's title, author, etc. [Figure 1]. On hitting the "Go" button, the toolkit generates the HTML fileset for the environment whose key features are shown in [Figure 2]. The discussion environment is a tailored version of HyperNews [NCSA], but discussion structures in other Web-based systems could be generated. Figures 1 and 2 illustrate an article being published in JIME.

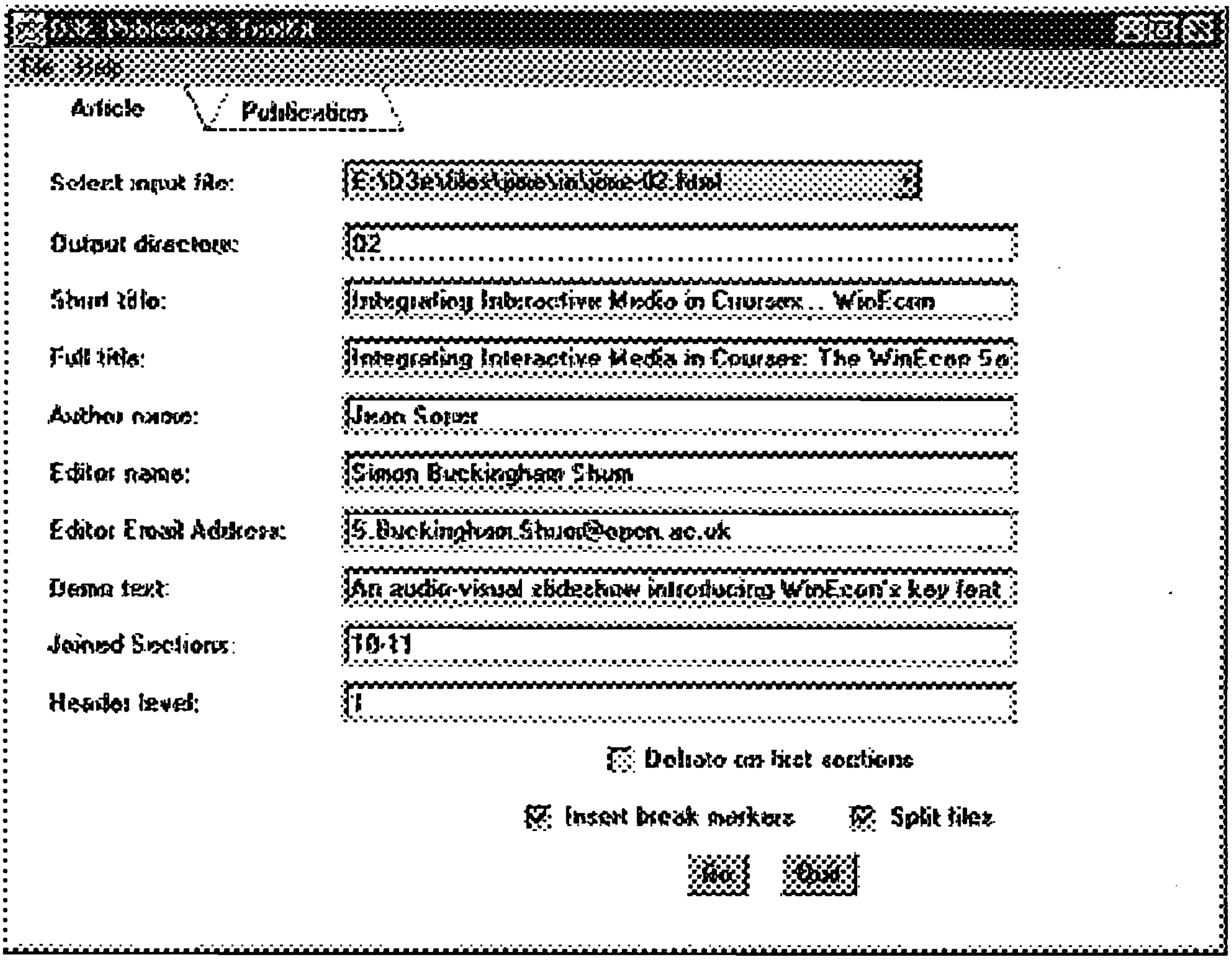

Figure 1: The D3E Publisher's Toolkit provides the tutor with a form to select the style of 'publication' (a student asignment), and a form for the article.

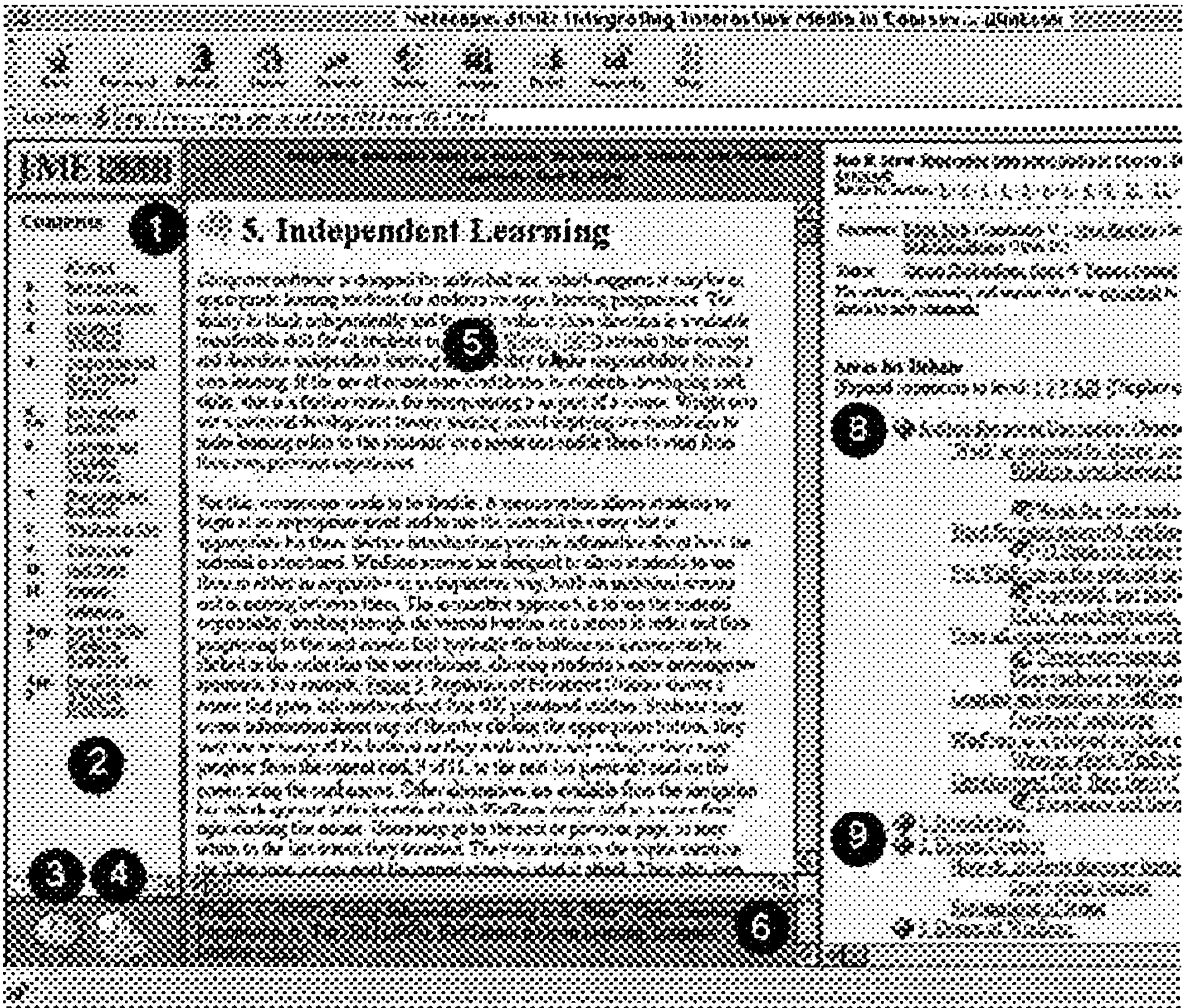

Figure 2: Output of the D3E toolkit from a source HTML file (example from JIME). On the left is the Article Window, on the right the Commentaries Window showing the outline view of discussion about the document. (The tiled-window interface for larger screens is shown; an overlapping window interface is provided for standard size displays).

A Student Assignment Scenario

An assignment on a distance learning course requires students to critique a conference paper which their tutor has placed on the course Web site. Students are required to construct a critique of it from a number of different perspectives. After the submission deadline, the tutor then allows everyone to see each others' critiques. In a follow-up exercise, the students and tutor discuss their

Key: [1] Comment icon embedded in each section heading: displays section-specific comments; **[2]** active contents list; **[3]** iconic link to display top level discussion outline, as shown on right; **[4]** iconic link to download Acrobat version; **[5]** citation is automatically linked to entry in references, displayed in footnote window; **[6]** reverse link to citation(s) in the text; **[7]** links from discussion back into article; **[8]** general heading (defined in toolkit) for discussion on the whole document; **[9]** headings for comments on specific sections of the document.

different interpretations. The students then write a summary essay which they publish as a Web document with links back into the group discussions as evidence for their claims.

Let us imagine that the tutor has downloaded a paper from the Web and obtained clearance to use it for a teaching exercise. She has generated an interactive site from the toolkit, as described above. When a student logs in to the Web site, they are provided with a structured area with headings to guide the construction of their critique.

There are general headings which the tutor has defined as important issues to consider:

- Relationships to other articles in this module
- Does this adopt a modern or postmodern perspective?
- Summarise the article for a web designer in 100 words

These are followed by headings for each section in the article, under which section-specific comments can be made (see [Figure 2], points 8 and 9 to see how these are displayed).

After the submission deadline, all students are sent the address of the shared discussion space which has clustered each student's private annotations under the three discussion headings [Figure 3]. The students can now view and comment on each other's analyses in the second phase of the assignment. All of the students are automatically subscribed to this discussion, which means they are sent e-mail copies of new comments. They can also submit responses to the Website via e-mail, which students with slower Web connections find particularly useful (standard features of HyperNews). In the final stage, the students compose their summary essays. Most of them do this using their favourite wordprocessor, convert it to HTML, and then make the links to the relevant commentaries that they are using as evidence to back up their arguments.

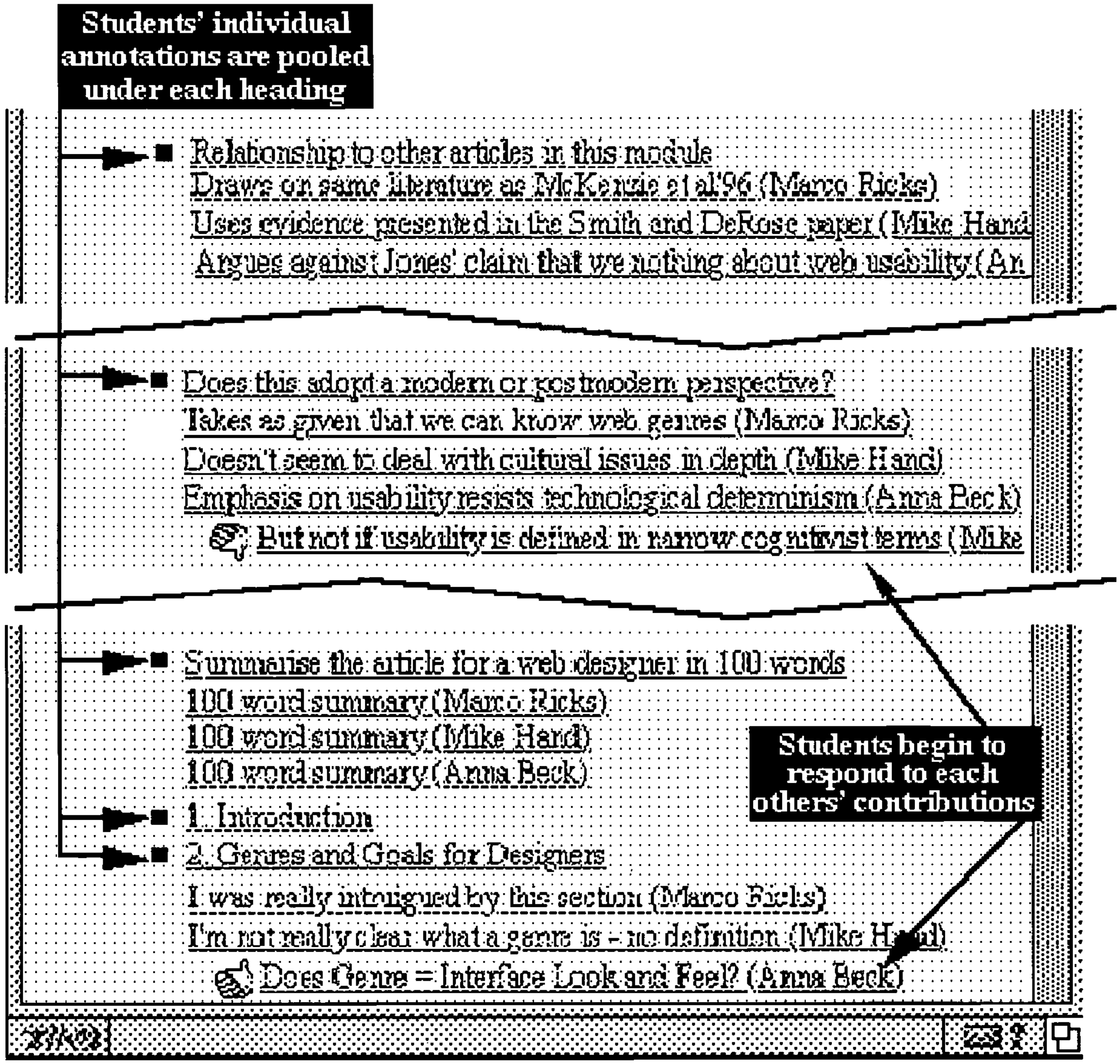

Figure 3: The shared discussion space where students can see and respond to each other's commentaries on the paper. Discussions are structured as threads, with the additional option of tagging a contributions as agreements ( ) or disagreements ( ).

Conclusion and Future Work

Given the ubiquity of document-centred work, D3E is also useful in contexts other than academic debate. We see supporting collaborative discussion of documents as important in the broader context of knowledge management in organisations, since documents acquire significance from the debate they provoke [Brown and Duguid, 1996]. D3E is being trialled within the Open University as a structured intranet environment for committee discussion documents. D3E has also been used to publish a national discussion Website to debate the recommendations of a government inquiry into the future of higher education [Dearing, 1997]. Comments and debate are organised on a recommendation-by-recommendation basis, to facilitate the pooling of related material in constructing responses to the inquiry. Elsewhere, we describe D3E's use to mediate discussion following a live webcast, in the build-up to a face-to-face conference [Sumner & Buckingham Shum, 1998].

Future work will address our ability to analyse the usage of D3E generated sites in more detail, development of a client-server version of the toolkit (to help students publish their own documents such as essays, for discussion by peers), richer encoding of Web documents, and the emergence of new genres in scholarly publishing.

The latter two issues are related in an interesting way. It has been argued that in contrast to static, predominantly hierarchical documents, interactive hypertext networks make possible important new genres of writing [Landow, 1992][Kolb, 1997]. By extension, the Web could form the basis for new genres of scholarly writing and argumentation. In our own work, we are extending our analysis from support for discourse about a particular document (as D3E does at present), to support for interpretation of a document in relation to other work [Buckingham Shum & Sumner, 1997]. We are investigating the feasibility of enriching Web documents in ways that support searches for conceptually related documents. Approaches to this problem include HTML metadata [W3C, 1997], and shared, Web-accessible ontologies [Domingue, 1998]. Such a representational scheme could form the basis not only for more powerful Web searching, but for generating graphical views of the research literature [Chen, 1997], scientific argumentation, or concept maps [Gaines & Shaw, 1995].

To conclude, in the rapidly evolving world of the Web, it is a constant challenge to know how to use the technology effectively. We have argued for a strongly user-centred approach to understanding what we want the Web to do for us. We have described how we are interpreting the challenge of designing appropriate support for publishing and critiquing documents, a form of work that dominates academic life. We have summarised the design principles underpinning the environment for publishing, reading and critiquing Web documents that the D3E publishing toolkit generates, and illustrated its application to an educational multimedia e-journal, and for tutors and students in a distance learning scenario.

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"They Are Catching Sounds in the Park!" Exploring Multimedia Soundscapes in Environmental Education

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Abstract: This paper presents a set of ideas designed to inform the integration of non-spoken audio in environmental education software. These ideas were developed, implemented and tested in the context of an educational project, named "Sounds of Serralves Park". The main goal of this project was to develop a multimedia application where children could learn about sounds in ecological systems. The design of this multimedia application was thought to offer sensory experiences that are not possible in the field, and also to support and complement meaningful explorations of the Serralves Park (Porto, Portugal) soundscapes.

1. Introduction

"Sounds of Serralves Park", the educational project presented in this paper, started in the context of a research focused on the use of ecological sounds to improve the interaction between learners and the software representations of environmental systems. This research made it clear that there is a need for learning environments that offer opportunities to discover, to hear and to interact with sounds in environmental systems. That is why it was decided to develop an educational project where multimedia potentialities were used to support and complement field explorations of soundscapes [Schaffer 1994]. The central aim of this project is the creation of a multimedia application that would support, in an integrated way, the development of sound awareness, the development of sound literacy and the learning of sensory ecology.

Nowadays, sound is widely used to improve *edutainment worlds*, such as movies, multimedia products and entertainment parks. In all these environments it is possible to find educational and entertainment activities that contribute to the users' engagement and to their ability of being aware of the sounds used. In movies and in entertainment parks public is invited to enjoy the engagement and fun factors of special sound effects and to understand how those effects were created. The number of available documentaries about the *making of* different films is increasing, and entertainment parks, namely the ones whose themes are movies, are also exploring the added value of enabling visitors to add sounds to images (just like *Foleys*) and to see the immediate effects.

In environmental education multimedia products, it is possible to find impressive examples of the integration of sound:

- It is relevant to mention *Dorling Kindersley's Eyewitness Virtual Reality: BIRD* where users can explore sounds in original activities such as listening to bird songs and calls, while learning about their characteristics and multiple ecological functions. These activities also include the observation of drawings, photographs, graphics (presenting sounds' characteristics) and videos.
- *Edmark Corporation's Sammy's Science House* is an educational application for young children, where the use of sounds contributes to children's engagement: they are funny and consistent with the global

metaphor (a house) and with children's worlds. The sounds are also used to improve user's feedback and to convey information. For instance, in the learning activities of the *Weather Machine*, non-spoken sounds are very helpful to understand the different elements of weather (such as the wind and rain) and their different intensities, making it easier to solve related problems.

- In *Microsoft Oceans*, sound effects are used to simulate oceans' soundscapes, contributing to the user's engagement and awareness. This product presents a learning activity that invites users to match different sounds with images of different animals.

Many other environmental multimedia products integrate sounds in the user interface to improve usability and learning, however this brief analysis aims to illustrate different strategies concerning the use of sound in environmental education multimedia interfaces.

The integration of sound dimension in *environmental education* can contribute to develop environmental sensibility and environmental understanding which are two main goals of environmental education. Consequently, the development of a more careful and critical listening ability [Schaffer 1994] should be an important concern in the design of soundscapes explorations. It is important that learning strategies designed to explore soundscapes include different ways of listening [Chion 1993]: to invite children and educators to identify the sources of sounds, to perceive their characteristics and to learn what a sound means in its environment. It is possible to hear different sounds in different points of an ecosystem (for instance on the ground, on the top of a tree or in the water) or at different parts of the day. Therefore, children and educators should also be invited to notice that there are different *listening points* [Chion 1992] in an environmental system, which influence the way listeners perceive sounds.

Understanding the importance and functions of ecological sounds is a subject of sensory ecology and ethology. While sensory ecology draws attention to the fascinating questions concerning the way organisms acquire information about their environment, ethology studies animal behavior in their natural environment [Dusenbery 1992]. These two domains are becoming increasingly important sources of contents and strategies for environmental education.

2. Designing Ideas to Catch Sounds in Serralves Park

"To catch sounds in a Park" is the *meta-concept* used to develop an integrated set of design ideas. These ideas were developed in order to be implemented in a prototype and tested with children in the context of environmental education activities.

2.1. "There's a World of Sounds Out There...": Exploring Serralves Park to Design a Multimedia Application

Landscapes and their ecological sounds have unique characteristics in the real world. That is why, in the context of environmental education, children should be invited to visit ecosystems, as much as virtual experiences can never substitute real explorations. Multimedia products and audio-visual representations can contribute in an extraordinary way to complement and improve these real explorations, making it easier to discover the different dimensions of ecosystems [Silva and Silva 1995].

In multimedia products, animals can produce sounds whenever the user wants and their intensity is also controllable by the user. Multimedia applications can also make it possible to travel almost instantaneously between sounds and images, following a line of thought, or to catch sounds in the context of interactive learning experiences. These potentialities support better and deeper explorations of ecological systems if multimedia products are designed on the basis of real systems. That is why field investigations should take place at an early stage of the design of multimedia products, and should integrate audio-visual recordings as well as the related knowledge of experts.

The "Sounds of Serralves Park" educational project is, currently, the result of the collaboration between the Environmental Systems Analysis Group and the Serralves Foundation. Serralves Park, one of the main green areas of Porto (Portugal), has been developing an intensive environmental education program. This program is based on the ecological diversity of this Park and it offers the opportunity to develop the "Sounds of Serralves Park" project in close collaboration with children, educators and environmental experts. This project is specially designed for children from 9 to 13 years old, however educators are also included in the target population. "Sounds of Serralves Park" multimedia application, designed in the context of this project, integrates landscapes and soundscapes from the Central Garden, the Rose Garden, the Pigeon House, the Wood, the Pond and the Farm. The sounds and images, included in the application, resulted from the collaboration with the technical staff of the Serralves Foundation. Sounds, such as the bird chorus and the ones made by visitors' steps on the different grounds, recorded in the Park can be considered *soundmarks* [Schaffer 1994].

2.2. "Who Is That Sound? Can You *Catch* It?": Linking Sounds and Images and Making Sounds Visible

Based on the way that aural and visual dimensions of ecosystems are related in reality, sounds should be linked to images in multimedia products. This will allow children to discover soundscapes, while exploring landscapes: multimedia products should offer the user opportunities to analyze landscapes, to discover potential sources of sounds, to hear sounds of hidden sources and to relate different sounds to their sources in different contexts and situations.

Catching sounds, like any other way of playing with sounds in multimedia products, makes it necessary to make sounds *visible*. Sounds should have a visual representation (a familiar one is an icon of a loudspeaker) in order to be manipulated by users. The design of icons, symbolizing the sounds and representing the tools to manipulate them, became an important concern of this project.

2.3. "To Catch Sounds, Follow the Line of Your Thought": Designing a Sound-Web

To catch sounds children can walk around in a park, while exploring the ecosystems and looking for potential sound sources. However, a multimedia application can also make it possible for children to travel between sounds following a line of thought, whenever they wish. A sound-web can support navigation between related sounds, the same way an image-web usually supports navigation between images. In this work, it was decided to design and implement a sound-web that allows users to navigate between animal sounds with related ecological functions. The central aim of this idea is to create an integrated and efficient way to discover sounds in the Park.

2.4. "Let's Talk About Sounds!": Contributing to Sound Literacy

An early stage of "Sounds of Serralves Park" project included a program of two meetings with children (one group of 4 and another one of 5 children), informal talks with 30 children, 22 students from teachers training schools and interviews with 5 environmental educators. During this program, participants were invited, using different strategies, to talk about ecological sounds. This experience was useful to confirm that they are not very familiar with many of the words used to refer to the different animal sounds. However, it was clear that talking about ecological sounds is a motivating invitation. It was interesting to verify that the interest in learning about sounds was visible and sometimes verbally expressed. This program confirmed the relevance of designing learning activities based on these topics.

Talking about sounds with children, with ages from 10 to 14 years old, was an impressive experience. Children were invited to different activities, such as to brainstorm about the sounds they would expect to hear in different ecosystems, or to talk about sounds they liked and they didn't like and to imagine a computer application to *catch sounds*. Based on their imagination and on photographs of ecosystems, they worked enthusiastically to give lots of examples and they represented them in very different and amusing ways, not only using the names of the sounds or of the sounds' sources, but also imitating the sounds, using onomatopoeic words and drawing their sources and effects. They proved how different strategies and materials could be important in talking about ecological sounds and, consequently, in developing sound literacy.

2.5. "Mr. Sounds Hunter": Learning With Children About Designing With Sounds

When children are asked to give suggestions about designing with sounds they can really surprise us. During the second meeting with children the authors asked the five children, with ages from 10 to 14 years old, to design a multimedia product named "Catching sounds". To perform this activity, that was based on the "Bag of Tricks" approach to design [Druin and Solomon 1996], children could use diverse arts and craft materials.
Among the fruitful design ideas, produced by children, it is illustrative to mention:

- In children's drawings, sounds were usually represented with lines drawn near the sound sources.One child came up with the idea of catching sounds with a vacuum cleaner.
- Another child drew a trash can to get rid of undesired sounds, and he explained the idea: "Then, Mr. Sounds Hunter went to get the sound. If he likes it, he lets it go, if he doesn't like it he puts it in the garbage".

During that meeting, and while exploring a mock-up (previously built by the authors with printings of the screens and with post-it), children also offered design ideas related with the development of the "Sounds of Serralves Park" multimedia application. These ideas will be referred in the context of the prototype presentation.

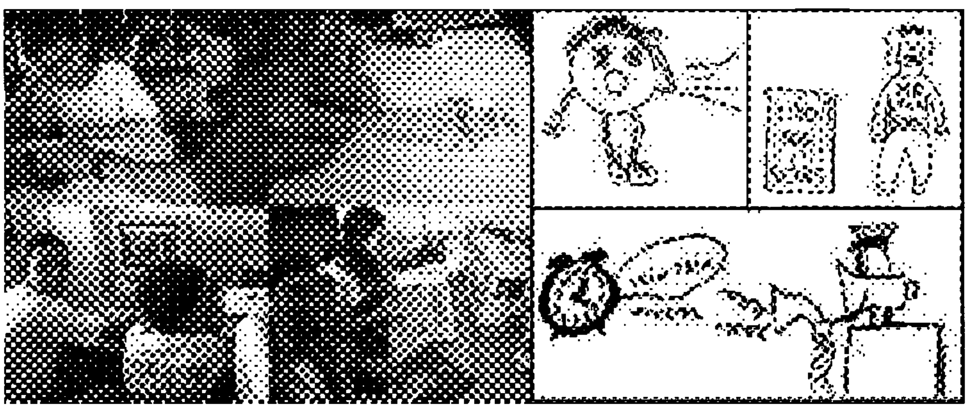

Figure 1 - Working with children

3. Catching Sounds in Serralves Park

3.1. Presenting the Prototype

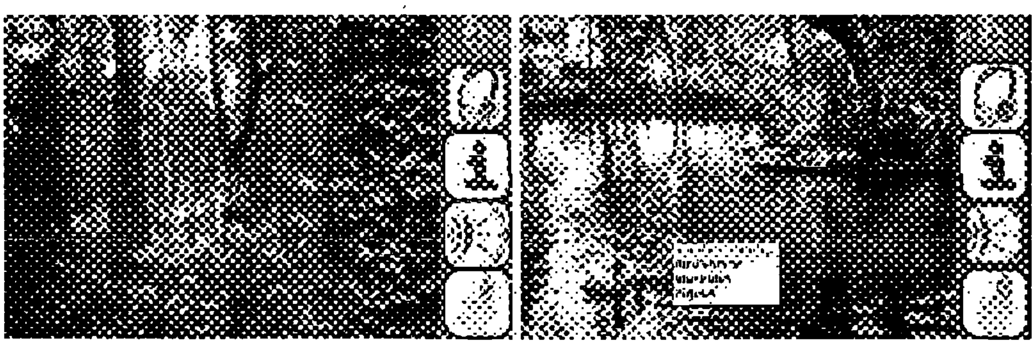

Figure 2 - Exploring the wood with the headphones tool and the pond with the navigator tool

A prototype of the "Sounds of Serralves Park" multimedia application was developed, using Allegiant Supercard 3.0. This process was iterative and partially simultaneous with the development of the presented design ideas: in a first phase the authors implemented a mock-up to be tested during the meetings with children. The tests performed with this mock-up led to the early identification of usability problems [Nielsen 1993] related with the design of the icons, and allowed the integration of children's suggestions, such as the use of more drawings in the interface and the use of an applause as feedback. It was also suggested the use of a little hand to catch and drag the sounds.

The implemented prototype allows children to travel between different ecosystems of Serralves Park and to use a set of tools to explore their sounds, visually presented as a *sound waves icon* [see Figure 2]:

- To discover and to hear sounds children should use the *headphones tool*. If they click on the image they will find sounds with visible (*e. g.* sound of sheep) and with hidden sources (*e. g.* sounds of insects).
- To explore textual information about sounds and their sources children should use the *information tool* and click on a sound or on the image of a sound source.
- To navigate between related sounds children can use the *navigator tool*. Using this tool and clicking on a sound they will find a pull-down menu offering the possibility to travel to sounds with similar ecological sources. For instance, if they click on the sound of the bird chorus the menu will offer them the possibility to travel easily to another bird sound such as a pigeon, a goose or a blackbird.
- To manipulate sounds children can use the *catch a sound* tool. Using this tool, they can drag, for instance, a sound to the right word (the sound of a goose to the quacking word), or to the *trash can* if they find a sound in a wrong place (if the cow is singing or the blackbird is cooing).
- The cursor changes its shape whenever children choose a different tool. This characteristic intends to help them to discover its functionality and to remember which tool is being used. for instance To navigate between the ecosystems children can use a *mariner's compass card*. This navigation is based on the geographical characteristics of the Park.

3.2. Testing With the Users

In order to prepare the tests of the implemented prototype, it was pre-tested in the laboratory with four children with ages from 13 to 14 years old. Afterwards the prototype was tested with 22 children, with ages from 10 to 13 years old, in the context of the environmental education activities of the Serralves Foundation. Although these tests were very effective in discovering small interface problems, they were designed to evaluate the potentialities of the use of this prototype in an educational context.

These tests were performed with groups of four children and one teacher. Children worked in pairs (one girl and one boy) and while a pair was visiting the Park and trying to hear and identify sounds, the other one was working with the prototype. These children had very different previous experiences with computers (some of them didn't know how to use the mouse) but they had already visited the Serralves Park in the context of other educational activities. It is important to present some of the more relevant observations made during these tests:

- Children and teachers declare that they did like to explore the prototype and that it was not difficult to learn how to use it. They liked to use the different tools and to discover its different potentialities. Discovering sounds in the landscape was regarded as an amusing and interesting activity. On the other hand, to catch sounds was considered a new and original activity.
- Virtual and real explorations of Serralves Park contributed to the understanding of local sounds in a complementary way. These two different explorations made it possible to analyze problems such as "Why didn't you hear the cows and the goats in the Park? They were there, laying down and eating in the field...". The answers to this kind of questions were in the prototype, namely in the textual information about the ecological functions of sounds. It was also possible to analyze why some of the sounds that they could hear in the Park were not included in the prototype.

- While traveling between the ecosystems, children seemed to find the use of a map and of the *mariner's compass card* useful and easy to co-ordinate. This activity integrated different representations, and children were also able to combine it with the navigation between related sounds (using the sound-web).
- Children showed different approaches to the prototype, depending on their styles and ages. As examples, it is possible to mention that one group adopted a strategy of trial and error in order to perform the learning activities, while another one read systematically the related information before deciding what to do next. Besides, it was possible to observe that older children read more carefully the textual information about sounds and their sources than the younger ones.
- After using the prototype, and when invited to make suggestions to improve it, children referred that the application should offer more sounds, videos and animations. They also expressed the wish to have more games and more levels of complexity. When they finished the exploration of the prototype most of the children asked to use it again and they also asked, specially the groups with the older children, if they could test the final product. Teachers declared that they did like to see children using the prototype and they found that it would be very useful to have this multimedia application in school, and in the Park, to support and complement the field explorations.

4. Conclusion & Future Work

The integration of non-spoken audio in environmental education software should contribute to the understanding of ecological sounds and to the learning of soundscapes. This paper presented a set of ideas developed on the basis of the meta-concept "To Catch Sounds in a Park" to support the design of multimedia applications. On the basis of these design ideas a prototype of a multimedia application was developed and tested in the context of the educational project "Sounds of Serralves Park". Linking the virtual and real explorations of this park and working in close collaboration with the future users were central concerns. One of the main design ideas was related with the possibility of traveling between sounds with related sources and functions and it was implemented in the prototype using a sound-web.

Testing the prototype with the users confirmed its potentialities to improve the learning of soundscapes, since it was possible to take advantage of the different characteristics of virtual and real experiences. Future work will include the development of a multimedia application to be used in environmental education contexts, and that should integrate children's suggestions.

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Practical Replacement of Lectures by Hypermedia Courseware

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Abstract: Many applications of technology to learning and teaching have been treated as special projects with unusual resources. Most have failed to make the transition to the mainstream of the organisations in which they are used. We report on an approach that is scalable and cost-effective, both for course construction and delivery. In particular, we report on a first-year university programming course offered without lectures. This course is one of a suite, at all levels, offered in the same general way. The course has been well accepted by both instructors and students, and we have some evidence of improved learning outcomes.

1 Requirements

We describe the development and delivery of a first-year programming course in which lectures have been completely replaced by hypermedia courseware. This course is one of a collection, at all levels of the curriculum, for which this approach has been successfully used [Skillicorn 1996].

We started with the following assumptions:

- Government funding of universities will shrink for the foreseeable future, and therefore applications of technology to learning must concentrate on doing more with less resources.
- Techniques for developing hypermedia courseware must be largely self-funding.
- The ongoing delivery of courses using new technology must actually save money.
- The learning outcomes must be at least as good as conventional (i.e. lecture-based) courses.

Although these assumptions are fairly obvious, many projects applying technology to learning have failed to sufficiently absorb them. For example, many projects assume that more resources will be available: more money for systems, and more money for salaries for courseware developers. It is easy to find mechanisms for funding the development of a single course. Such mechanisms rarely generalise to permit the development of enough courses to make a significant difference to institutions. It is also surprising how often approaches are proposed that have ongoing costs much higher than traditional courses. For example, university-provided PC labs are a substantial, continuing cost, and course delivery that relies on them must find ways to pay this cost.

An attractive way to cost-effectively develop courseware is to do it incrementally. The key is to make sure that the effort and cost put into developing courseware gets repaid almost immediately, freeing up resources to be put into further development. For example, many traditional courses have some material that is already in electronic form; indeed, the use of web pages to distribute assignments and the like is well-established. Courseware development can begin by making this material into an integrated whole. Once some of the basic course material is on-line, lectures can take a more discursive form, since the basic content is available to students via textbooks, and the new on-line material provides the framework and perspective that an individual instructor brings to a course. This provides some reduction in preparation time for the instructor, time which can be used to further develop the course material.

An important extra source of course material is the students themselves. Once a system is in place that captures their interactions, these become a useful resource in themselves. For example, if students can ask questions on-line, with both question and answer publicly available, or can annotate existing course material, then these new documents can become part of the material for subsequent classes. This has the added advantage that material clearly generated by peers is more convincing, since students are compelled to believe that it is accessible to them.

We have used this approach to develop a number of courses: fourth-year courses in advanced computer architecture and in networks and communication, a third-year course in digital logic, and a first-year introductory computing course. Several of these are now offered without lectures, that is all of the course learning and discussion takes place on-line. We concentrate here on the first-year introductory course.

2 Related Work

Surprisingly little work applying technology to learning has been aimed at replacing traditional systems. Most existing work can be classified as:

- Developing multimedia and hypermedia courseware for delivery on CD-ROM. While useful, we view this as replacing textbooks rather than courses.
- Developing material intended to supplement existing courses. There are two problems with this: first, it requires extra resources and most universities are unlikely to have them in quantity and, second, it imposes extra workload on students.
- Developing multimedia lecture presentations, often delivered using a computer system in the classroom. While this can be very effective, it is expensive to produce, and limits learning to particular times and places.
- Web-based courses. These are closely-related to what we are doing, but suffer from inability to control access well (and thus maintain revenue), and weak facilities for students to create, as well as read, material. Together these limit interaction, since the environment is neither flexible nor private. We regard on-line interaction as critical to compensate for the lack of face-to-face interaction.

The Microcosm project at the University of Southampton [Davis et al. 1993] is a success story. Their system, however, is so open that it is hard to provide guidance about what students must, may, and might interact with. Also the system is not fully-accessible from the Internet, so it cannot be easily used for distance learning.

We are convinced that successful learning using technology must take place in a learning community. It is not sufficient to provide content. Students must encounter the content in the company of others who are also dealing with the same content. Thus the technology base must provide flexibility (different styles, different speeds) within an overall community framework.

3 System and Delivery

We use the Hyperwave [Kappe et al. 1993][Maurer 1996] hypermedia system as our development and delivery system. It provides several enhancements over the Web:

- It uses a hierarchical structure as well as arbitrary links. Thus navigation is easier, since there is always a natural local structure.
- It has full access controls for arbitrary groups of users (in the Unix style), so that courseware can be both read- and write-protected, at the level of individual documents.
- Links are stored separately from documents. This means that dangling links are not displayed (which is both cleaner and helps incremental development), and that users can create links leading from documents that are write-protected from them. This is the basis for annotations, which are a natural way to generate, and structure, discussions based on existing material.

Of course, it also provides all of the same benefits as web delivery: html as the markup language, worldwide accessibility, links to external documents and search engines and so on.

The Hyperwave system provides a web gateway which handles the enhanced features of Hyperwave by inserting buttons in the pages it serves. These buttons provide for identification, annotation, and insertion of new text. Our students use a standard web browser to access the course material.

The course material is accessed in a variety of ways: public sites on campus, workstations in the library, student-owned PCs in campus residence rooms (which are all connected to the university backbone), from home via dial-in lines or cable, and via local Internet service providers. Very few of our first-year students do not own a PC, so very few actually come to campus to access the material. Of course, the material is available at all times, and many of our students access it at unconventional times.

The course material consists of three parts:

1. Administrative material, such as announcements, assignments and their solutions, exercises and their solutions, questions and answers, on-line quizzes used for self-test, and suggestions.

2. The core course content. This is organised in a way that reflects its origins, into 'weekly' units, each of which is further subdivided into three 'lecture' units. This reflects our belief that first-year students need strong cues about the rate of progress they should be making through the material. This core content is mainly textual, but a large number of images are used, and program fragments are ubiquitous.

3. Programming material. The course is based on the programming language Turing. Unfortunately, the Turing system does not provide a command line interface, so it is the one component that we are unable to include seamlessly within the hypermedia system. We suggest that students run the Turing environment in a window next to their web browser, and we make all of the program text mentioned in the courseware available as source files, so that they can experiment with executing and modifying them.

The top level organisation of the course is shown in [Fig. 1]. Note the buttons across the top of the page, and the user identification. Hyperwave adds small flags to collections (folders) that are new or updated. This, together with organising most collections in reverse chronological order, makes it easy to check whether something new needs to be looked at.

The detailed arrangement of topics is shown in [Fig. 2]. There are three streams of material: programming concepts, areas of computing that are of interest, and accessible, to first-year students, and a weekly large program example, which connects the two previous streams by illustrating the programming concept applied to the computing topic.

All other aspects of the course are conventional. There are a series of programming assignments, a midterm examination, and a final examination. The instructor has office hours where students can come to ask questions in person. Teaching assistants mark the assignments, and are available at scheduled times for questions and discussion, as well as spending some hours each week in the programming laboratory. A reference book for the Turing programming language is recommended to the students.

The development costs so far have been modest. A half-time curriculum development specialist, a teacher and computer science graduate, was employed for sixteen months. Most of this time was spent developing the first year course, a significant amount of it going towards learning the Hyperwave system and toolset and discovering which specific presentation techniques worked. For example, we originally planned to develop a screen-by-screen presentation in the style of Authorware or Powerpoint, but this was found to be too restrictive, technically and pedagogically. The server for the Hyperwave system is a Sun Sparc5, which easily supports the current 200 student-courses per term now in use. We estimate that we can develop further introductory courses in three to five months of work, and upper-year courses much more rapidly. This magnitude of cost can be repaid in reduced contact hours within the first year or two. Upper-year course have been developed without external funding. The time cost of preparing an initial hypermedia offering is about the same as preparing a conventional lecture course for the first time, and so is readily handled within the usual course load framework.

4 Experiences

We used a number of formal and informal mechanisms to get student feedback. First, there are a number of on-line paths for feedback: the kind and number of questions, suggestions made, and annotations on the courseware. There is also an on-line social area, which we provided to enhance a sense of community among the students. Their initial assignment was to insert a short description of themselves in this area. Later in the term it provided a place for students to raise issues that were not strictly academic.

We also conducted a series of detailed course assessments. The response rate for these was not high enough to allow for serious statistical analysis (itself a sign that students were not, on the whole, perturbed by this approach), but some interesting trends could be seen.

There were two obvious groups. The first were very appreciative of the any time, anywhere availability of the course material, and the freedom from having to meet at particular times. It is difficult to be sure, because the assessments were anonymous, but from other comments made on the forms, this seemed to be because they led lives that made rigid schedules awkward: because they live further from campus, or simply because they were night owls. Some also appreciated being able to have more than one chance to go over the material.

The second group were initially resentful about the absence of lectures, although they clearly appreciated the properties of the on-line material. Their comments suggested a belief that formal class meetings caused them to be taught, rather than to learn. In other words, they believed that class meetings were places where instructors

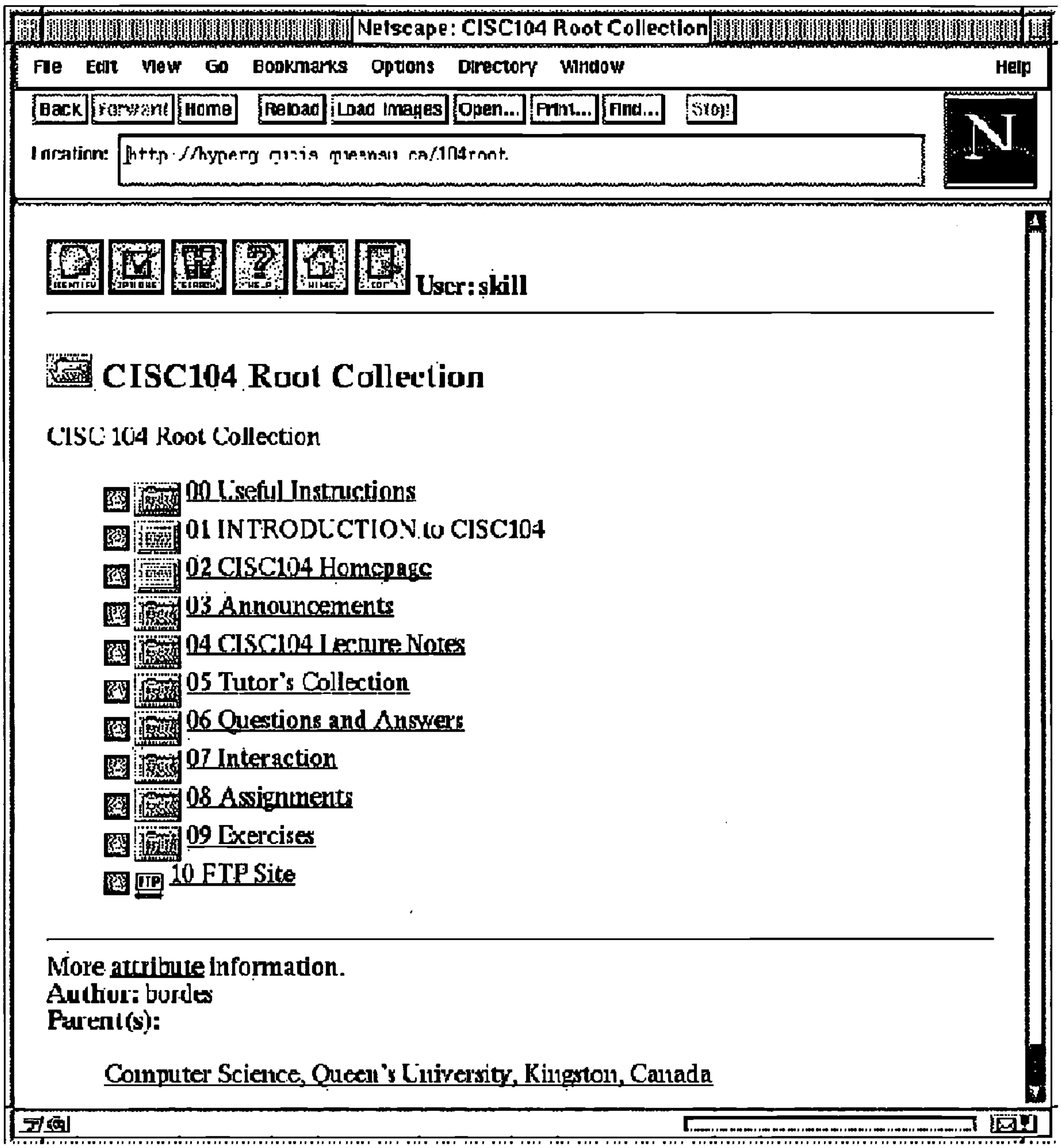
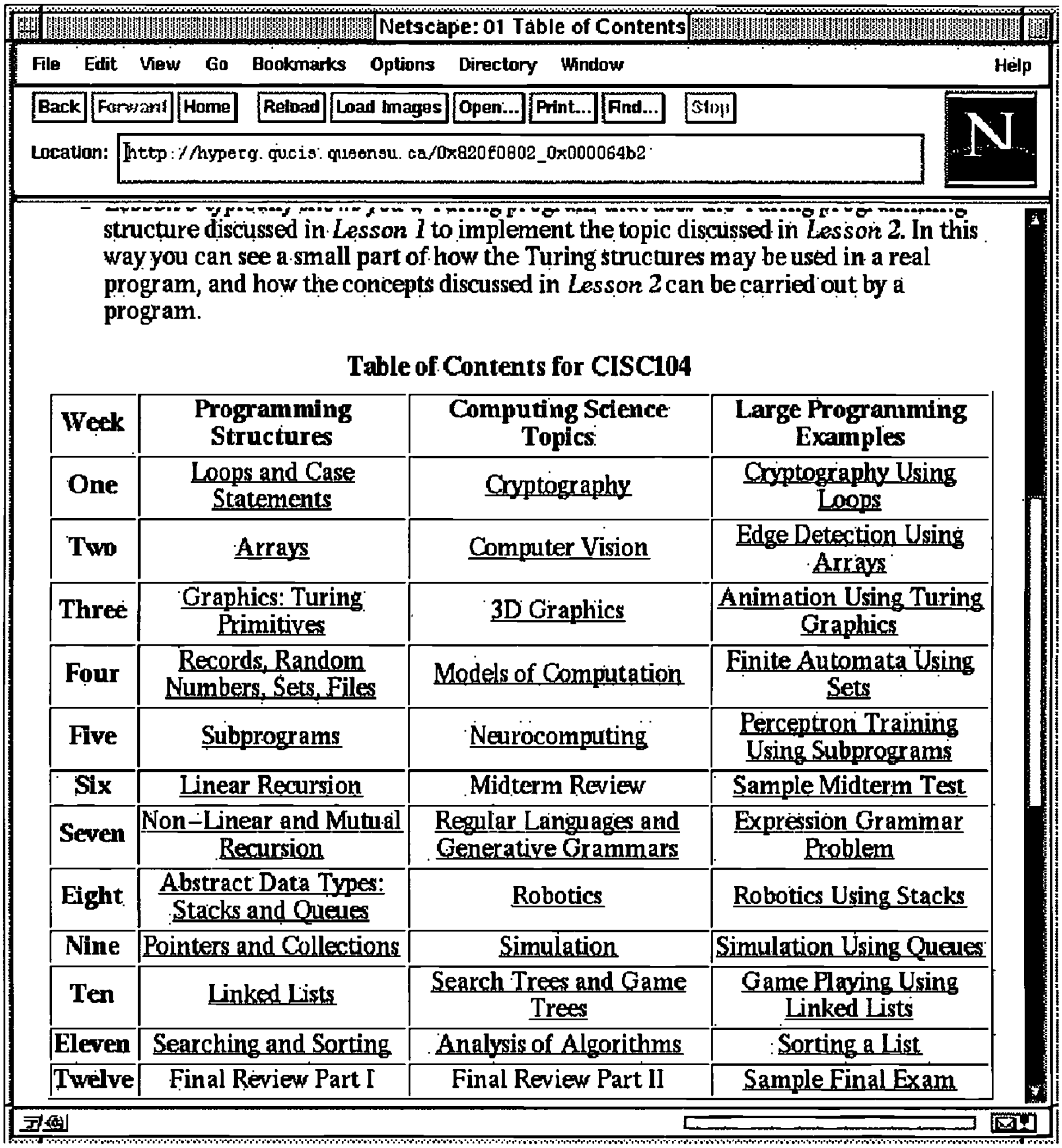


Figure 1: Top Level Collection for the Course



structure discussed in *Lesson 1* to implement the topic discussed in *Lesson 2*. In this way you can see a small part of how the Turing structures may be used in a real program, and how the concepts discussed in *Lesson 2* can be carried out by a program.

Table of Contents for CISC104

Week	Programming Structures	Computing Science Topics	Large Programming Examples
One	Loops and Case Statements	Cryptography	Cryptography Using Loops
Two	Arrays	Computer Vision	Edge Detection Using Arrays
Three	Graphics: Turing Primitives	3D Graphics	Animation Using Turing Graphics
Four	Records, Random Numbers, Sets, Files	Models of Computation	Finite Automata Using Sets
Five	Subprograms	Neurocomputing	Perceptron Training Using Subprograms
Six	Linear Recursion	Midterm Review	Sample Midterm Test
Seven	Non-Linear and Mutual Recursion	Regular Languages and Generative Grammars	Expression Grammar Problem
Eight	Abstract Data Types: Stacks and Queues	Robotics	Robotics Using Stacks
Nine	Pointers and Collections	Simulation	Simulation Using Queues
Ten	Linked Lists	Search Trees and Game Trees	Game Playing Using Linked Lists
Eleven	Searching and Sorting	Analysis of Algorithms	Sorting a List
Twelve	Final Review Part I	Final Review Part II	Sample Final Exam

Figure 2: Outline of Topics Covered in the Course

did something, and they did not. Replacing lectures completely challenges this belief at its core. Once it was challenged, this group discovered that they *could* learn, they did, and became supportive of the approach. This belief had not been visible in earlier, hybrid course offerings. It may be that only a few class meetings are sufficient to sustain a belief in teaching rather than learning. Indeed, students may put disproportionate emphasis on the importance of class meetings when they are rare.

We hypothesise that this transfer of responsibility from instructor to student explains the recent results of Schutte [Schutte 1996], who has documented improved learning outcomes using on-line material without lectures. While we have not carried out formal measurements of learning outcomes, it is clear from test results that students learn at least as well using hypermedia instead of lectures.

In the second, full-scale delivery of the course without lectures, the second group of students did not appear to exist. This may reflect growing confidence that the approach was workable, passed on by word of mouth from the previous year's class. It may also reflect the rapid change in students' previous experience. At the beginning of the course, very few had never used a web browser to look for something. It may be that a learner-based paradigm for information retrieval is becoming pervasive among those who routinely use personal computers.

Overall, our approach permits cost-effective development of hypermedia courseware over all levels of the undergraduate curriculum; it is practical to deliver to students, both on and off campus; and it attains the same level of learning success as conventional lecture-based courses.

5 References

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Acknowledgements: A large number of people had some part in the development and experimental delivery of the courseware described here: Jimena Bordes, Mary Mccollam, Dave Dove, David Fleet, and Roger Browse.

Computer Tutorial "Higher Mathematics" for Engineering Specialities

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Abstract: In the article the computer tutorial "Higher mathematics" for engineering specialities of universities is represented. The tutorial includes 17 computer programs of educational purpose. The programs of the package allow to solve practically any problem from higher mathematics course. The package is prepared on CD-ROM.

1. Introduction

It is hard to find in Russia a university, an institute, a faculty (humanitarian, natural science, engineering), where the attempts are not undertaken to use modern computer technologies in educational process. Small creative groups (1-3 participants) make a lot of computer tutorials intended for educational purposes. Many unstate organizations create such programs as well.

Representing a new Russian courseware, computer tutorial "Higher mathematics" for engineering specialities, the authors would like to tell about one of the approaches to the problem of "computer in education", which is realized in this tutorial.

The situation with the use of computers in education is paradoxical. On one hand, the computer programs of educational purpose were developed always and everywhere. From the very beginning of computer era, as soon as a working electronic computing device appeared at school, high school, research institute, there was at least one person there (enthusiast, the fanatic, maniac) who started creating computer programs intended for tutoring. On the other hand, in reality computers are used in tutoring very little (except computer science), and, as a rule, it is done by developers themselves or their colleagues. Why? Such self-made programs usually support the study of rather small part of the course, they are strictly limited by a concrete technique of teaching (material presentation), by concrete educational plan, and usually they are badly documented or have no appropriate methodical documentation at all.

The situation with the use of universal mathematical packages, such as Mathematica, MathCad, MapleV, Derive, MatLab etc. in education is similar. These programs are attractive by their high-power graphic and computational capabilities, and by the possibility to make analytical transformations (symbol calculations). The teacher who masters the package of that kind, as a rule, can effectively use it in tutoring. On the base of universal packages special educational programs are created (for example, StudyWorks is created by MathSoft on the base of MathCad), and the tools for creation of educational courses are developed. However, in spite of the fact that the mathematical packages are known long ago and are rather widely spread, it is too early to speak about adequate use of them in educational process. Why? Since these packages initially were developed to support scientific and engineering researches, their interface is badly adapted for educational purpose. So there are problems in mastering a package (the user, the student or the teacher, should learn the interface or command language of a package). The efforts to master the interesting part of the problem (from the point of view of the subject under investigation) are often comparable to energies spent on a solving of technical problems, concerning the method of a problem notation and interpretation of results in a medium of a concrete package.

Though the market of computer programs of educational purpose is extremely poor, the demand for them grows. A few programs available either decide particular problems (teaching English, increase of grammatical correctness, teaching arithmetic etc., i.e. they are oriented mainly on children before 12 years), or have no adequate methodical support. The appearance of tutoring CD-ROMs hasn't changed the situation (as a rule, it is English for kids and teenagers, children's encyclopedias, museums, historical and geographical excursions, fragments of mathematical courses for junior school, teaching games).

For several years the seminar "Computers in mathematical education of engineering specialities" works on the faculty of higher mathematics in Moscow Power Engineering Institute. A great number of various computer programs of educational purposes in mathematics, physics, mechanics, programs for schools and high schools, both authorship and created on the base of universal packages, were discussed at that seminar. At the same time in Informational Systems Research Institute of Russia the fund of computer tutorials was analyzed. As a result of these discussions and analysis it was possible to work out a constructive approach to a problem.

This approach consists in attempt to unit the existing educational mathematical programs realized by different authors, in a package on a uniform methodical basis in aim to receive a full computer support of higher mathematics course for engineering specialities, i.e. the computer program, which will assist in teaching of this course.

By results of expert examinations and experimental operation 17 educational mathematical programs created in leading Russian universities were selected. Put together, these programs enable to solve practically any problem from the course of higher mathematics for engineering specialities, and the students often escape laborious calculations and get the visual graphic interpretation of results. In Informational Systems Research Institute of Russia selected educational mathematical programs were incorporated in a uniform package. The staff of the institute and the authors of the programs carried out the task using tool system HM-Card (see below).

The package can be useful to the system of education as a whole, since it contains all necessary tools for introduction of the computer in process of teaching of higher mathematics on a complex basis, that will allow to increase efficiency of teaching process.

The package can be useful to the teachers, since it contains only tools for problem solving and the methodical part of its application is completely determined by the teacher. Thus, the package is free from methodical dictatorship of any kind.

The authors hope, that the package will be useful to students, for it contains not only tools for problems solving, but also demonstration programs showing how to solve a problem.

The created package of educational programs can be called a computer tutorial for higher mathematics, the tutorial assisting in mastering the course of higher mathematics with the help of computer.

One of the main properties of an offered package is that it combines works of different authors for complex computer support of the study of mathematical disciplines. The package is open for inclusion of diverse programs assisting the study of mathematical disciplines. Each work of the authors from different schools can be put on a certain "methodical shelf". It will allow students and teachers to choose and to use in the study of the subject such tools that suit them. The package is also open for connection of any universal mathematical package, that enable to create a highly effective medium for study of mathematical disciplines including both educational programs, and universal packages.

2. Structure and Properties of the Courseware

The computer tutorial for engineering specialities is the library of educational mathematical packages and Navigator for the course of "Higher mathematics".

The library consists of computer programs of educational purpose, developed in the leading Russian universities.

Educational mathematical packages "FORMULA", "MATRIX", "ODE — Ordinary Differential Equations" are developed in Moscow Power Engineering Institute (MPEI) on the Department of higher mathematics by collective of authors: Kirilov A.I., Slivina N.A., Chubrov E.V., Demushkin A.S., Morozov K.A.

Labs on computational mathematics is created on the Department of Computational Mathematics in Moscow Institute of Physics and Technology (MIPT). The scientific principal is Ryabenkii V.S. The group of authors: Petrov I.B. (supervisor), Ivanov V.D., Korotkin P.N., Kosarev V.I., Pirogov V.B., Severov D.S., Tormasov A.G., Ustyuzhnikov S.V.

Computer system of control of knowledge in higher mathematics "Ordinary differential equations" is developed in Moscow State University (MSU) at the Department of Differential Equations. The authors: Baula V.G., Lokshin B.J. Rozov N.C., Sushko V.G., Shikin E.V.

Subject-oriented educational package "MATRIX" provides computer support to the study of linear algebra and analytical geometry. In [Fig. 1] the main dialog window of "MATRIX" is represented. The package enables a user to investigate a wide range of exact and approximate algorithms of linear algebra.

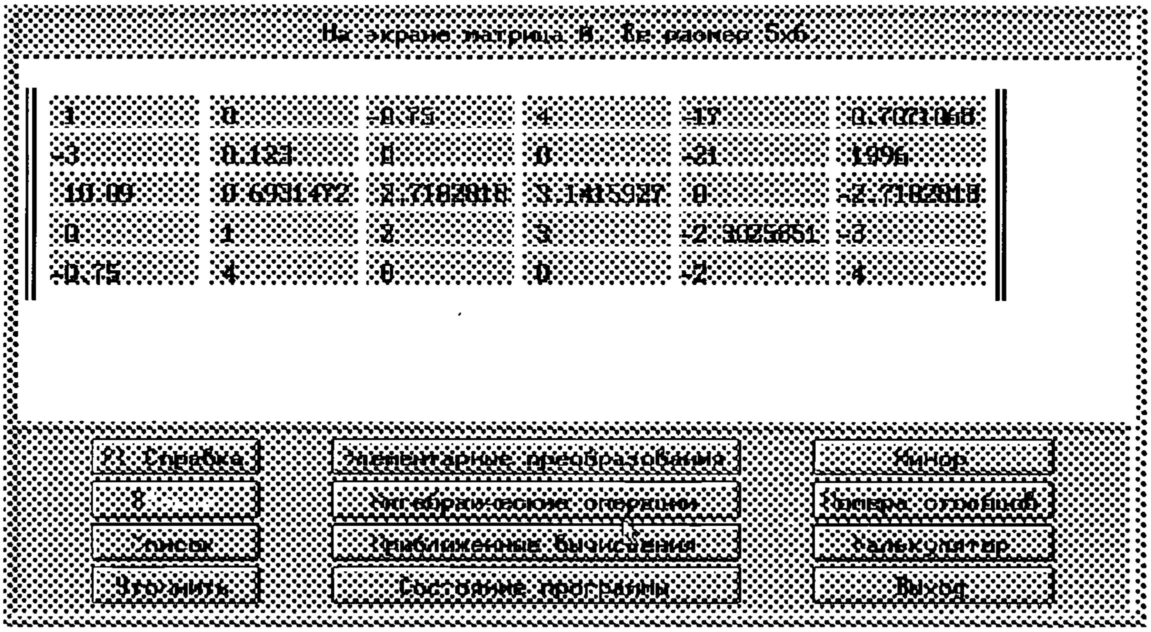

Figure 1: The main dialog window of "MATRIX". The switching of modes is done by one click of the mouse.

Package "FORMULA" is a subject-oriented medium for solving problems in calculus and approximate calculations. The program has broad computational and graphical capabilities. "FORMULA" enables to perform diverse calculations, from arithmetical expression evaluation to special functions and partial sums evaluation, and symbol differentiation of functions of one or several variables. The analytical and graphical capabilities of the package completely cover the needs of classical calculus course. The friendly interface and effective organization of computing procedures allow to illustrate and to investigate rather complicated models. In [Fig. 2] the example of trigonometrical series investigation is shown.

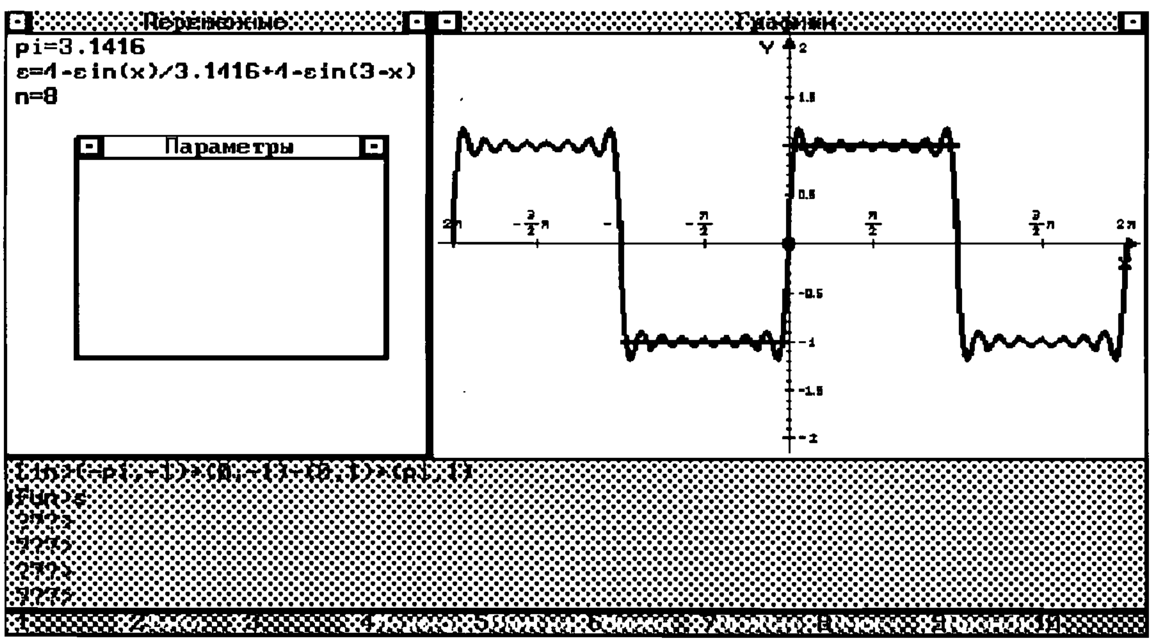

Figure 2: The graphic window of "FORMULA". The next harmonics is added by pressing of one key.

The main purpose of the package "ODE" is to help in understanding of qualitative aspects of the theory of differential equations by consideration of many meaningful examples and solution of many problems, which are hard or sometimes impossible for student to solve without computer. The package allows to input and to investigate any differential equation or system of differential equations up to the sixth order inclusively. The package has the friendly and logical interface. [Fig. 3] shows the phase portrait of an autonomous system: .

$$x' = x(x^2 + y^2 - 1)(x^2 + y^2 - 4) - y, y' = (y(x^2 + y^2) + x/3)(-4) + x$$

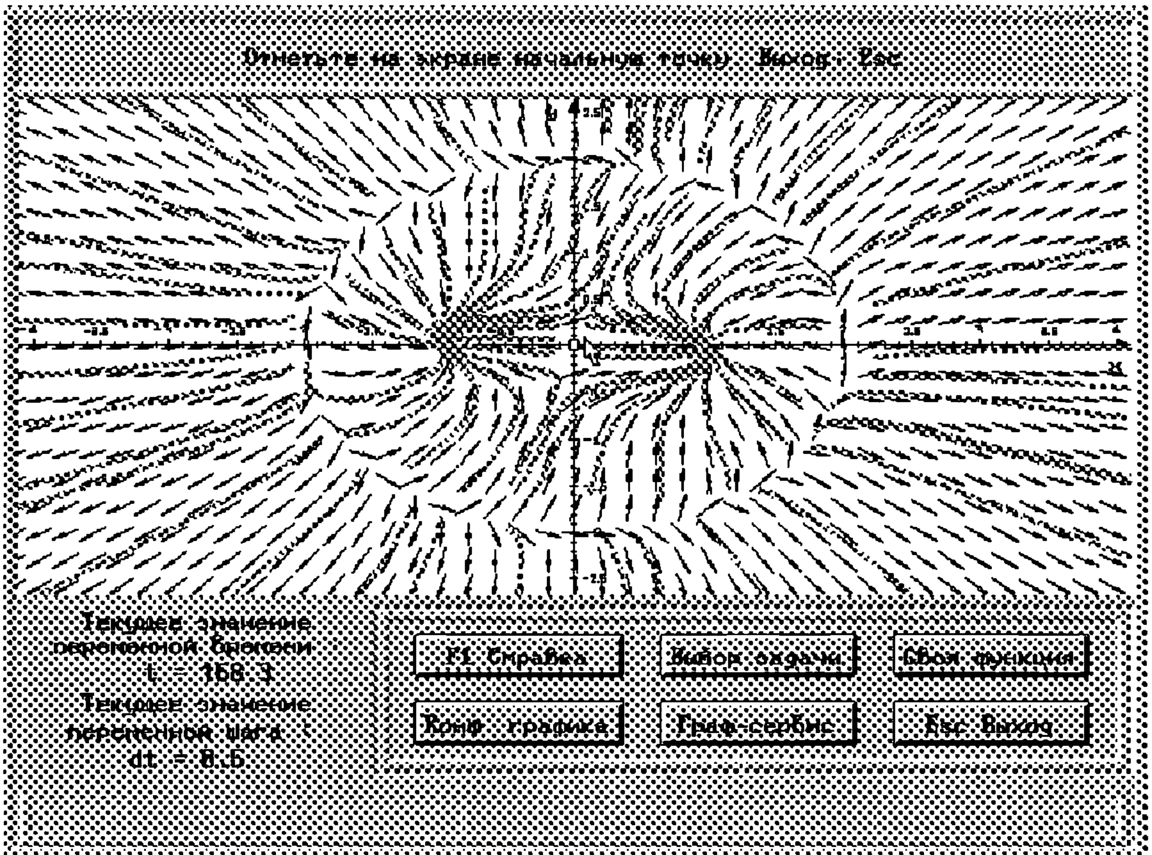

Figure 3: The graphic window of "ODE". The phase portrait is built by several clicks of the mouse.

The labs in computational mathematics enables to master the known numerical methods traditionally used in solution of scientific and practical problems. The package instills skills of investigation of numerical algorithms properties, helps to understand the boundaries of their preferable applicability. The graphic capabilities of the programs in the package and well thought-out distinct interface, uniform for all the programs, allow to learn characteristic effects arising in a numerical solution of practical problems in clear and visual form.

Besides the course of computational mathematics the labs can be effectively used in the study of calculus, linear algebra, differential equations and equations of mathematical physics.

On [Fig. 4] the screen during the work with the program "Numerical integration" is shown.

The computer system of control of knowledge in higher mathematics "Ordinary differential equations" is a remarkable problem book containing over 300 problems, composed by the noted experts on differential equations, qualified teachers with long-term experience in teaching of differential equations at Moscow state university.

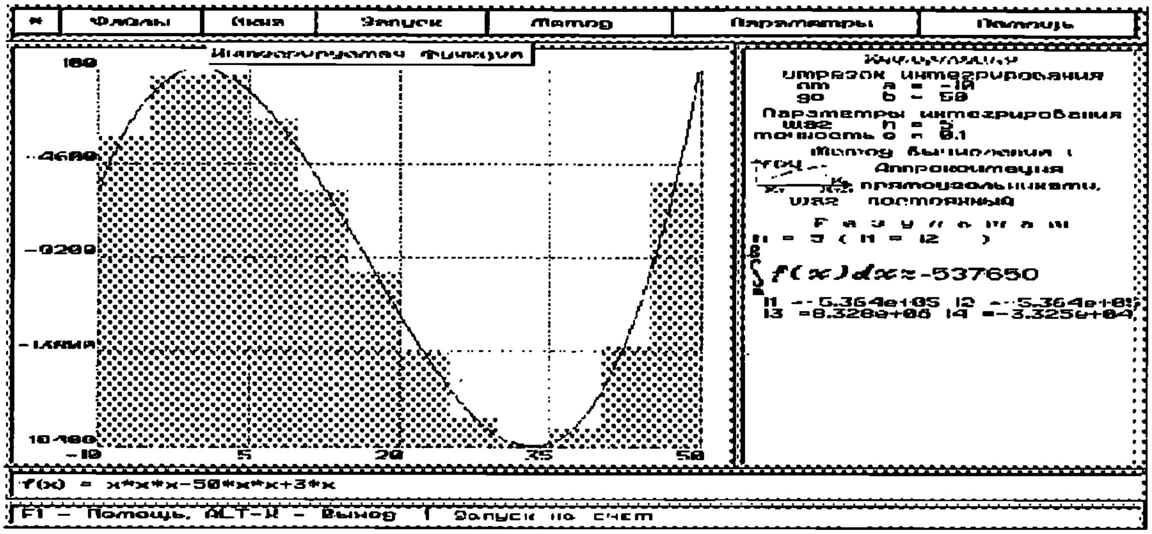

Figure 4: A screen in the package "Numerical integration".

The navigator of the courseware is constructed as a hierarchical menu that permits to move through sections, subsections and topics of the course of higher mathematics for engineering specialities. Besides, the Navigator introduces main functions and technique of work with each educational mathematical package from the library. It helps to understand how to apply a concrete educational mathematical package for solution of the problem from the course of higher mathematics. To reach this goal over hundred examples of solutions of typical problems from standard problem books are included in the Navigator. The examples are executed as demonstrations with detailed explanation of the course of solution. The menu of the lowest level consists of two parts: the list of problems, that can be solved within the framework of the concrete topic, and the title of an educational mathematical package from the library, that helps to solve the problems in the given topic [see Fig. 5]. The navigator allows the student to keep to the studied course, to receive an information about methods of solution of typical problems from demonstrations and to call for a solution of the problem just that educational package, which suits this purpose in the best way.

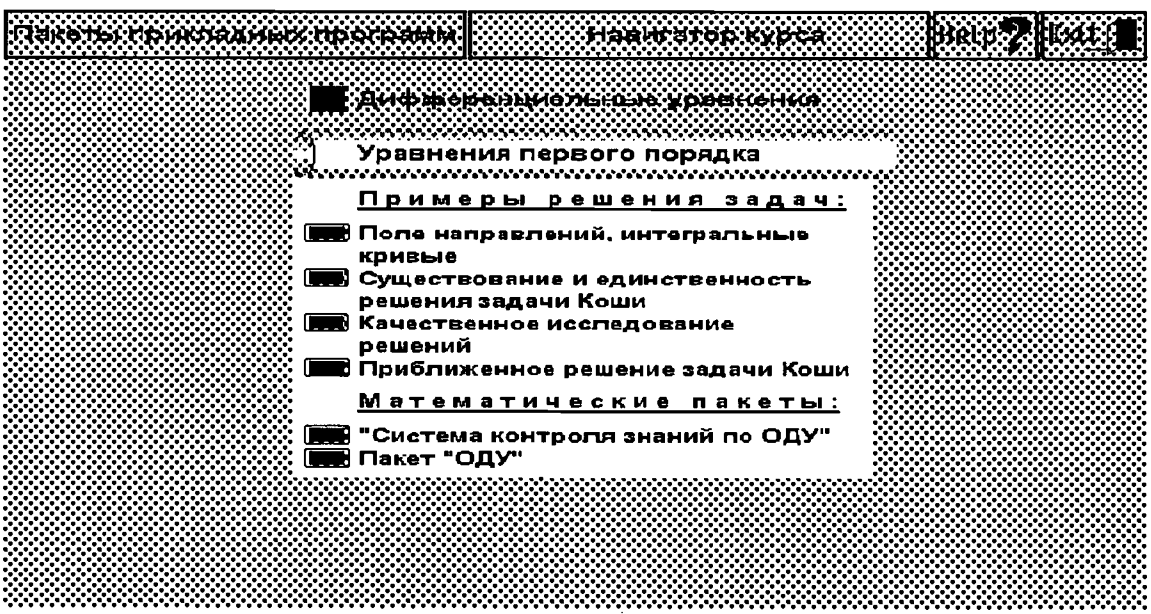

Figure 5: Navigator. One of the menus of the lowest level.

Navigator helps to receive enough information on the work with a concrete educational mathematical package: to read the author's summary, to start a demonstration, or to take advantage of the built-in help by starting a concrete package. The tutorial is accompanied by four books (user manuals and methodical instructions).

3. The Tool of the Courseware Creation

The navigator of the courseware is realized with the help of multifunctional tool hypermedia system HM-Card. This tool system developed at Technological University of Craz (Austria), is primary oriented on creation of educational computer programs of various types.

4. Perspectives of Use in the Net

The toolkit system HM-Card, by which Navigator is produced, allows to create packed files with an image of software for transfer in the net. The educational software can be located both in the Internet and on the server of a local network of the university. To run the program on a local workstation Netscape Navigator can be used. The demo-version of the tutorial is published on the WWW-server of ISRIR for free access (http://www.riis.ru).

5. Conclusions

The presented computer tutorial is the first courseware of such class in Russia. The authors hope, that it will help the teachers (to prepare lecture and seminar demonstrations and tests, to give lessons in computer class and to develop of new modem courses), and students (to investigate a subject under the direction of the teacher, to work independently or to deepen their knowledge). Note that all the programs are used by the authors for a number of years in real educational process, as well as in scientific researches and methodical work; these programs are used by the students for self-education and in preparation of degree works and, that is very important, in different universities.

The method applied for creation of the computer tutorial in higher mathematics allows to build blocks of uniform computer support of courses of any educational discipline.

The navigator of the computer tutorial in higher mathematics is open for updating: it is possible to expand the list of sections and topics, to include new educational packages, to enter in the menu of the concrete unit some programs with close capabilities. Thus, the courseware can be built up by integrating developments of various universities, high schools and concrete authors. This approach allows to create by common gains an educational software, which is meeting the requirements of significant number of students, and to avoid so-called methodical dictatorship of single school or direction. The students will have an opportunity to select the most suitable tool from several educational resources.

The authors see in pilot-project of the computer tutorial on higher mathematics the probable prototype of the similar projects on other disciplines. The work on upgrading the tutorial goes on.

Competency-based Learning in Business Education

From Knowledge to Skill

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Abstract: Knowledge is the motor of economic growth. Via knowledge networks knowledge flows to spots where it may be used in new products and services. Higher Business Education plays an important part in this knowledge network by offering direct and practically applicable knowledge in the fields of markets, finance, information supply and organisational forms.

The pressure on Higher Business Education to anticipate new developments is increasing. Current educational systems are insufficiently equipped to anticipate these developments. The project *Competency-based learning in business education* is aimed at preserving the position of Higher Business Education in the knowledge network and at strengthening it where possible. By means of the Competency-based learning concept a guaranteed link between developments in professional practice and vocational training in economics is possible.

A Vision, a Model, a Project

Competency-based learning:
a familiar vision with new perspectives

Competency-based learning as an educational vision aims at a close interaction of vocational education and professional practice. The training has been organised on the basis of two key-questions:

1. Does the knowledge meet the needs of professional practice?
2. Can the knowledge be put to practical use?

Competency-based learning aims at introducing competencies. By that we mean combinations of know-how and abilities as required in practice. An example to make this clear: the issue is not to possess knowledge of marketing and written reporting as separate final products, but to acquire the ability to write a marketing plan that is professionally sound and communicates well. So *Competency-based Learning* is not new, but based on the traditions of Higher Business Education: education in broad expert knowledge, skills and practical confrontations.

In the Netherlands the concept of competency-based learning has been used by Nijenrode University in the reform of management courses. American training institutes for business administration are also developing educational forms aimed at competency-based learning. Many business courses have been developed on the basis of the principles of competency learning.

At this time the fingerprint of professional practice is not yet sufficiently visible in the training. Education in expert knowledge, skills on the one hand and practical confrontations (work placements, projects) on the other hand are still offered too rarely. The educational organisation (subject structure, timetable, media) is ill-equipped to provide integrating study activities that offer a high degree of applicability.

The cultivation of professional skills forms the "raison d'être" of Higher Business Education. *Competency-based learning* is a vision that logically continues the profile of Higher Business Education and that wants to give it strength and sharpness again. In the first place it is nothing more - but also nothing less - than strengthening the own identity of Higher Business Education. It links up with the shortcomings felt by the institutes of Higher Business Education themselves for years and the urgent wishes of representatives from the professional fields.

A second element in vision is the wish that Higher Business Education should present itself more distinctly as a partner in a knowledge network with other educational institutes, businesses and government institutions, so that, by means of intensive interaction, it can play a role in the innovation of the knowledge required in professional practice.

Thirdly, competency-based learning emphasises learning rather than education. Education needs room for a more active study attitude of the student and a better connection to the abilities of the individual student, together with a more counselling role of the lecturer.

Competency-based learning is not a vision that turns everything upside down; on the contrary, it links up effortlessly with existing educational practice and can be expanded according to capacity and need. That does require a clear image of the desired final situation. For that purpose the educational model of Competency-based learning is being developed.

Competency-based learning:
the educational model

The existing educational model (final attainment levels, curriculum, didactic, media) will be revised in a number of steps. Final attainment levels and curriculum will be tested and adjusted on the basis of the criteria of practical relevance and applicability. Instruction in expert knowledge will be linked direct to application-oriented skills, the number of practical confrontations will be extended. In addition training and learning will be given a more "outward" orientation. New study activities, media and forms of counselling will be developed. Information technology will be an important integrating factor in the new educational model.

Competency-based learning in business education:
the project

The project of "Competency-based Learning in Business Education" is an initiative of the Faculty of Economics and Management of the Hogeschool van Utrecht. The Cetis expertise centre handles the program management on behalf of the Faculty of Economics and Management.

The project is aimed at further development of the model and the development, realisation and testing of a number of illustrative learning environments surrounding practical confrontations.

The planned project results:
- a blueprint for competency-oriented curricula;
- a training and educational program for management and lecturers;
- three multimedia practical confrontations for courses in the fields of logistics, strategic marketing and business information systems;
- an Internet facility to exchange know-how and experience concerning entrepreneurship;
- a management game.

In addition to the Faculty of Economics and Management of the Hogeschool van Utrecht the following parties participate

in the project:
- Origin Interactive Media Competence Centre;
- Rematch BV, development and exploitation of computer supported management simulations;
- PTT Telecom;
- Instituut voor Commerciële en Strategische Beleidsvorming;
- Jurjen de Vries, Bureau voor Management en Efficiency;
- Uitgeverij Lemma;
- PiMedia, developer and supplier of services in the field of assessment technology;
- Open Universiteit;
- Expertisecentrum Cetis.

The project started in September 1996. The duration of the project has been set at three years. During the project period initiatives will be prepared from within the project to create new development activities and activities aimed at implementation of part results.

The project has been made possible by a subsidy from the HBO (Higher Professional Education) innovation fund. The contribution from the Open University is made within the framework of the Consortium for the Innovation of Higher Education.

Please consult the www-site for information about the project http:/www.cetis.hvu.nl/cleo/

You may also apply to the program manager of this project,
Mr. R.H. Slotman MA,
address see above, phone +31 30 2586290, fax +31 30 2586292

When Dictionaries Talk: Proununciation in EFL MM MRDS

Abstract:

1. Introduction

2. Pronunciation in EFL MM MRDs

English-Polish/Polish-English Multimedia Dictionary [illegible] *Interactive English Dictionary* [illegible] *Pronunciation Dcitionary* [illegible]

[illegible]

2.1. Quality

[illegible]

[illegible]

[illegible] *abundantly* [illegible] *abundant* [illegible]

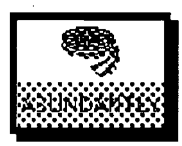

Figure 1: [illegible] *abundant* [illegible] *abundantly.*

[illegible]

[illegible]

[illegible]

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sharp-tempered ... *sharp-witted* ... *alcali, alcaline* ... *analysis, analyses*

LONGMAN COLLINS

Figure 2:

ä:

- ... *admit of* ... *admit to* ...

2.2. Access and User Interface

... *get-together, get together, bad-tempered, admit to, attend to, bad debt* ... *acid test* ...

D-day

Longman Dictionary of Contemporary English

2.3. Coverage and Consistency

Abbey National *abashed* *ABA*

Yule log

Longman Dictionary of English Language and Culture *Longman Pronunciation Dictionary*

AT&T

AB

[illegible]

[illegible]

[illegible] *absent* [illegible] *'absent* [illegible] *abstract* [illegible] *ab'stract* [illegible] *n* [illegible] *vt* [illegible] *abuse* [illegible] *accent* [illegible] *addict* [illegible] *advocate* [illegible] *n* [illegible] *vt* [illegible] *aggregate* [illegible] *n* [illegible] *vt* [illegible] *combine* [illegible]

2.4. Record-Yourself Facility

[illegible] *New Oxford Picture Dictionary,* [illegible] *Student's Dictionary* [illegible] *German-Polish/Polish-German Multimedia Dictionary* [illegible] *Flying Colours* [illegible]

> [illegible]

[illegible]

[illegible]

[illegible]

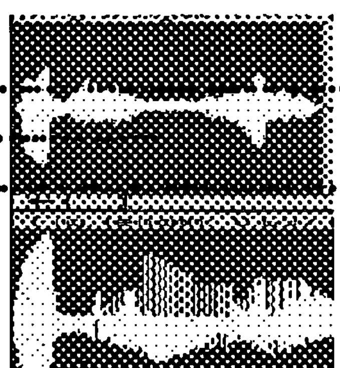

Figure 3. [illegible] *good morning* [illegible]

[illegible] *good morning* [illegible] *Flying Colours* [illegible]

[illegible]

3. References

[illegible] *In honour of A.S.Hornby* [illegible]

[illegible] *Linguistics and bilingual dictionaries* [illegible]

[illegible] *Looking up.* [illegible]

[illegible] *Études Anglaises,* [illegible]

[illegible] *Applied Linguistics,* [illegible]

[illegible] *Rask,* [illegible]

[illegible] *Transactions of the Philological Society* [illegible]

[illegible] *ITL, Review of Applied Linguistics,* [illegible]

[illegible] *Applied Linguistics,* [illegible]

[illegible] *Nordlyd,* [illegible]

[illegible]

[illegible] *System,* [illegible] *Cambridge Language Reference News* [illegible]

[illegible] *Jêzyk i technologia* [illegible]

[illegible] Ø [illegible] *ALLC-ACH '96 Conference Abstracts* [illegible] *New technologies in language education* [illegible]

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A Remote Control System of a Telescope by WWW and Real Time Communication for Astronomical Education

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Abstract: We have started a project of making remote control system for a telescope in a public observatory in Japan. This one year we have developed a prototype system, although it was only a conceptual primary design in 1996. The system has user-friendly interface on a web page. The web page has two menus, one is a menu of celestial bodies of Messier catalog, the other is a menu of bright stars. Also it has slight motion buttons. A remote client user can put in the celestial position of a target, or select a celestial target by the web home page of the system, and the telescope catches the target. The main purpose of this system is to show real time images to remote students for education. If this system is used from high schools in western countries such as Europe or U.S.A., the students can see real time images of celestial bodies and celestial phenomena in the school hours. If this system is used from southern countries such as Australia, the students can see northern celestial bodies that is never seen from those countries. Therefore this system will contribute science education internationally. We are developing this system now. In this paper, we describe prototype system and experiments. Also, this paper suggests CANES (Computer Assisted Navigation and Explanation System), which is under development.

1. Introduction

Recently in Japan, attractive science education is necessary for students, since many high school students don't want to study science. One of the largest reason of it, is that the lectures of science in high schools are not interesting, because they are only inputs of knowledge by text books without observation of real objects.

In this situation, celestial phenomena and celestial bodies seem to be prominently attractive, especially for young generation, because many planetariums and public observatories are always crowded with young generation. Although astronomy is a part of earth science in the curriculum of Japanese high school, it is not educated enough. Because it is impossible to show real celestial phenomena and celestial bodies to students in school hours, since most celestial phenomena and celestial bodies are seen in the night sky.

On the other hand, these ten years, a lot of public astronomical observatories are established in Japan, and

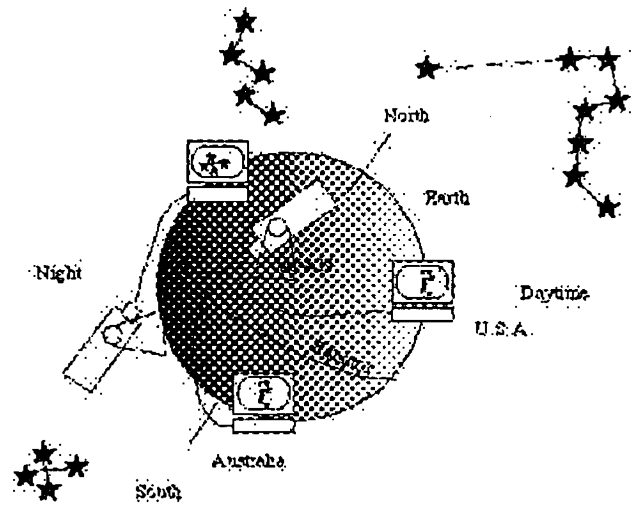

Figure 1: Global use of the remote control system of the telescope

the total number of them is around two hundreds. Around fifty observatories among them have telescopes of more than 0.5-m, and four of them have telescopes of more than 1.0-m. Misato observatory in Wakayama prefecture in Japan has 1.05-m telescope, that is the largest one among Japanese public telescopes. On the other hand, only two public observatories in Japan connected to Internet by digital leased lines. Misato observatory is the first one among those two observatories. Misato observatory and Wakayama University have already been cooperating to try some new attempts for education by Internet and video conference tool[Watanabe et. al.1996a, 96b].

In these environments, we have started the new project to make remote control system of the telescope by using WWW for educational use. In this project, we prepare three servers, web server, telescope server, CU-SeeMe server. A Remote client student accesses the web server, and gets home page of remote telescope project. The student can select a celestial target in a pop up menu, or can put in the celestial position of a target. Then the web server transfers the position to the telescope server. Then the telescope server moves the telescope to the direction of the target. A CCD video camera is set on the telescope. After getting real time image of the target by the CCD video camera through the telescope, the image is transferred to CU-SeeMe server. It transfers the real time image to the client student.

Many remote control systems have been developed for astronomers to make observation easier, but those telescopes can be controlled only by LAN. Therefore they are not adaptive to public use [Richimond et. al. 1993, Colgate et. al. 1982, Smith et. al. 1990, Perlmutter et. al. 1990, Tosti et. al. 1996]. The purpose of these systems is to reduce astronomers' load. Astronomers can drive the telescope from remote room with comfortable environment. In the supernova search, for instance, astronomers only have to put in some job schedule of getting images of the sky by CCD camera, then the telescope system executes the job automatically.

On the other hand, a few remote telescope systems began to be made for educational use. Especially, Mar J.Cox and John E. F. Baruch in University of Bradford have developed excellent system called robotic telescope that can be used on WWW[Cox et. al. 1994]. Their system attaches greater importance to technology of full-remote control, but the image of celestial bodies are not real time image. The requests from client users are stored in a queue, and the system makes a schedule to take CCD image of the requests. After taking CCD images at clear night, the images are put on the web page of the robotic telescope. So the images are still images. We think that to provide real time image is much more exciting for client students compared with still image, to enhance their interests of astronomy.

A part of our system is similar to their system in the architecture of remote control with WWW, but our

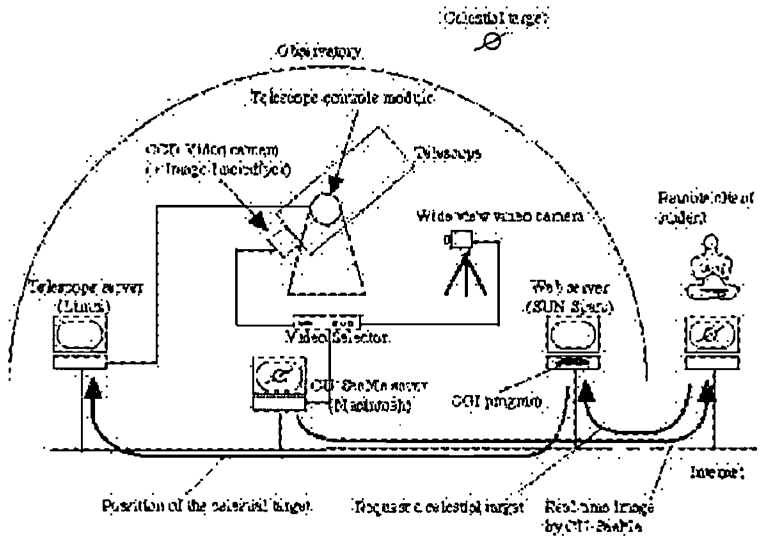

Figure 2: The architecture of the remote control system of the telescope

system provides real time image. The web user interface of our system supports slight movement buttons of telescope that enables to control telescope interactively. This kind of user-interface on the web for remote telescope is the first one in all over the world.

In this paper, we describe a prototype system of our remote telescope project, architecture of our remote control system. Until now, the second version of the web interface and the program of telescope server are completed. Therefore client student can control the telescope from all over the world through Internet by web user interface, although we still have a problem of time lag between sending request and starting to move the telescope.

When Japan is at night, foreign countries such as USA. or Europe is in the daytime. Therefore those who live in the countries can see real time image of celestial bodies at the daytime. This remote telescope system can be used at schools to teach science, and can be used in the planetariums for visitors in the daytime in the foreign countries [Fig.1]. This global idea is proposed by some projects of remote telescope for education use, such as the robotic telescope project mentioned before and HOU (Hands On Universe) project[1]. Also, from southern countries such as Australia and South Africa, they can see the real time images of celestial bodies in northern sky, which is never seen from those countries. So this project will contribute science education internationally.

In this paper, we finally describe how to apply the remote control system to education. Also, we expect that students will be interested in not only astronomy and science but also Internet, WWW and computer science. Robotic telescope project, HOU project and TIE (Telescope In Education) project[2] also make some science program combining astronomy and engineering. We also think that it is possible to make original combined curriculum of astronomy and computer science with this remote telescope in Japan.

2. System Architecture and Mechanism of Moving Telescope

[Fig.2] shows the architecture of the remote control system of the telescope. The user interface is made by web page with HTML on the web server. It has some blank to put in celestial position of the target [Fig.3], and

[1] http://hou.lbl.gov/

[2] http://www.mtwilson.edu/Science/TIE/

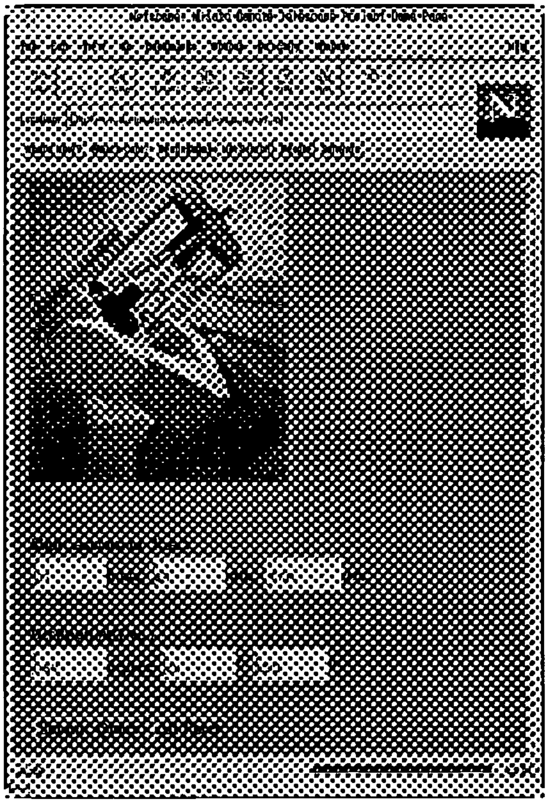

Figure 3: The blanks for target position on the web user interface

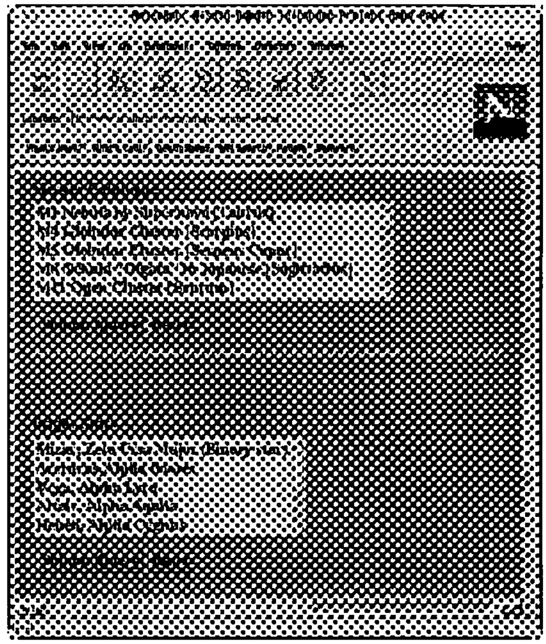

Figure 4: The celestial target menus on the web user interface

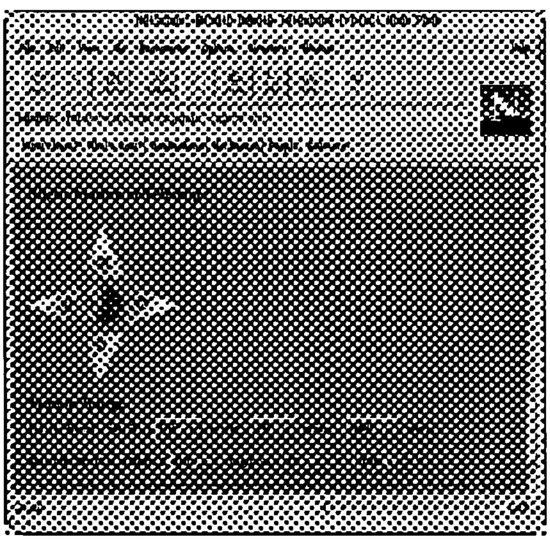

Figure 5: The slight motion buttons on the web user interface

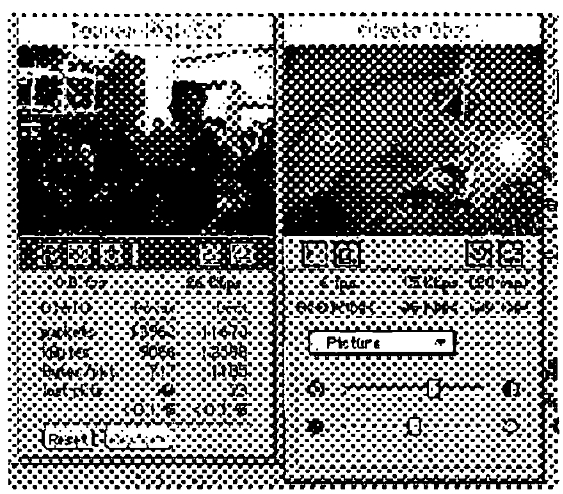

Figure 6: An experimental demonstration of moving telescope and a scene of class room on CU-SeeMe

pop up menus to select a target [Fig.4]. A student selects a target, or puts in the position of the target that he/she wants to see. The position is put in by equatorial coordinates. Then the position is transferred to the web server, and a CGI (Common Gateway Interface) program in the web server gets the position and put it in a temporary file. The web server is SUN Sparc workstation.

A telescope server always monitors the temporary file by NFS mount, and if new values are put in it, the telescope server reads them. The telescope server is personal computer with Linux. It calculates the sidereal time, by the Japan standard time, latitude and longitude of the observatory. Then the telescope server transforms the position of the target on equatorial coordinates into horizontal coordinates. If the altitude of the target is more than 20 degrees, the object can be seen in the sky clearly. If the altitude is less than 20 degrees, the object is seen low in the sky or cannot be seen because it is under horizon. Even if the target is seen lower in the sky, it is dangerous to move telescope towards such a target, since there is possibility that the telescope crashes into objects in the dome. In these cases, the telescope server cancels the student's request.

If the target is seen in the sky at the safe direction for the telescope, the telescope server calculates the difference between the position of the target and the current direction of the telescope. Then the telescope server sends necessary serial signals to the control module of the telescope. Finally the telescope is moved toward the direction of the target.

The web user interface also has slight movement buttons that moves the telescope to north, south, east, and west directions in a range decided by the student [Fig.5]. This type of user interface of telescope control system on the web is first one in all over the world. The buttons makes the system interactive. For instance, when a student is observing a large celestial body such as the moon or Andromeda galaxy, he can see only a part of it because field of view is too small to see whole of it. In such a case, the student can move the field of view by the slight movement buttons. Also , we have our original idea of CANES (Computer Assisted Navigation and Explanation System) described in chapter 5. The slight movement buttons are very useful with GANES.

3. Catching Real Time Image by CCD Video Camera

A CCD video camera is set on the eyepiece of the telescope. If the target is very bright one, such as the moon, Jupiter, or Saturn, the CCD video camera is enough to get the real time image. If the target is not bright one, such as a galaxy, nebula, and cluster of stars, an image intensifier is necessary between the eyepiece and the CCD video camera. By this composition, real time images of famous galaxies, nebulas, and clusters of stars in Messier catalogue can be provided.

On the other hand, wide view video camera is prepared for providing real time image of movement of the telescope. It catches the real time image of which the telescope is moving according to the student's request.

Both images of CCD video camera and wide view video camera are sent to CU-SeeMe server through a video selector. At the first, wide view video camera catches real time image of movement of the telescope, and it is sent to the client student. After the telescope caught a target, the real time image is changed into the target image by video selector. Both real time images are sent to the student by CU-SeeMe.

4. Experimental Observation

We have several experiments of observation with some high schools by the remote control system of the telescope. However, we are so unfortunate that they were always cloudy or rainy days. To get real time image, client users have to contact observatory and make reservation of day and time of observation previously. Because the telescope server program has to be started before operating the telescope from remote site. The day and time cannot be changed easily, since the telescope has other many schedules of research and public use.

[Fig.6] shows the scene of telescope movement and a classroom of Tonan high school in Kyoto city. Although it was clouded day and students cannot see real time image of celestial bodies, they are strongly interested in real time image of telescope moving in accordance with their requests from web user interface. The distance between the school and the observatory is about 120 km. The telescope started to move in a few seconds, after the CGI program sent request of a student. We had some other experiments to move telescope from remote site from National Astronomical Observatory (Tokyo), University of Calgary CANADA, and California.

5. CANES

Every celestial body such as a star, galaxy, nebula, and cluster has its own position values on the equatorial coordinates. Also, our remote control system always keeps position values of the direction of the telescope on the equatorial coordinates. Therefore the system can know which part of a celestial body a student is observing. Sometimes a student gets lost when he/she is traveling around a celestial body by using the slight motion buttons. So we suggest new idea of navigation and explanation system for a student to observe a celestial body. The system is called CANES (Computer Assisted Navigation and Explanation System). CANES is now under development, it is not completed yet. Here we explain the mechanism of the CANES, using observation of the Andromeda galaxy as an example.

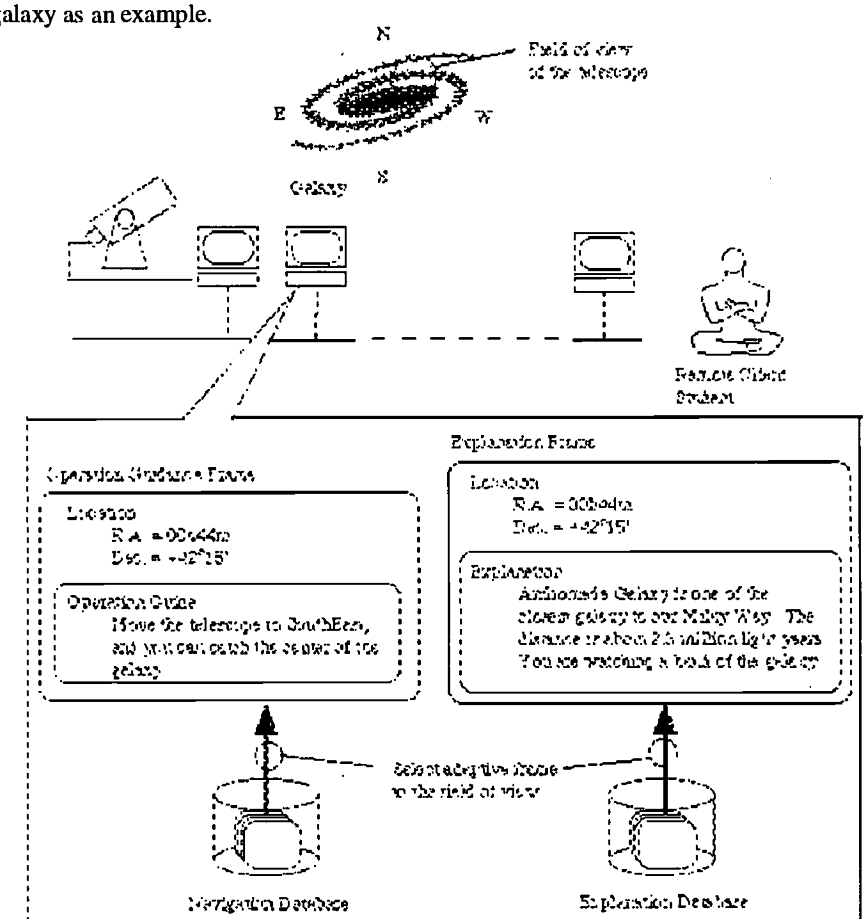

Figure 7: The mechanism of CANES (Computer Assisted Navigation and Explanation System)

[Fig.7] shows the mechanism of CANES. It has two databases, explanation database and navigation database. Both databases have many frames called explanation frame and navigation frame. Every explanation frame has an explanation about a part of the celestial body. Every navigation frame has navigation information around the field of view of the telescope. Every explanation frame and navigation frame has its own values of equatorial coordinates. CANES retrieves adaptive explanation frame and navigation frame by the direction of the telescope, and shows them to the student. The student can know much about the part where he/she is watching by the explanation, also can know where to move the telescope to catch a part he/she wants to observe.

6. Conclusion

In this paper, we described the concept, architecture and a prototype system of our remote control system of a telescope with CANES on WWW. The purpose of our system is education use. Therefor the system does not need to realize full-remote control, although a telescope for research use needs it. In the full-remote control system for research use, dome is also controlled from remote site, but it is not so necessary for education use. The main reason why we try to realize remote control, is to increase student's feeling as "using telescope by oneself", and to increase student's interest. Only a part of the celestial body is observed at a moment by a high magnification, if the celestial body is large, such as the moon, Andromeda galaxy, or Orion's nebula. In such a case, it is important that the student can control the telescope according to his/her desire, since the remote control brings him/her the feeling of voyaging in the space. CANES helps such a voyage. On the other hand, if a staff is in the dome, it is possible to move the telescope by the staff according to the request from a student by phone call or e-mail. However this kind of system is not so interesting for the student, since it has less interactive feeling.

It is desirable that remote telescopes for education exist as many as possible in all over the world, because weather condition is not always good in one observatory. If there are many remote telescopes, some of them can catch the target in a good weather condition. For another reason, the view of celestial phenomena by the moon, is dependent on the location on the earth. For instance, a total solar eclipse can be seen in a narrow zone where the umbra by the moon passes on the earth. In neighbor area of the zone, partial eclipse can be seen. Therefore, if there are many remote telescopes on the earth, from an observatory in the zone of totality, the real time image of total solar eclipse can be sent to remote clients. On the other hand, from another observatory in neighbor area of the zone, the real time image of partial eclipse can be sent. If a remote client student receives some real time images from some observatories on the world, he/she can understand the difference of view of the eclipse. Also he/she can understand the umbra and penumbra passes on the earth as time passes.

Eclipse of the sun is quite rare phenomenon, but occultation of stars by the moon can be often seen. As well as the eclipse of the sun, the view of occultation of a star depends on the location of the observatory. The point and time of disappearance and reappearance of the star against the moon differ according to the location of the observatory. Therefore if a student compares some real time images of occultation of the star from some different observatories, he/she can understand and measure parallax of the moon. By the parallax, it is possible to make an education program to calculate the distance between the earth and the moon. This kind of education program is a desirable science program. Because it includes observation phase of real objects and consideration phase of the observation. It enhances ability of observation of real objects and ability of consideration and study.

CANES is our original idea, that gives some explanations and navigation information of the target. It helps the student to drive the telescope. It is also possible to put in questions instead of explanations in the explanation frame. In this case, CANES becomes another type of CAI system, that consists of questions and answers. It will be an excellent CAI system that utilizes real time image as teaching material. It is our future work.

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Distance Retraining System for Teachers in Korea

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Abstract : The basic philosophy and current developing status of Distance retraining system for teachers in Korea is presented. The system was planned and has been implemented by the Korean Minister of Education and Korea multimedia education center. The targets the system pursues is to minimize teachers' retraining cost and provide more chances to teachers who need to get new information through retraining programs. The exhibition system was designed and has been partially implemented. The proposed system will be the basic retraining system in Korea in near future and comparing with the cost for retraining teachers under the existing retraining system, it is expected that the proposed system reduce the cost more than twenty percents.

I. Introduction

Every year more than 100,000 teachers participate in a variety of retraining programs held in forty five institutes in Korea. To take the programs, teachers who are geographically distributed throughout Korea always have to attend the classes in the institutes. This kind of retraining scheme continuously increases the retraining cost and gives many difficulties to teachers who are always struggling with time. In addition to that, the facilities in very limited number of institutes are not enough for providing good quality of retraining service and accommodating many teachers. But what makes the matter worse is that even though many rich courses are offered, teachers are not able to get the courses, depending on their major fields and levels, due to the limited resources and uniform training programs. [Choi 1995]-[Jin 1997]

With the help of the current communication infra-structure which can overcome time and space limitations, and make remote retraining system feasible, the Minister of education and Multimedia education development center in Korea has been developing "Distance retraining system" to resolve the above problems. They utilize "Edunet", a global service system for education information in Korea which is accessible by everybody [Lee 1997]. They expect that the Distance retraining system removes many problems associated with the current retraining programs and makes it feasible for the teachers to participate in the programs from anywhere and in anytime. The Distance retraining system aims at enhancing the specialties of teachers and lets them prepare for intellectual and informational society of the 21st century. The system may also extend retraining chances by amortizing time and space limitations, and reducing retraining cost.

The Minister of education established the Distance retraining system with 10 million dollars in 1997 and has run the exhibition system for a limited number of retraining programs in two provincial retraining institutes since April, 1998. As the network, "Edunet" is being utilized. The Edunet was installed in June 1996 and is running successfully. [Lee 1997]

Section two describes the procedures for developing Distance retraining system. In section three, the implementation plan of the Distance retraining system is presented. Finally section four addresses the expecting effect and future plan, and wraps up this paper.

II. Procedures for developing the Distance retraining system

The procedures for developing the Distance retraining system has included modeling a remote training system with considering the current situation and expected future environment in Korea, establishing a practical system based on the model, and developing a platform which will serve as the management system for all retraining programs. Creating coursewares for retraining programs and installing the infra-structure were also included.

In modeling procedure, a basic model was developed. The model includes the scheme for setting the relation between distance and in-class retraining, the credit system for distance retraining courses, the grading system, and the future improving plan. In establishing step, running the retraining programs and supporting the prototype system were considered. For these activities, the materials for distance retraining were developed and the strategy for utilizing the materials was set up. To verify the performance of system, three institutes were selected and have run the system. And the future plan for extending the number of the institutes which are going to use the Distance retraining system was also set up. The complex retraining management system is a web-based application for running the Distance retraining system. The components for performing the retraining system consist of lecturer, student, and manager. And the complex retraining management system is a platform to support the components according to their roles. The platform includes the following sub-systems : 1) authoring sub-system served as an authoring material pool, served for establishing course types, designing lectures, and creating the contents for lectures, 2) remote lecture support sub-system for supporting distance retraining, controlling classes, and the activities of lecturers, 3) retraining support sub-system for searching retraining materials, and supporting classes, 4) management and evaluation sub-system for managing credits, securing the system, counseling, and evaluating statistics.

III. Implementation of the Distance retraining system

Distance training using computer and communication can be classified into two types : Non-realtime system and Realtime system. BBS(Bulletin Board System) type and VOD(Video On Demand) type are included in non-realtime system. Considering the fact that it is hard for teachers to make enough time in daytime for participating in extra training programs besides their normal classes, the proposed system has been developed as a kind of non-realtime system. Therefore, teachers can take programs they want when they are free. Since the current communication environment is not enough to fully support VOD system which requires extremely high data bandwidth and sophisticated equipments, it's not easy for teachers in remote places to get high quality retraining programs. Therefore, a Web-based instruction system which is a kind of multimedia BBS type is hired in the proposed system. We have a plan to move for VOD system in near future, expecting that communication environment is improved.

For the first stage of running the Distance retraining system, teachers who wish to take retraining programs attend cyber-classes after class hours through Edunet and get credits. The classes use training materials made by typical multimedia authoring tools. The classes offered in the current exhibition system are very limited. The number of the classes is eleven and they are all liberal arts courses. The other classes are held in the previously mentioned 45 institutes. To get the credits, teachers have to attend the classes held in the institutes. The number of cyber classes is going to be larger and eventually all retraining programs will be done through the proposed distance retraining system.

To diversify retraining programs, six basic courseware databases are being developing. The number will be increased and the field will be extended. The coursewares are developed in four class models. They are basic courseware model, lecture model, problem solving/information searching model, and seminar model. They have different class scenarios which were developed with considering the characteristics of the models. And thus the scenarios provides friendly interactive environments to teachers in remote places.

For the exhibition system to be worked, Korea multimedia education center cooperates with two other institutes : Education center in Korea national university and Kyoungnam teachers training institute. Korea multimedia education center serves as the central center. It installed Web server, DB server, and Mail server. It also loaded the coursewares which had been developed in the early stage of the proposed system development. And the coursewares can be accessed through Edunet. The two cooperating institutes manage the teachers in retraining programs using the DB server and monitor the offered courses. For the communication network, dedicated 256Kbps network is utilized currently. But it is going to be replaced with 465Mbps fiber network in 1998. Figure 1 shows the configuration of the exhibition Distance training system for teachers in Korea.

The teachers who want to take the courses in the retraining program register via PSTN or PSDN. Any questions during the classes are asked by teachers and the answered are supplied by lecturers on-line bases. For supporting this scheme, a FAQ utility is provided. A complex retraining management program is also provided. It includes an authoring system, a lecture support system, a learning support system, and a total management and evaluation system.

To monitor the efficiency of the proposed system and give the chances to comment on the future improvement, the Ministry of Education, Korea multimedia education center and sixteen municipal and provincial education offices are connected through a teleconferencing system.

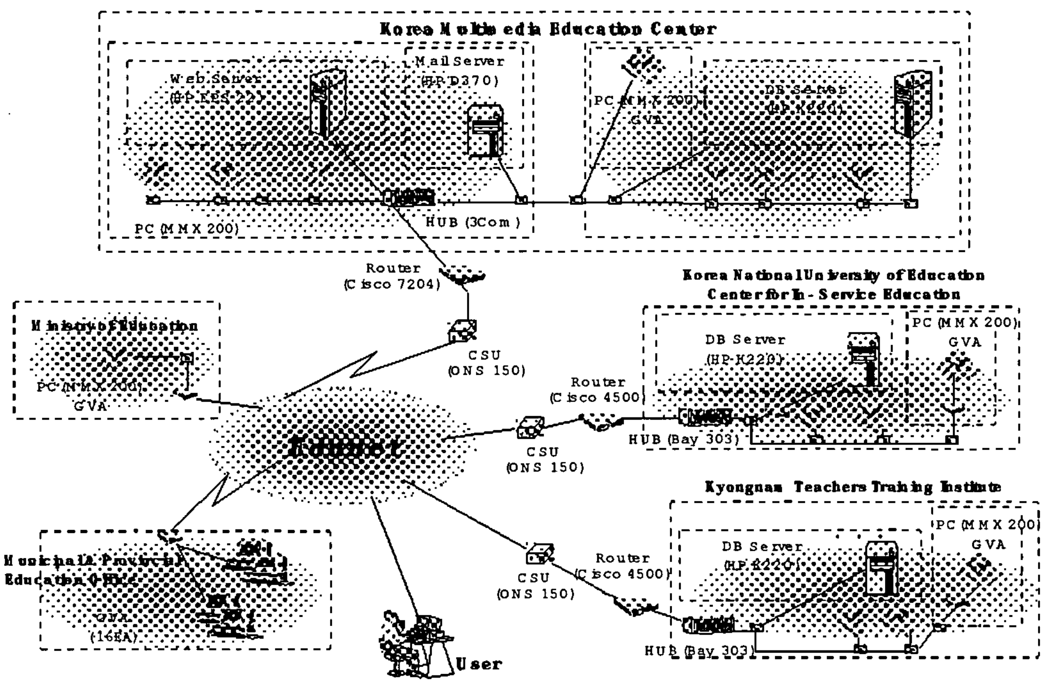

Figure 1. Configuration of the Distance training system for teachers in Korea.

IV. Effect and future plan

The following effects are expected by running the proposed system. First, retraining cost will be reduced. About 20 percents of the traveling cost to attend the institutes and the charge for board and lodging is expected to be reduced. In addition, the replacement cost occurred due to the absence of teachers can be reduced. Second, it becomes possible to immediately collect the information on the organizations of retraining institutes and the management for running retraining programs. Recognizing the current state of retraining programs becomes easier. Therefore, the time for dealing with the dirty works associated with retraining programs may be utilized efficiently for other purposes, since everybody can access the information on retraining programs via public network. Third, the proposed system can contribute to installing a lifelong-retraining structure because every teacher can take the chance to participate in any courses which are offered by any institutes in any time. Especially in the case that an emergent program should be propagated to all teachers throughout the nation urgently, the proposed system will be a very strong and only way to get the job done.

To improve the efficiency of the proposed system and make the system work smoothly, thirty institutes are going to utilize the proposed Distance retraining system by 2000. Along with that, more than a hundred more cyber coursewares are going to be developed. To encourage teachers to use the system, there is a plan to provide the well graded teachers with merits. And other media such as TV, CATV or satellite are considered for the future implementation. The proposed system utilizing Edunet will be connected with the existing Korea educational network and Information superhighway which is going to be installed by 2005, allowing everybody to access the system from anywhere in anytime.

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Music Cognition by Auditory Perception: A Multimedia, Asynchronous, Individualized Computer Mediated Course with the Web as Communication Vehicle.

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Abstract: "Music: A Listening Experience" is a computer mediated, college introduction to music course. The course was designed for self-paced, individualized instruction with all learning taking place in a computer lab. This course has now been redesigned into a hybrid Web/CD computer mediated course. The Web functions as a communication vehicle between students and instructor, as well as, between students and their peers. Students use the Web to upload files containing test results and to communicate with the instructor. The instructor downloads test results and poses discussion topics on a conferencing program. The principal educational objective is the development of skills for attaining music cognition through auditory perception. It is a hands-on listening course intended for learners with none or limited musical preparation. All learning occurs off the Web and thus requires no connect time. A final exam is presented on a floppy disk.

1. Courseware Design

The multimedia program, *The Anatomy of Music*[1], was designed as stand-alone courseware for individualized instruction. Its principal objective is to develop in the learner skills for auditory perception of musical forms. Programmed with HyperCard, it is currently available for the Macintosh platform (with CD-ROM drive) only and the packet includes a floppy disk containing the program to be installed on the hard disk, a student disk that stores data of test results and also serves as key disk, three specially created CDs containing all the music needed for the course, and a workbook.

The main task preceding the development of the courseware involved selecting appropriate musical examples to suit the purpose. These examples had then to be analyzed into such syntactic units, or musical strings, that the average learner could be expected to perceive auditorily. Obviously, the dissected syntactic units had to correlate with the actual forms, so transferability of what is learned in the course to real-world situations would be enabled. Consequently, the analyses represent each form at its most general or inclusive level, its metaform.

The actual program development began with the preparation of graphic representations of the musical forms to be used in the course. In the program, these are called form-maps. The following is an example of the form-map of a minuet (Figure 1).

Minuet						Trio						Minuet		
A	A	B	a	B	a	C	C	D	c	D	c	A	B	a
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Figure 1

The program was then designed to synchronize animated highlights on the form-maps with the appropriate music played over a CD-ROM drive. Thus, each highlighted box serves to visualize the location of the

[1] David Sonnenschein. *The Anatomy of Music* Tinoteca Music Courseware Production, P.O.Box 95, Saratoga Springs, NY 12866, 1995. http://www.tinoteca.com.

various musical statements that make-up the forms as they are heard; guiding the learners in their perception and classification of the musical statements. Parallel inputs from auditory and visual modalities reinforce conceptualization and categorization of the discerned musical events.

The program is designed for interactivity. By clicking on anyone of the boxes of the graphic, the music will instantaneously synchronize with that location on the form-map. This enables the student to learn by experimentation. Comparing various sections and listening repeatedly to those sections experienced as being unclear will reinforce the learner's auditory understanding.

2. Other Items in the Program

The software also includes listening exercises and relevant historical background information. Listening exercises are available for every composition in the program. They permit students to select the composition on which they wish to assess their listening skill. Once a composition is selected, the computer screen presents the selected composition's form-plan. The form-plan is presented without highlighted boxes. After the music is started, the student is expected to click in real time on a box that represents the music heard. If the box clicked is in sync with the music it represents, the box will highlight and a positive score will show. These scores are for practice only and are not saved. The purpose of these "Listening Exercises," as they are called in the program, is to build-up the learner's self confidence.

The historical background information is presented in several scrolling text fields that can be read on the screen in the context of a chapter studied. The information is also available in hard copy in the provided workbook. The information relates directly to each particular form class and this information represents the basis for the question part on the final exam.

Finally, the whole program was compiled as an application, an option provided by later versions of HyperCard. This makes it unnecessary for users to have HyperCard on their computer.

3. The Web as Communication Vehicle

The Anatomy of Music is the basic "text" for a computer mediated course entitled "Music: A Listening Experience." The course has a Homepage on the Web and its URL is http://multimedia.dac.neu.edu/aom/.

The Homepage contains several links to other locations such as university administrative centers for registration, etc., or to other related sites, as well as to the publisher of the text materials for the course.

The four credit course is offered as a free elective at a college of Arts and Sciences. Designed as a self-paced course, students can study at any location and almost without fixed schedules. They can study and experiment in any order or sequence though, chapter-tests have to be taken in sequence. To pass a test, students have to accumulate a predetermined number of score points. They cannot proceed to a subsequent chapter test before the previous chapter-test has been passed. All test results are accumulated on the student disk, which, as was mentioned earlier, also serves as a key disk needed to access the program.

The Web functions as a communication vehicle between students and instructor, as well as, between students and their peers. In its function to communicate between student and instructor, the Web is used for the periodic uploading of test results accumulated on the student disk. Space on a server at the University has been set aside for this purpose. The instructor can download student files from the server and save them with a separately designed course management program.

In addition to its up and downloading of homework function, the Web is also used for e-mail communication between instructor and students for answering student questions, prompting, or for providing additional information or explanations when needed.

To encourage "class participation," the instructor poses periodically questions on the conferencing program which is accessible from the Homepage. Ability to answer these questions requires task oriented listening. Students are not graded on these questions. After seven to ten days, the instructor posts the answer. All who participated in a meaningful manner between the time a question was posted and the answer provided will be credited for class participation. The same conferencing program is also usable for discussions between students and can thus be used for cooperative learning.

3. Testing Instrument

Tests are considered learning experiences and designed to probe and monitor progress in the learner's skills and understanding. The learner can call up questions until the needed score has been attained. And since feedback is immediate, learners can self assess their performance continuously in a non threatening environment.

Testing modules includes form-plans with randomly selected highlighted boxes. The music, also selected randomly from among several examples for each chapter, is then started and the learner is asked to identify the musical events highlighted on the form-plan by clicking on the appropriate boxes in real time.

To be able to do this successfully, the learner has to track the music mentally, discriminate and categorize musical events as they occur, and have committed to memory sufficient data for comparison and orientation.

Each chapter includes a context related auditory test unit. As students answer each question, they accumulate score points. Once the required minimum score for passing the chapter test is reached, the program informs the student by flashing a congratulating dialog screen with an option for printing it for the student's record.

4. Final Exam

After students complete successfully all tests for five chapters, they are ready to attempt the final exam. This exam contains listening questions as well as questions drawn from the historical background information provided both on the computer screen and in the workbook. The listening part is based on a chapter that differs from the others by not having listening exercises or tests. The chapter contains form-maps and commentaries for Beethoven's 3rd symphony, the Eroica.

The final begins with the listening part. The program selects randomly one movement from Beethoven's Eroica symphony. The work has three of its movements in forms that were studied earlier in the program and one movement in a modification of a form studied. The learner can prepare for this exam by working and experimenting with the form-plans and the recording provided in chapter six.

Five locations on the presented form-plan are highlighted by random selection. The learner has to be able to locate these in real time as s/he listens to the music over the CD-ROM drive. Unlike in the chapter tests, no feedback is provided as to whether an answer given was correct or not.

After the listening part is completed, a set of randomly selected questions is presented in multiple choice format. Each question is followed by four possible answers and the learner has to respond by selecting one of these. A review of all answered questions with allowance for changes is available as long as all is done within the time limit.

Because all questions, listening as well as verbal, are randomly selected from a significantly sized pool, the possibility of two finals being identical is extremely remote. The obvious reason for this design is to discourage the transfer of information from one student to another.

The final is provided on a floppy disk and obviously several security issues had to be addressed in the programming. For example, the design makes it impossible to attempt the final more than once. Also, it has to be taken in one continuous period and within a set time limit (controlled by a time bomb). Once the time limit has elapsed, the final program is no longer usable.

After completion, the file containing the results of the final is uploaded in the same way as were the regular home work results, and again the instructor can then download the data and includes it in the student's file with the course management program.

5. Fundamental Educational Consideration

One of the learning theories that permeate this hybrid Web/CD computer mediated course pertains to mastery learning. Students have to attain a certain level of mastery before moving on to the next stage. But unlike the classic application of this theory, students are free to learn by experimentation and may select objects of study out of any prescribed sequence. This brings the didactic strategy closer to the Constructivist approach. It is assumed that most students can learn the materials if they are permitted to do so at their own pace and in their own manner.

Another instructional theorem underlying the design of this courseware is that learning a general principle is of greater value than learning specific instances of it. As applied here, the focus is on comprehension and perception of a form and not on any number of compositions in that form.

Assessments are performance based. It matters not how much time was needed to complete a chapter test. Grades for this course are determined by number of chapters completed, class participation, and performance on the final. Currently, the course is available only to students of this university and adheres to its college's time schedule and therefore has to be completed within one term. Future plans call for making this course available to students outside this university. This may make its scheduling more flexible.

6. Ordering the Content Hierarchically

The five basic forms included in the program are: minuet, rondo, theme and variations, sonata-form, and concerto - modified sonata-form. They represent most of the forms found in compositions of the selected period. In most larger, aggregate, forms such as symphonies or concertos of the period, each separate movement is cast in one or another of these forms.

The forms were ordered hierarchically according to levels of difficulty for auditory perception. These levels were based on results from an earlier performed items-analysis study.

7. Complexities in Teaching Music Listening

For this course, music cognition is defined as being made up of three related elements: a) knowledge of several of the most common composition plans - the forms - of musical masterworks composed between ca 1720 and
ca 1920, b) ability to discriminate by auditory perception between discrete musical events that define these forms, and c) ability to categorize these musical events according to their proper location and function along a known musical form.

Given the ineffability of the emotional and aesthetic qualities of music, this college introduction to music course , designed for the non-major in music, applies a novel approach by utilizing musical syntax as the central didactic strategy for the achievement of music cognition. The aim is for the student to attain skills in perceptual categorization of sonic data into coherent musical statements.

The historical period selected contains composition representing some of the greatest human achievements. And one objective of this course is to make these masterworks accessible to anyone who is interested but feels intimidated for lack of musical knowledge in general, and music theory and music reading skill in particular.

Composers of the period under consideration composed their works for amateurs and not for the professional musician. They took great pains to create compositions within the accessibility limits of their listeners by following established norms. One of these norms related to the syntactic order. or forms, all composers adhered to.

Many who listen frequently to Classical music, including most professional musicians, are unaware of their own mental processing as they listen to music. They already have attained the necessary skills and possess the required knowledge, and thus, listen to music as one listens to language, i.e., without paying attention to its syntax or grammar. Many others, however, need instruction to attain the needed skill and knowledge and it is for those that this course was designed.

Although an understanding of musical form and possessing the skill of becoming aware of it by listening can provide considerable satisfaction, the course aspires a broader objective. Most written accounts of music, weather in program books for a symphony concert or in music appreciation books, refer to specific musical events in a composition discussed. To locate these events, the reader has either to have the work completely memorized in every detail, be able to read the musical score, or know the form of the work and have the skill to follow it auditorily. Thus, since the achievement of the last of these presents the main objective of this course, its approach and content are intended to provide a solid basis for the continuous accumulation of musical knowledge that reaches beyond the limits of this course.

In music, form has several meanings. Its definition depends on whether one speaks about a small detail of a composition or the entire composition. For example, we can say that the form of a typical concerto has three movements. This is probably the broadest use of the term form. In contrast, theorists discuss at times the form of a fragment of a melody. For the purpose of the current discussion, we use the term form as it applies to the composition plans, the mappings of an entire movements of a composition.

The number of different musical forms used by composers of the selected period is astonishing small considering the infinite possibilities. Hence, a comprehension of these forms on a purely intellectual level is not much of a challenge and would not require the devotion of a whole term to their study. The real challenge lies in the auditory perception of these forms.

Musical information reaches the listener in both serial and parallel modes. To perceive a coherent cognition of music's syntactic structure requires the listener to engage in "thoughtful" listening. Obviously, there are different modes of thinking. We are so used to thinking in words that it seems to us to be the natural and perhaps the only thinking mode. But of course we also think in numbers, in symbolic representations, and in images; and some of us also think in music.

However, to most of us, thinking in music does not come naturally and we have to acquire it by learning and practice. To be able to follow at least some of the composer's intellectual organization of his/her compositional materials, we have to discriminate between numerous musical events as they are perceived via auditory input, categorize and recategorize these, since continuous new inputs may affect our conception, and commit enough to memory for comparison with future inputs. This is the challenge and it requires learning and practice.

The style of all compositions of the selected period is characterized by a shared common theoretical foundation. This style can be elucidated by using a concept borrowed from a different discipline. The psychology of visual perception uses the *figure-ground* concept to explain the mechanism by which we menage to discern a *figure* embedded in a background.

Gestalt psychologists maintain that we grasp the world in complete configurations and not in minute components. When we look at a representational painting for example, we see the objects represented and not the brush-strokes. Also, we focus our attention primarily on the figures and less so on the background. When we listen to music we do essentially the same thing. We listen to complete musical statements and we do not listen to individual tones. We pay more attention to the themes than to the harmonic progressions in the background or the accompanying events.

When we listen to a composition sharing the common theoretical style mentioned, we have to discriminate between *figure* (musical statement) and *ground* (musical background) and remember enough of both to recognize them when they recur. This is essential because if we limit our listening to a continuous present only, we are limiting our perception to what is called low-level. Everything we hear is immediately replaced with something new and nothing of the past is ever stored even temporarily. To achieve any level of music cognition requires to do some mental mapping of the form with at least a vague memory of the discerned musical statements.

Most, if not all, composers who created their works during the period discussed here worked mainly in a kind of musical *figure - ground* style. The musical term for this is *homophony* . It is defined as a style having prominent musical statements embedded in a less pronounced accompanying environment.

This style made it possible to create musical forms by assembling musical statements in various arrangements or mappings. Once a musical statement was created and embedded in an appropriate musical background, a composer could decide whether to repeat it or follow it with another statement. The manipulation and the arranging of these statements determined the form of the composition.

Let's continue with the visual metaphor a little longer. *Figures* can be clear and have obvious boundaries, or they can be rather blurry with less defined contours. On occasion, the background will be made purposely to obscure the *figure* so it gets lost within. The same applies to music. The musical equivalent term for the visual *figure* is *theme* or *subject*. It is the musical entity that is usually the easiest to commit to memory.

Once stated, a *theme* becomes something like fiber which the composer will use to spin the fabric of a work. The musical theme is the basic intellectual material for creating a whole *section*[2] of a composition. The composer will draw from the theme many different elements such as rhythmic figures, melodic fragments or elements from the accompanying events, and use these to expand and elaborate the section. Hence, think of a musical section as an entity that in most cases will contain a quite easily discernible theme, and that this theme will be followed by a strain of related musical material. In most cases, the theme will appear at the start of a *section.*

At times, the strain that follows the theme will contain some elements that protrude more than others and eventually develop a life of their own. They can be considered *sub-sections*.

Themes can be short and simple, and they can also be extensive and very complex. A complex theme may contains several "themelets" that are clearly discernible. This can make it difficult at times, especially for the novice, to distinguish between a short theme followed by a strain with several *sub-sections* and an extensive, complex theme.

The end of a *section* may or may not be defined by a clear boundary. Sometimes, it will be noticed only by the introduction of a new theme at the head of a new *section*.

Once the learner has developed the skill to discern a musical *section* and to discriminate between one *section* and another, s/he has taken an important step toward auditory cognition of music. Being able to isolate musical *sections,* enables the learner to tell, for example, if two adjacent *sections* are similar or different; an important observation for the perception of form in music.

Themes, sections and sub-sections are some of the smaller structural elements the learner has to deal with. Musical forms contain many more group levels, and the auditory perception and categorization of these requires much trial and error experimentation by the learner. But it will ultimately lead to a firm foundation for attaining music cognition.

This brief description of the complex nature of even a limited level of music cognition was intended to underscore the difficulty in teaching music cognition by auditory perception. It should be quite obvious that doing so in a traditional lecture recitation class-setting would not be appropriate. It is questionable indeed, whether it would be possible to do so at all without the availability of the new technological tools.

[2]There are no generally accepted terms for the various elements of musical syntax. The terms used here were selected for the purpose of elucidating the discussion for the lay reader.

Interaction: What does it mean in online distance education?

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Abstract: Evolution of communication technology has now enabled us to interact synchronously or asynchronously with almost equal ease. Many instructors feel that synchronous interaction is the epitome of learning while others feel that asynchronous interaction offers better learning opportunities. This paper uses the Delphi Technique in an attempt to arrive at an indication of whether instructors favor one interaction mode above the other. Eight experienced Distance Education instructors were interviewed for their opinions on the interaction types that are considered essential in online learning environments. The results show a predominant preference for the asynchronous mode for all types of interaction and a strong preference for teacher-learner interaction in the synchronous mode.

1. Introduction

Distance education is defined as education that "takes place when a teacher and student(s) are separated by physical distance, and technology is used to bridge the gap (Willis, 1993, p. 4). The separation of instructor and learner is sometimes viewed as a problematic issue in learning because it poses a barrier to interaction. Bates (1995, p. 13) asserts that high quality interaction with learning materials, between teachers and learners, as well as among learners, is essential for effective learning.

Within the constructivist framework and the learner-centered theory of learning, there is the notion of students creating their own meaning when they learn. If meaning is to be constructed, then the learner is central to the learning process in that personal experiences constitute what the learner comes to realize as "real" or viable. Interaction is crucial to student learning as the learner's experiences come from the interactions he has with the learning environment. The social negotiation of meaning is emphasized where interactive collaboration is seen as central to the learner testing the viability of his understandings in interactions with others (Duffy & Bednar, 1992). However, while everyone is in agreement as to the significance of interaction to student learning, the concept itself may have different interpretations for the online learning community.

2. The nature of interaction

Moore and Kearsley (1996) noted that the nature and extent of the interaction that would be deemed appropriate for any learning environment vary according to the teaching philosophy, the nature of the subject matter, the maturity of students, and the media used in the course. Given the large number of variables included, it is not surprising that it is difficult to agree on what is interaction. Moore and Kearsley got around the problem by categorizing interaction into three types: learner-content interaction, learner-instructor interaction and learner-learner interaction.

Learner-content interaction is the interaction the student has with the subject matter that is presented for study. Interaction between learners and content refers to learners constructing knowledge through a process of accommodating new understanding into their cognitive structures.

Learner-instructor interaction refers to the assistance, counsel, organization, stimulation and support that the instructor provides to the learner in helping the latter construct new understanding of the content. When the learner "applies" his new understanding through his interaction with the instructor, the instructor serves as a representation of the expert knowledge with which the learner can test the viability of his new understanding. Moore and Kearsley see this type of interaction occurring even when there is no face-to-face contact between the instructor and the learner, for example, in correspondence courses. When the correspondence instructor sits with a set of student papers, he enters into a silent dialogue with each individual learner-writer.

Learner-learner interaction refers to the interaction between one learner and other learners, whether alone or in group settings, with or without the real-time presence of an instructor. This is particularly important during application and evaluation of new knowledge as the learner's peers serve as a touchstone for his understanding.

Learner-self interaction refers to the learner's reflections on the content, learning process and his new understanding. Many educators would agree that an important goal of instruction is to develop skills of self-regulation in an effort to make the learner an independent and self-directed learner. This can be done by supporting the learner in reflecting on his learning and his learning strategies. In addition, we see reflection as conversing with oneself - a sort of "inner dialogue", where the learner takes on both the protagonist and the antagonist roles sequentially in an attempt to reframe his understanding. As such, learner-self interaction is very much a type of interaction and because of its importance to learning, it is included in this study.

3. Method

The study aims to clarify what types of interaction are considered essential for online distance education. To do this, this study attempted to capture the informed judgments of experts in the field of distance education.

Using the Delphi Technique, a total of three questions was sent, one at a time, to eight experts in distance education. These respondents were anonymous to each other. Their responses to each question were analyzed and used to generate the next question. With each question, more data were elicited to form a comprehensive picture of the issue. The Delphi Technique has the added advantage of being an established tool for generating a reliable ranking of options, in this case of the types of interaction deemed essential to online distance education.

4. Results and Discussion

The responses to the questions generated are presented in the tables below. These results are also discussed with regard to their implications for instruction in and design of online learning environments.

Table 1: Experts' responses as to types of interaction essential in online learning

Question 1: What type(s) of interaction is(are) necessary for learning in online distance education?

AM We feel that extensive interaction is needed. On the Internet, we have unique opportunities to incorporate all types of interaction. Our institution creates a virtual classroom that allows all participants to interact in real-time discussion. However, the most important thing about online interaction is that the technology used to enable such interaction is ***easy to use***. Some good tools are listserv, and bulletin boards.

CB Good quality learning requires discussion, debate, team exploration, role-playing, competition, and project work. This level of interaction can only be gotten from peers. Since the teacher cannot respond to all requests for assistance, students have to depend on their peers. Such a range of interaction would require private chat tools, email, fax, and asynchronous conferencing. Basing a portion of final grades on peer responsiveness and dialogue depth will enhance interaction.

CS For students to interact with each other, using a listserv is sufficient. However, such interaction must be mandatory or it would not happen.

DM The types of interaction necessary range from interacting among themselves as needed in student-based learning to just receiving information as in teacher dominated learning. At a minimum, a chat room is necessary and ideally, a video link at each site.

EC Students need to interact with each other. Chat lines, email, and moderated newsgroups will enable the needed interaction.

JH Both synchronous and asynchronous interactions are necessary. Asynchronous interactions are needed to set up conferences and sub-conferences to organize interactions between participants and for sharing and manipulation of educational material. Synchronous interaction is needed for private and public discussion. A chat room serves this purpose.

JS Real-time interaction in medium-sized groups is most important. That is the chief advantage of classroom instruction. Video-conferencing captures this edge better than email, computer conferencing, or any type of one-to-one communication.

The responses in Table 1 show that a range of interaction types is deemed necessary although learner-learner interaction seems to be more prominent. An interesting finding is the prominence of tools in the minds of the respondents. Interaction seems to be inexorably linked to technology tools and their uses. This is indeed one of the distinguishing features of distance education. Technology appears to be the factor that both enables and constrains the learning we want to instill in these online environments. As educators, we should, indeed must, begin our inquiry from the kind of learning and by extension, the types of interaction that we want. However, the second step is to refer to the technologies that exist to see if they support the interaction and learning we want. It is possible that not all the types of interaction we want can be supported by the technologies available in our instructional environments. Instructors are then faced with the choice of whether to accept running a program with limited interaction capabilities or eschewing distance education until the technology supports the range of interaction we want. It is not the purpose of this paper to explore the match of technology and interaction. However, it would be useful to rank the types of interaction mentioned in this study according to their perceived importance to enable educators in this dilemma to make a more informed decision.

To enable ranking of the types of interactions, we first grouped them into the six categories listed below:

Synchronous Learner-material interaction - refers to student learning from instructional events such as live broadcast or doing a scientific experiment. The learners are not interacting with other people even though the event he is watching may be happening in real-time.

Synchronous Learner-self (reflective) interaction - refers to reflection. Editing stuff one has just written is one example. Only one party is involved here - interacting with one's own thoughts. Sometimes this takes the form of a debate with oneself, taking on both the roles of protagonist and antagonist.

Synchronous learner-learner(s) interaction - refers to interaction between learners that occurs in real-time such as in face-to-face communication, IRC, or computer video-conferencing. This is particularly valued for group collaboration.

Synchronous teacher-learner interaction - refers to interaction between instructor and learners. Teacher-centered instruction over the web will be one extreme of this category, while two-way question-and-answer sessions will be the other extreme. In most instances, interaction between learners is not included.

Asynchronous Learner-material interaction - refers to students learning from instructional materials such as web-pages and books. Again, the learners do not interact with other people although materials may be animated.

Asynchronous Learner-self (reflective) interaction - Reflecting on one's work may not occur instantly. Some people will deliberately put aside stuff they have written and go back to it some weeks or months later, with a fresh perspective developed in the intervening period.
Asynchronous learner-learners interaction - refers to students interacting with each other but not in real-time. Email and newsgroups are the most common examples.
Asynchronous teacher-learner interaction - refers to interaction that is broken by a time lag. There is no immediate conversation-style interaction. An example would be when the teacher emails the student or puts out an announcement on the listserv.

Having established our categories, we posed the second question.

Question 2: How would you rank the following types of interaction?
(A ranking of 10 denotes "most important" while a ranking of 3 denotes "least important". Each ranking can be given only once, for example, there cannot be more than one category ranked 10 by the same respondent.)

Table 2: Types of interaction ranked according to importance in online learning

Ranking	Type of interaction
8.750	Asynchronous learner-learners interaction
8.500	Asynchronous teacher-learner interaction
7.875	Asynchronous learner-material interaction
6.125	Synchronous teacher-learner interaction
5.625	Asynchronous learner-self (reflective) interaction
5.250	Synchronous learner-learners interaction
5.000	Synchronous learner-self (reflective) interaction
4.875	Synchronous learner-material interaction

Asynchronous learner-learner interaction was rated the most important type of interaction for online distance education, as seen in Table 3. The three top-ranked categories are asynchronous interactions and the three lowest ranked categories were synchronous interaction. This indicates that real-time interaction is not highly valued by distance educators. Two other features stand out. Both types of teacher-learner interactions are in the top half of the table, ranking second and fourth respectively out of eight. This indicates the respondents think the teacher has a fairly important role in online learning environments. However, as noted before, the respondents obviously believe in learner-centered learning since they rated learner-learners interaction as most important. Both types of learner-self interaction are in the bottom half of the table, ranking fifth and seventh respectively out of eight. Reflection has relatively low priority in the scheme of things in this learning environment.

The findings above reflect an artificial averaging of disparate ratings by individuals. It is not a true consensus. While we think it is unlikely to achieve a true consensus in this matter, we feel that it is beneficial to narrow the divergence between the individual respondents and elicit information about why they ranked the categories in the ways they did. To achieve this aim, we posed the third question.

Question 3: Considering the averaged rankings (in Table 1), **indicate why you would, or would not, agree with the ranking given for each category of interaction** (You may revise your original rankings if you wish).

This question gives the respondents an opportunity to reflect on and justify their original positions. To facilitate this, Table 1 was made available to them and they were asked to revise, if necessary, their original rankings. However, only three of the eight respondents responded to this question. Table 3 shows the revised rankings of the categories based on the ranking of these three respondents.

Table 3: Types of interaction according to revised rankings of importance in online learning

Original Ranking	Revised Ranking	Type of interaction
8.750	9.333	Asynchronous learner-learners interaction
8.500	8.333	Asynchronous teacher-learner interaction
7.875	7.333	Asynchronous learner-material interaction
6.125	7.333	Synchronous teacher-learner interaction
5.625	6.000	Asynchronous learner-self (reflective) interaction
5.250	5.667	Synchronous learner-learners interaction
5.000	4.000	Synchronous learner-self (reflective) interaction
4.875	4.000	Synchronous learner-material interaction

The revised rankings do not differ from the original rankings. Due to the relatively few responses, some categories were ranked as equally important. Asynchronous learner-material interaction is rated 7.333, as is Synchronous teacher-learner interaction. Synchronous learner-self interaction is rated 4.000, the same as synchronous learner-material interaction. The experts' reasons for their ranking in Table 3 are discussed below.

Asynchronous learner-learners interaction

From their ranking, it is evident that the experts regard learners as the most important aspect of learning. Thus the learner is central to any learning that may take place. Distance learners are generally mature learners with commitment to careers and families and busy schedules. Hence, asynchronous interaction is often regarded by instructors as the most productive and appropriate form of communication in online courses.

Asynchronous teacher-learner interaction

While learners are central to the learning process, guidance from teachers is still necessary. This partnership in learning explains why this interaction is ranked second. In fact, the experts are mindful of *not* using the teacher-centered approach and they see the asynchronous mode as the best way to ensure that teachers become less domineering and improve thoughtfulness in their responses to the learners.

Asynchronous learner-material interaction

Students eventually will need some content material to dwell on. The asynchronous mode allows them to read and react in a manner that is independent of time and place in this mode of interaction.

Given these perceived advantages, asynchronous interaction is deemed to be more prominent to the synchronous mode for *learning*. This is especially so since learners can make use of asynchronous interaction more conveniently, for instance, at home or in the workplace.

Synchronous teacher-learner interaction

Synchronous teacher-learner interaction is deemed slightly more important than asynchronous reflections. This is because reflection is deemed to have occurred as part of the first three categories and therefore need not be emphasized. On the other hand, real-time contact with a teacher might keep the learner motivated and involved.

Asynchronous learner-self (reflective) interaction

Reflection is critical to learning. In fact, this is ultimately where learning occurs as learners retreat from interaction to focus on individual and internal reflections. In fact, some experts consider this to be slightly more important than real-time teacher-learner interaction. However, most instructors regard this as occurring naturally as part of other interaction and therefore did not rank it highly.

Synchronous learner-learners interaction

Surprisingly, synchronous interactions are not highly valued, even interaction between learners. An expert felt it may be needed for some learning activities such as reflection on expert panels but is not really a necessity.

Synchronous learner-self (reflective) interaction

Revising one's thinking is regarded as one type of interaction wherein good learning occurs. The learner plays around with ideas and contemplates on his actions and thinking. However, as with learner-self reflection, the experts see this as occurring naturally and therefore did not see the need to rate it highly also.

Synchronous learner-material interaction

The experts see this type of interaction as more important in certain subject areas like physics and chemistry, and to a lesser extent in subjects like music, art, sports and so forth.

Overall, this is a composite image, that is, an average ranking of often sharply differing views. One expert refused to accept the overall ranking because he believes that real-time interaction is the key to effective learning. His institution has been committed to using the synchronous interaction mode since 1982. He believes that the other experts in the group rated the synchronous mode low because they do not have a way to do it easily and well. However, he also feels that the asynchronous mode is also important and a blend of the two is needed for effective online learning.

5. Conclusion

The reasons put forth by the experts show that the rankings were not given randomly. They had put much thought into the exercise, and much of that is supported by their experience in distance education instruction.. It is unlikely that a consensus can be reached but it would appear that the majority supports the use of the asynchronous mode. Advocates of this mode feel that the use of this mode is more convenient for distance learners and meets learners' interaction needs. On the other hand, the synchronous mode has an unassailable immediacy and this condenses communication in a way that cannot be duplicated fully online. The classroom is the foremost example of the synchronous mode and its continued prevalence even with a generally inferior cost structure shows that it is still the favored way to learn. That it has been often misused by a dominance of teacher-centered instruction does not detract from its inherent flexibility and compactness.

When it comes to the different types of interactions, there is a clear preference for learner-learner interaction followed by teacher-learner interaction. The surprise is the low ranking for reflection but this does not mean it is regarded as unimportant. Clearly, distance educators regard reflection as part and parcel of the other highly ranked interaction types. However, this situation should not be taken for granted and educators need to focus on learning strategies that would foster critical reflection to improve higher level thinking among learners.

Perhaps the question of what types of interaction and mode are needed in distance education should be answered by the learners themselves. While experts have a good perspective on these issues because of their close involvement with the field, it is the learner who knows best what works for him or her. Also we need to bear in mind that what is best for a learner can be the sum of many factors - accessibility and costs among them. It does the learner no good if we know what the best mode and types of interaction are for the learner but the learner cannot afford them.

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Empirical Evaluation of Adaptive Annotation in Hypermedia

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Abstract: Empirical evaluations of learning with hypertext have shown contradictory results. Adaptive hypertext was introduced to solve some problems when learning with hypertext. In the following paper two empirical studies comparing different forms of adaptive hypertext are described and the results are discussed. In the first experiment four treatments where realized by a combination of adaptive annotation and incremental linking of hypertext. Results show significant better improvements in knowledge tests for subjects learning with adaptive annotation *and* incremental linking. In a second study different forms of adaptive annotation where integrated in the WWW-based learning environment AST. Results showed a significant interaction between previous knowledge of students and the adaptive annotation of the learning materials. Students who performed well in an introductory knowledge test seemed to work more intensively and successful with a more supportive form of adaptive annotation, while students with less previous knowledge seemed to need more guidance and profit from a more restrictive form of adaptation.

1 Introduction

Empirical studies have shown contradictory results about the efficiency and effectiveness of learning with hypertext as compared to linear textbooks. The benefit of learning with hypertext seems to be dependent on various factors like previous proficieny in the domain, the complexity of the domain or the learners motivation. Arguments for better learning with hypertext are the cognitive plausability and assumptions about the acquisition of meta-cognitive knowledge. However there are some problems with hypertext often mentioned in the literature. Students loose orientation or are overwhelmed by the mass of information presented to them [Conklin 1987; Conklin & Begeman 1988].

Adaptive hypertext was introduced as one possible solution to overcome these problems of learning with classical hypertext,. Adaptive methods in hypertext try to make an adequate presentation and selection of content for individual learners. However, beside the argumentation that adapted hypertext must be a better learning medium because information and presentation is tailored to the student, empirical studies on the effects of learning with adaptive hypertext are rarely found. Furthermore differential effects between various adaptive methods are not evaluated in experimental studies until now. The need for differentiating between adaptive methods becomes obvious when considering the consequences of these adaptive methods for the learner. For example, the method of incremental linking[1] hides hyperlinks that in some sense are not adequate for the learner. This restricts the learner's navigational freedom and can have important drawbacks on learning. On the other hand adaptive annotation like introduced in ELM-ART [Weber & Specht 1997] gives adaptive navigation support to the learner without any restrictions on the content or navigational level.

In this paper two empirical studies are presented which compare learning with hypertexts that were enhanced with adaptive annotation and incremental linking. The first study compares learning with adaptive hypertexts and a static hypertext in an experimental setting. The second study compares three forms of adaptive annotation in an WWW based learning environment on statistics: AST [Specht, Weber, Heitmeyer, & Schöch 1997].

1.1 Adaptive annotation as a learning aid

In his review of adaptive methods in hypermédia Brusilovksy [1996] distinguishes two major groups of adaptive methods: methods of adaptive presentation and methods of adaptive navigation support.

In this paper the focus will be on methods of adaptive navigation support, especially adaptive annotation and incremental linking. Methods of adaptive navigation support differ in their impact on learners freedom to navigate

[1] The main idea of incremental linking is to incrementally introduce hyperlinks in a document depending on the knowledge a student has already acquired. Implicitly this method restricts the navigational freedom of a learner through hiding hyperlinks to complex contents.

in a hyperspace. Furthermore, combinations of adaptive methods can restrict the users of a system in varying ways. The amount of learner control seems to be a central variable when integrating adaptive methods in educational settings. In the literature there have been mentioned several arguments for and against learner control:

Acquisition of metacognitive skills: Devoper und Quintin [1992] stress the importance of learner control for the acquisition of metacognitive skills. They argue that the amount of learner control should be dependent from the age, the domain knowledge or the complexity of learning materials. Greer and McCalla [1993] criticize a surplus of confidence in the abilites of learners for self controlled learning.

Acceptance: Restricting learners in learning environments can be frustrating for them and therefore be rejected by the learners. The amount of control of a learner and the acceptance of a "teaching system" is dependent on the preskills and the knowledge state of a learner. Novices often want to have some guidance, while experts are just annoyed by restrictions.

Additional mental load through learner control: Beside the freedom for learners learner control requires additional efforts. Decisions about where to navigate and what is best to be learned next have to be made by the learner. This adds meta-tasks of monitoring and self-evaluation to the the learners tasks of learning the domain. Hammond and Allison [1992] showed that the improvements of learning through learner control depend on the previous experience of a learner the subject matter. Secondary and metaanalysis of learner control show disappointing results: although motivation and engagement of learners seem to increase through learner control, results in performance tests are mostly better in adaptive and systemcontrolled learning environments.

1.2 An experiment on adaptive annotation and incremental linking in hypertext

1.2.1 Method

In the following study learning with three different forms of adaptive hypertext and learning with a static hypertext were compared. The four experimental treatments where realized by a combination of the two adaptive methods of adaptive annotation and incremental linking.

Adaptive annotation of hyperlinks supplies the user with additional information about the content behind a hyperlink. The annotation could be adapted to the individual user by taking into account different aspects of the learner and relations of the contents to be learned. In the following study information about the learner's knowledge state and a didactic model of the domain concepts were used to adapt the presentation of coloured balls in front of each hyperlink. The knowledge state of a learner was represented in the learner model by simply storing if a concept was seen by the learner. The didactical model of the domain specified prerequisites (concepts) for each domain concept. Concepts which had been visited by the learner were annotated with a hook, concepts which the learner was not ready to learn (because of lacking prerequisites) were presented with a red ball, and recommended concepts were annotated with a green ball.

Table1: Experimental treatments from combining adaptivce annotation and incremental linking

	Adaptive annotation	**No annotation**
Incremental linking	*Treatment: IncAnno (Fig.1)* • Restricted navigational freedom • Additional information through adaptive annotation • Transparency for the learner (All hyperlinks were visible from the beginning)	*Treatment: Inc (Fig.2)* • Restricted navigational freedom • Surprising introduction of hyperlinks • No transparency
Static linking	*Treatment: Anno (Fig.3)* • No restriction for navigation • Additional information through adaptive annotation	*Treatment: Text (Fig.4)* No adaptation

Incremental linking can be considered as a special way of adaptive hiding. In contrast to adaptive annotation, adaptive hiding restricts the learners freedom to navigate in a hyperspace. While adaptive annotation just gives additional information adaptive hiding simply hides some information that is not adequate for the learner in the current situation. Based on the didactic model and the learner model concepts which the learner was not ready to read are hidden. In the following experiment the information that was not adequate for the learner was not directly hidden from the screen but there was no way to get to this information. Concepts the learner was not ready to visit (cause of missing prerequisites) where not presented as a link in the hypertext.

From a combination of these two adaptive methods four different experimental treatments were realized, which are shown in [table 1]. In the experimental treatment *IncAnno* both adaptive methods were applied to present the hypertext. Consequently learners were restricted in their freedom to navigate the hypertext because of incremental linking. Learners had full transparency of the whole hyperspace because they could see where they need to go and where they will be allowed to hyperjump later on. [Figure 1] shows the hypertext in the treatment *IncAnno.* In the treatment *Inc* learners could not see where they will be allowed to jump later on, only concepts that were appropriate to their current knowledge state were presented as a hyperlink [Figure 2]. In the adaptive condition *Anno* all hyperlinks were presented from the beginning, learners were not restricted in their navigational freedom and had additional information about the adequacy of hyperlinks [Figure 3]. In the last experimental condition a static hypertext with no adaptation was presented to the learners [Figure 4].

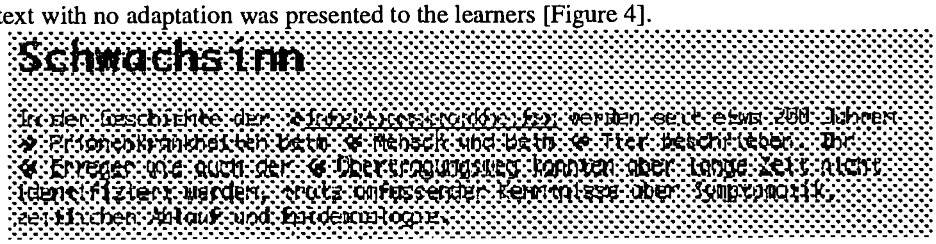

Figure 1: The main page of the hypertext in the experimental treatment *IncAnno*

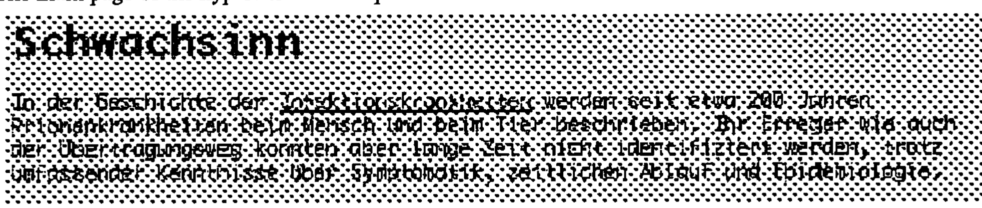

Figure 2: The main page of the hypertext in the experimental treatment *Inc*.

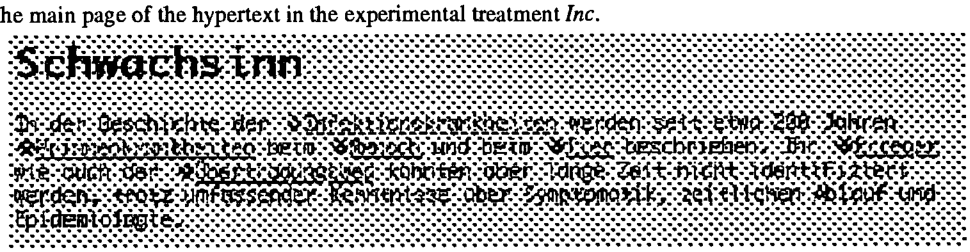

Figure 3: The main page of the hypertext in the experimental treatment *Anno*.

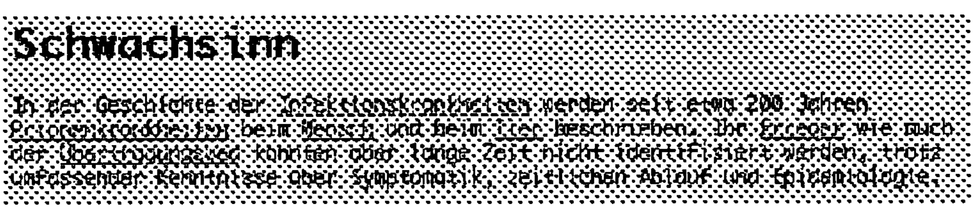

Figure 4: The main page of the hypertext in the experimental treatment *Text*.

The underlying hyperspace consisted of 16 concepts about prionic diseases. 12 concepts could be reached directly from the main page, while 4 only could be visited via another concept. The only static link in all treatments was the possibility to jump back to the main page from each concept.

1.2.2 The experiment

All subjects had to answer a demographic questionaire and a knowledge test about prionic diseases. The knowledge test included 12 questions about central concepts of the curriculum with variing difficulty. Next a short introduction to using hypertext and information about the specific experimental treatment was given. When the subjects had visited all hypernodes the system automatically presented the concluding questionnaire. This included the knowledge test from the beginning and additional questions about the usability and helpfulness of the adaptive methods. As the main dependent variables the time to read all hypernodes and the number of correctly answered questions was measured.

1.2.3 Results

85 subjects completed the experiment. In the demographic questionaire there were no differences in the experience with computers and the WWW experience between the four groups. In all experimental conditions there was a significant improvement of correctly answered questions from the introductory to the knowledge test at the end (F(1,81)=308 ; p•0.01). In the introductory knowledge test the treatment group *Text* had the best results, in the knowledge test at the end the group *IncAnno* showed the best results. For browsing the hypertext the group *IncAnno* needed less time than all other groups, subjects in the condition *Text* needed more time than all others. The means of the two knowledge tests and the time to browse the hypertext are shown in [table 2].

Table 2: The means of the four groups for the knowledge tests and the time to browse the hypertext.

	Treatment			
	Anno	Inc	IncAnno	Text
Questionaire before Learning	4.67	5.22	4.88	5.53
Questionaire after Learning	10.45	10.0	11.33	9.94
Mean time of browsing (in sec.)	692	765	618	893

To be sure that the experimental groups didn't differ in their previous knowledge about the domain a variance analysis was computed on the data of the introductory knowledge test, which showed no sigificant differences (F(3,81)=0.37 ; p•0.05).

A variance analysis comparing the treatments for the second knowledge test showed a hardly not significant main effect for the adaptive annotation of hyperlinks (F(1,81)=3.91 ; p=0.052) and no significant effect for the incremental linking (F(1,81)=2.410 ; p•0.05). Significant effects for both adaptive annotation (F(1,81)=13.17 ; p•0.05) and incremental linking (F(1,81)=4.49 ; p•0.05) could be shown for the time to browse the hypertext.

Comparing only the two experimental groups which had both adaptive methods (*IncAnno*) and which had no adaptivity (*Text*) showed a significant effect on the correctly answered questions (t(39)=2.38; p•0.05) and the time needed (t(39)=-4.23; p•0.05) to browse the whole hyperspace.

1.2.4 Discussion

The results show better improvements in a knowledge test when learning with adaptive hypertext than learning with static hypertext. Learners which were restricted through incremental linking needed less time to read a hypertext and did not report problems with restrictions. By a combination of adaptive annotation and incremental linking learners got information about the whole hyperspace and the concepts that can be learned when progressing through the curriculum. This kind of transparency led to significantly better performance in a concluding knowledge test than learners in the static hypertext condition.

From our point of view the differences between the treatment Anno and IncAnno are interesting. Allthough there was the same navigational support available for learners in the two treatments, there were no restrictions to navigational freedom in the treatment Anno. Learners were not prevented from jumping to complex concepts before reading about the prerequisite concepts. On the one hand one may argue that this would evoke feelings of loss of control (which were not reported in a questionaire). On the other hand the restrictions lead to a more effective and efficient learning of the curriculum in the experiment. Of course this difference could be dependent on the complexitiy of the curriculum tought. We see two main conclusions from the results of this study:

1. The effects of adaptive methods in learning environments should be investigated in isolation and in view of synergetic effects between the methods.
2. The main criticism on integrating adaptive methods in educational hypertext are dependent on various learner features, the setting and the curriculum. Following a more instructional approach could be appropriate for learning small curriculums in a effective and efficient way. A more constructivist approach could be appropriate for complex curriculi and domain experienced learners.

1.3 A field study on adaptive annotation in a learning environment

In the second study different forms of adaptive annotation were integrated into the WWW Courseware "Adaptive Statistics Tutor" (AST). AST is an adaptive learning environment for learning introductory statistics on the WWW. Learners can read texts, look at examples, play around with concepts by manipulating interactive java applets or html-forms, or work on tasks and tests. Students can start from any point in the curriculum. When a learner selects a new section the system checks if all prerequisites for that section are already covered by the student. If a student lacks some knowledge for working on that section, the system presents some tests for the lacking knowledge. Depending on the result of the tests the system infers that the learner already knows about the prerequisites or recommends some hyperlinks.

1.3.1 Method

Similar to the experimental conditions in the first study three adaptive treatments were realized in the AST learning environment. The three treatments resulted from a combination of adaptive annotation and adaptive hiding.

1. ANNOTATION Annotation of Hyperlinks: With each hyperlink a colored ball was presented, which gave some information about the concept behind the hyperlink. The color of the balls was adapted to the knowledge state of a student. Green balls classified the corresponding link as a recommendation, orange balls were presented when all prerequisites to this concept were learned and red balls meant that the hyperlink leeds to a hypernode with prerequisites that were not yet learned by the student.

2. HIDE Annotation of Hyperlinks and hiding of "red" hyperlinks: In this treatment adaptive annotation of hyperlinks was realized like in treatment 1. except that hyperlinks which lead to "not ready to be learned" hyperlinks were hidden. When a student had mastered all prerequisites of a concept than the hyperlink to this concept was made visible and presented with a orange ball. The annotation of hyperlinks with green balls was computed by the system taking into account the knowledge state of a student, the learning material that were already seen by the student and a didactic model for sequencing concepts and learning materials.

3. STATIC Annotation of learned and not learned concepts: In the third treatment all annotations were done with white balls and hooks, so learners only got information about what concepts they already had learned (hook) and what concepts they needed to work on (white ball).

1.3.2 A field study

In the field study the courseware was accessible to students of the University of Trier. Before working with AST students had to fill out a demographic questionnaire and work on a knowledge test about the statistics curriculum. The curriculum contained 23 concepts in 8 sections about descriptive statistics. With each section and concept 5 to 15 tests were stored. When learners mastered a certain amount of tests correctly the system assumed that the students had learned that concept. The students were allowed to work with AST as long and as much as they wanted and the system was able to keep the user model over multiple sessions.

1.3.3 Results

In a period of three months 180 subjects worked with AST. In the following study only 67 subjects are taken into account because they did more than 20 requests to the system. The number of requests and the requested type of learning material was dependent on the adaptive treatment.

Table 3 : The mean number of requests splitted by type of learning material and the experimental treatment

	Introduction	Text	Test	Summary
ANNOTATE	1.04	1.0	3.70	.64

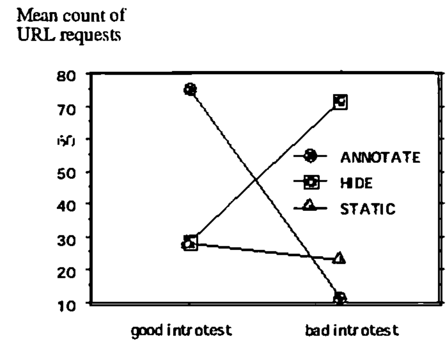

Figure 5: The interaction effect between the results in a preliminary knowledge test and the adaptive treatment

HIDE	1.13	.59	5.39	.68
STATIC	1.01	.62	2.17	.40

Subjects in the *ANNOTATION* group requested significantly more text material (F(1,2)=6.11; p•0.05) than the other groups, while the subjects in the *HIDE* condition requested more tests (F(1,2)=5.77;p•0.05) than the other groups. The mean number of requests for the different learning materials are shown in [table 3]:

The number of requests was not confounded with the preferences for different materials specified in the introductory questionaire. In the knowledge test before learning with AST there were no differences between the experimental groups. After introducing a post-hoc split between students with good results and with bad results in the introductory knowledge test an interaction effect on the number of requests could be clarified. Students with good results in a preliminary knowledge test worked more intensive with the system when they were in the *ANNOTATE* group. Vice versa, stu-dents with bad results in the introductory test worked better (more requests) in the *HIDE* group. The interaction effect between the results in a preliminary know–ledge test and the adaptive treatment is shown in [figure 5].

1.3.4 Discussion

The different learning materials requested by subjects of the different treatments could be evoked by the nature of the adaptive treatments. This becomes obvious when looking at the HIDE treatment: Students could only get to more complex contents when working on the tests of the visible concepts. Similar to the first experiment the restriction of learners to certain subparts of the hyperspace can have different effects which are reflected in the interaction effect with the domain knowledge of learners. Learners who have good working knowledge in the domain seem to prefer more navigational freedom like in the ANNOTATE treatment. Learners who do not have much previous knowledge of the domain seem to prefer more directive guidance and work better with restrictions of navigational freedom.

2 General discussion and further work

Two experiments evalutating the effects of adaptive methods in two different settings were reported. In the first study a combination of adaptive annotation and incremental linking showed the best improvements of the knowledge acquisition process. In the field study reported second the shortcomings of empirical investigations in complex learning environments prohibited as clear results as in the experimental study. Most of the students did not complete a concluding knowledge test. This made it impossible to compare the knowledge improvements in the different experimental treatments. Nevertheless, results showed that the type of adaptive annotation can have important impacts on the learning process and the style of learning. Different forms of annotation can have consequences on motivation and the acceptance of a learning environment. This is concistent with earlier results of Weber and Specht [1997]. In the future interactional and synergetic effects of different adaptive methods, learner features and characteristics of the educational setting have to be investigated in more detail.

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Teaching Statistics to Engineers – Towards Developing a Multimedia Teaching Environment

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Abstract: This paper discusses the problems of teaching statistics to engineering students and how multimedia and the World Wide Web alleviate and enhance many of the traditional limitations of teaching a "theoretical" subject to non-specialists. The paper presents examples of several multimedia and Internet projects and developments which help make statistics more accessible by reducing the theoretical demands of the subject and more effectively illustrating its practical applications.

Introduction

Multimedia systems offer great potential in engineering education in their facility to present concepts and applications in a highly interactive and visual environment. Traditional educational techniques are often limited in providing effective communication of engineering ideas to both undergraduate and practicing engineers.

Engineering is demanding both to learn and teach. It requires a broad base of background information, conceptual understanding and knowledge of practical applications. Traditional teaching methods often fall short in providing students with the all round appreciation necessary for an efficient and thorough understanding.

The teaching of statistics to engineering students is difficult for several reasons [Bisgaard 1991]. Many courses do not provide the time necessary to assimilate the concepts. The terminology philosophy and mathematics of the subject is therefore daunting to many engineering students. Statistics however is particularly important as applications abound in many engineering fields. More emphasis needs to be placed on a deep understanding and application of subjects such as statistics rather that just a theoretical underpinning. Traditionally this has been one of the major hurdles in teaching statistics to non-specialists. It in not just sufficient to say that these students do not have the proper background. The most significant shortcoming is if they do not appreciate the relevance and application of the subject to their particular field of interest.

At Nanyang technological University (NTU) in Singapore statistics is taught as part of several courses including:

- Quality Assurance and Quality Engineering
- Systems Modelling and Simulation and
- Manufacturing Management Decision Support
- Engineering Research Methodology

Multimedia offers a facility to enhance the learning experience of engineering students by providing interactive and visual support to teaching and an exciting way of linking the theory to the practice of the subject. [Norman 1997], [Lane and Atlas 1997]. This approach is particularly useful when teaching large class sizes, which are often a feature of university teaching.

Often similar topics in different disciplines have similar theoretical content in a different context. Multimedia offers an easy way to adapt the material by creating different examples depending on a particular subject and to develop a more relevant approach for courses that may emphasise either the technical or management aspects of the subject.

Naturally many resources exist on the World Wide Web (WWW). There are excellent examples of on-line textbooks (for example [Lane 1997]), tutorial packages and Java applets. A group of seven UK Universities, for example, established a consortium called STEPS (Statistical Education through Problem Solving) to provide tutorial modules for various statistical techniques which can be downloaded from the Internet [STEPS 1997]. These may be used in a tutorial environment or by the individual user.

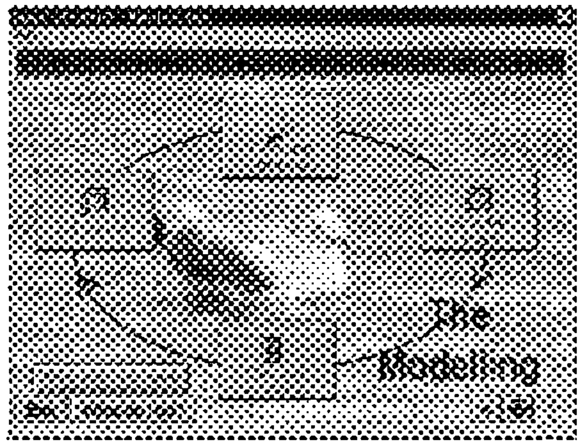

Figure 1: Example from STEPS Tutorial

One obvious problem of the World Wide Web is quality control. Developing a home page for the subject provides one solution to this problem. Home pages developed for statistics based subjects at NTU (as in other Universities) provide the student with on line access to course details, time tables, lecture notes and links to relevant and critically acclaimed sites. A second limitation of the World Wide Web is that it is not always possible to use these resources in a classroom environment if connection to the Internet is not readily available. Even where connection is available, access to the Web is often painfully slow which is not tenable in a teaching environment. However these limitations will almost certainly be overcome in the near future.

The next section examines some specific examples of multimedia developed for teaching statistically based engineering subjects at NTU.

Examples and Illustrations

The Central Limit Theorem is one of the fundamental theorems in statistics. The theorem is relatively easy to prove mathematically and it has far reaching in effects. However it is not always easy to put the concepts across to engineering students. The example shown in figure 2, developed in *TOOLBOOK* (Asymetrix) , a multimedia authoring software, shows an animated illustration of using the central limit theorem to simulate the average waiting time in a bank. This particular example is used for business students. The same text is used with a different animation (average waiting time for a machining operation) when teaching engineering students.

Statistical Analysis software such as *STATISTICA* (Statsoft) provide useful interactive capabilities, colorful graphics, a downloadable demo version which can be used by students to solve simple problems and an excellent on-line manual with full hypertext and extensive references. Whilst *STATISTICA* and similar statistical software packages would not usually be termed as multimedia, they do provide facilities such as excellent on-line graphics for data visualization, multimedia tutorials and a fully linked hypermedia on-line help facility. A particular useful feature (figure 3) is interactive graphical exploratory data analysis, (an interactive method known as brushing which allows the on-screen selection of specific data points or subsets of data to identify their characteristics, or to examine their effects on relations between relevant variables. These sort of facilities offer an exciting challenge to the engineering student in developing an all-important visual approach to a subject, which is often considered theoretical and irrelevant, by engineering students.

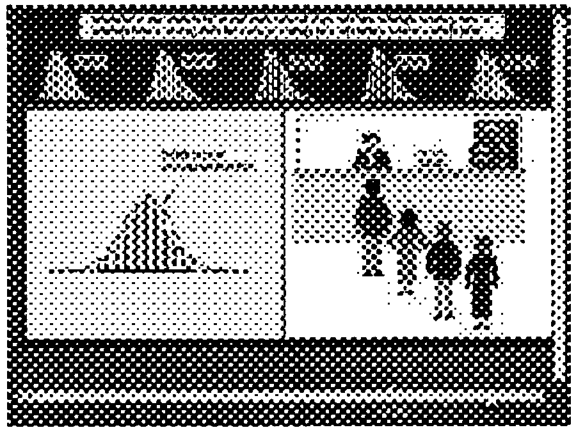

Figure 2: Illustration of the Central Limit Theorem using TOOLBOOK™

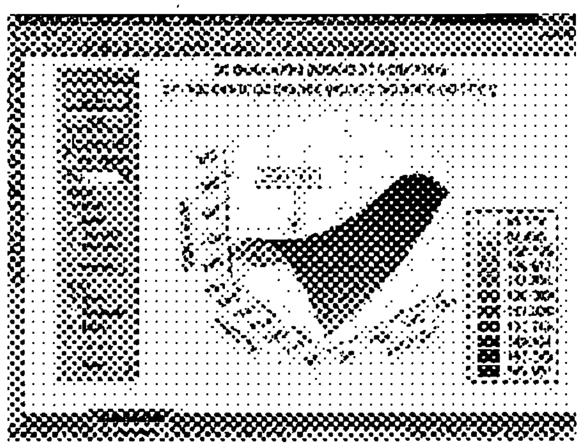

Figure 3: Interactive graphical exploratory data analysis using STATISTICA

Figure 4 shows a simulation of the Funnel Experiment [Deming 1986] developed in *TOOLBOOK* . The experiment illustrates that if a process is in statistical control then tampering with it will increase the variation of the process. This is particularly simulation allows interaction in a classroom environment. The student volunteer is asked to run the multimedia presentation of the funnel experiment. The student is cajoled and persuaded by the lecturer and other students (as he would be in industry) to attempt to improve the performance of the system (without the opportunity to redesign the system). This realistic scenario quickly results in an increase in the variation of the system.

Teaching decision trees as part of decision analysis illustrate a very simple innovation which can be performed easily in software such as *POWERPOINT* (Microsoft) – The sequence of building the tree and solving the necessary equations can be developed by displaying the diagram (and or equations) in a natural sequential order (figure 5). Recent versions of *POWERPOINT* allow diagrams and text to be built incrementally on the screen. This allows the students to visualise the sequence of the problem solving steps as well as providing opportunities for classroom interaction as the problem is solved. *POWERPOINT* is particularly easy to learn and it is fully integrated with Microsoft's wordprocessor and spreadsheet. The latest version of the software allows multimedia components to be seamlessly integrated with presentations.

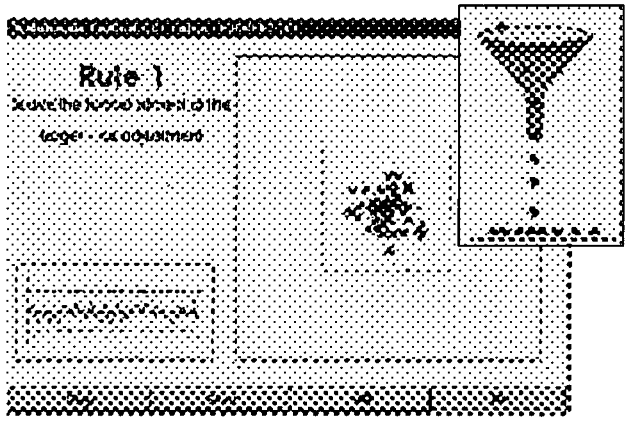

Figure 4: The Funnel Experiment in TOOLBOOK

One of the most significant factors constraining the development of multimedia systems for teaching in the lecture theatre is the investment in development time. *POWERPOINT* offers the facility to develop a complete system in a relatively short time. Incremental development using the integration facilities provided by *POWERPOINT* allows a sophisticated multimedia presentation to be realised. This approach is particularly useful in situations where the lecturer wishes to adapt the system during the teaching cycle to incorporate particular subject material relevant to his student requirements. A complete *POWERPOINT* presentation can then form the blue print for future development on a more sophisticated multimedia platform [Spedding and deSouza 1995].

Figure 5: Decision Analysis using POWERPOINT

Discrete event simulation techniques demonstrate a host of statistical techniques and can be applied directly to the manufacturing environment or service industry. Usually discrete event simulation software have a powerful animation capability and so can be excellent tools for providing the creative link between statistical theory and the engineering application (Figure 6). Recently for example, the Promodel Corporation gave their discrete event simulation software (PROMODEL) to 15 year old high school children as a mechanism for learning statistics. As part of the project these students took the software into local industry to solve real problems. The multimedia capabilities of such systems are becoming more comprehensive. This is not only important in teaching the concepts of simulation but also very useful in the industrial context were engineers can witness a realistic animation of their manufacturing system and have a multimedia interpretation of the statistical output [Spedding, deSouza and Chan 1995].

Figure 6: Discrete Event Simulation using PROMODEL™

Figure 7 shows an interactive assessment of a student laboratory using TOOLBOOK™. This work is part of an ongoing project for developing a virtual laboratory environment. Students answer questions based on the statistical analysis of their laboratory results. The questions are designed to be visual and entertaining and test the student's knowledge and understanding of the subject. If required an interactive help facility will lead the students to the correct answer but marks will be deducted depending on the extent of its use. Marks are stored on the database system for easy access by lecturers. A similar system in the University of Western Australia is used as part of a continuous assessment programme [Scott, Devenish, Entwistle, and Stone 1995]. Students are required to use the assessment system to answer progressively harder questions throughout the semester. One particular feature is an automatic tracking system which allows the lecturer to keep a watch on student performance thus making it possible to identify weak students at an early stage so that the can be offered the necessary help and encouragement.

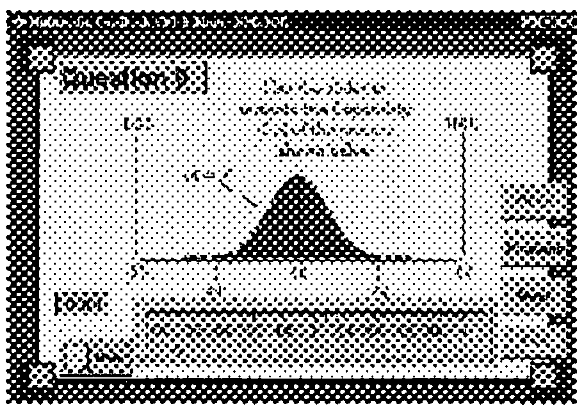

Figure 7: Interactive Student Assessment using TOOLBOOK

Conclusions

This paper has illustrated several multimedia applications specifically developed to teach statistic to engineering students. Multimedia facilitates the transfer of knowledge which might not be inherently obvious to a student. It also provides a link between real applications and theory. Engineering is a multidisciplinary subject and so engineering students are forced to learn and develop an appreciation of many "non-engineering" subjects. Multimedia provides the mechanism and flexibility to communicate the essence and relevance of non-engineering subjects in a dynamic and interesting fashion.

Davies [Davies 1995] succinctly sums up the importance of using educational multimedia for teaching statistics:

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Assessment in Open and Distance Learning.
Teeode project

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http://www.doe.d5.ub.es/te/teeode/**

Introduction

Distance learning courses are an important way of meeting society's needs for more flexible ways of educating and training a modern work force. Supporting students at a distance raises new and interesting questions. Of particular interest to the TEEODE project were the methods of assessment and evaluation employed by the various suppliers of distance learning courses. The aim of the TEEODE project was to develop a representative survey of the models of assessment and evaluation used by institutions supporting distance learning. This survey endeavoured to cover all fifteen member states of the European Union.

For each of the member countries of the EU we attempted to survey up to 10 institutions on their formal procedures or framework for assessment and evaluation; and up to 10 tutors on individual courses within those institutions on how they conduct their assessment and evaluation.

In this part of the TEEODE project we have focused upon issues of Course Development and Assessment, and in particular, on how we achieve effective learning outcomes and how that learning is communicated to the learner. Other parts of the project have looked more closely at the institutional issues. The emphasis here is on the tutors' perceptions, teaching assessment and support-related issues.

If distance learning is to be seen as legitimate it must meet student, tutor and, in many cases employers', needs. In assessing their students, tutors should have a clear idea of their learning goals and they should also be able to match those goals to the assessment and evaluation instruments they employ.

Marton and Såljø (1976) showed that students that tackled their studies in a way which was called a 'deep approach' gained a through understanding of the material studied. On the other hand, students whose approach was labelled a 'surface approach', failed to gain a grasp of the material which had been studied. Ramsden (1988) provides a useful summary of 'deep' and 'surface' approaches to learning.

Deep Approach Intention to Understand	Surface Approach Intention to complete learning task assignments

Focus on what is 'signified', i.e. the author's arguments	Focus on 'signs", i.e. the text itself
Relate and distinguish new ideas	Focus on discrete elements
	Memorise information
Relate concepts to everyday experience	Unreflectiveley associate concepts and facts
	Fail to distinguish principles from evidence, new information from old
Organise and structure content	
Learning is internal	Treat the learning task as external imposition focusing on the assessment

In the tutor questionnaire presented here we were interested in identifying tutors´ perceptions of:

1. the learning goals of the individual course they chose to tell us about;
2. the modes of assessment they felt aided them in achieving those goals;
3. any mismatch that might occur between those goals and the modes of assessment.

1 The Course Tutor Questionnaire

The Course Tutor Questionnaire (CTQ) was based on interviews with tutors and administrators in ODE institutions, and the final versions (pilot as well as translations) were also checked for readibility and understandability.

Translations of the English version were made into Finnish, French, German, Italien, Portuguese, Spanish and Swedish.

In the process of translating the English version, a number of problems were encountered which had to do with differences in the educational systems in the different European countries. What, for instance, is the equivalent of an English BA in other European countries? We endeavoured to approximate to the English original as close as possible to make results comparable across European countries.

The final form of the CTQ consists of seven parts which relate to

1. the tutor,
2. the course,
3. the students,
4. the assessment of the course,
5. production of the assessment material,
6. delivery of the assessment instruments,
7. staff development.

If the respondents were interested in receiving a copy of the results of the investigation, they were asked to provide their address.

The different versions of the CTQ were made available in the internet at

http://www.doe.d5.ub.es/te/teeode

The user was asked to type in his or her responses and these were then collected at the the University of Barcelona. Also, paper versions of the CTQ were sent to ODE institutions in different European countries.

2 The Sample

The initial sample of 10 tutors from each of 10 institutions for each of the member countries of the EU we attempted changed over time. One of the main reasons for this was the method of data collection (paper-based questionnaires sent out by regular mail and on-line questionnaires made available on the web).

There were two main benefits of the on-line questionnaire. The first was that it widened the sample beyond the initial fifteen member states, hence the inclusion of data from Israel, Mexico and the USA in our survey. It also proved highly efficient in gathering data together and the transfer from questionnaire to data-sets for analysis was achieved with efficiency through this route of data collection.

Unfortunately, however, there were some problems with accessing the on-line questionnaires and we have suffered data loss, thus some 25% of the UK sample is missing and we are aware that our Scandinavian contacts also had difficulty in initial access to the web questionnaire.

We tried to reach as many ODE institutions as possible, being well aware that, within the limitations of our budget, it was not possible to have neither a truely representative nor a purely random sample. We did hope, however, that we might achieve representativeness at least to some degree.

There were 224 CTQs returned. They were distributed across the different countries very unevenly. It is difficult to establish the reason for this, but one explanation that seems very plausible is that ODE institutions in Europe vary very much with respect to the extend and importance they have in the different European educational systems. In the UK ODE is well established but this is not the case for many of our European partners.

3 The tutors

Of the 224 respondents, 59 (26.3 % of 224) indicated they were course organizers and 175 of them (78.1 % of 224) declared to be course tutors. However, only 17 (7.6 % of 224) acted both as course organizers and course tutors.

Somewhat more than half of the tutors were employed on a full-time basis (125 versus 99 half-time, i.e. 55.8 % versus 44.2 %). An interesting finding was that all of the tutors were relatively new in their courses: none of them had worked for more than three years in his course, 99 (44.2 %) had given his course for less than three year but for more than one year, and 125 (55.8 %) had given his course for less than one year. This finding may reflect that rapid and recent rise in interest in ODE across our institutions or, it may be the case that tutors selected to talk about new courses rather than courses they have worked on for a number of years.

4 The courses

Table 1 gives an overview of the subject areas that were covered by the different courses. The single most cited category is languages (33.5 %), followed by literature (20.5 %). If we subsume the first six categories under the heading "Science of Letters", than almost three quarters (71.4 %) of the courses fall under this heading and a remaining 18.3 % (categories 8 to 12) under the heading natural sciences. This contrasts sharply with the findings of the Institution Questionnaire in which Business and Management Studies dominate the ODE field.

	Frequency	Percent	
Literature	1	46	20.5
Social Sciences	2	9	4.
Languages	3	75	33.5
Education	4	19	8.5
Humanities	5	11	4.9
Arts	6	-	

Medicine	7	1	.4
Math & Statistics	8	12	5.4
Business and Management Studies	9	11	4.9
Engineering	10	-	-
Computer Science	11	5	2.2
Natural and Physical Sciences	12	13	5.8
Others	13	22	9.8

Table 1: Subject areas of ODE courses

Of the 224 tutors, 175 (78.1 %) rated their courses as academic and 45 (20.1 %) as professional or vocational. The length of the different courses varied substantially. 68 (30.4 %) of the tutors indicated that their courses lasted less than a year, 81 (36.2 %) had courses lasting between one and two years, 20 (8.9 %) were involved in courses lasting more than one year but with a time limit, while 55 (24.6 %) indicated that their courses did not have any time limit.

Table 2 shows how the tutors rated the level of their courses. As is evident, the vast majority of the courses (170 of 224, i.e. 75.8 %) lead to an academic qualification. This is very much in line with the tutors´ labeling the courses as academic versus professional or vocational.

	Frequency	Percent
Postgraduate degree	34	15.2
Bachelor degree	21	9.4
Certificate or diploma	115	51.3
Professional qualification	14	6.3
No qualification	8	3.6
Other	30	13.4
No answer	2	.9

Table 2: Level or courses

Cross-tabulating subject areas by course level shows that 63 of the 74 language courses (85.1 %) and 37 of the 47 literature courses (78.7 %) are academic while of the remaining subject areas in the sample , 23 of 58 are (71.6 %) academic.

5 The students

We asked for the age of the ODE students, but the results were rather inconclusive. 130 tutors (58 %) indicated that there was no set age and 69 (30.8 %) judged the age of their students to be more than 23 while only 25 (11.2 %) assumed their students to be younger than 23. It therefore seems that the age of the ODE students of our sample may be somewhat higher that that of "normal" college and university students. This is consitent with a view of ODE as an important way of gaining qualifications while working.

Concerning the entry qualifications of the students for the ODE courses, about half of the courses require no prior qualifications while requirements for qualifications are almost evenly distributed across the categories GCSE or General School Certificate (post 16; 15.6 %), A-level or Advanced School Certificate (16.5 %) and Bachelor Degree or equivalent (17.4 %).

6 Assessment of the courses

Of the 224 tutors, 92 (41.1 %) reported that formative assessments were undertaken during the course, 16 (7.1 %) indicated formative as well as summative assessments were being conducted while 116 (51.8 %) reported that formative as well as summative assessment was being done.

The most preferred mode of assessment turned out to be written assessment (208, corre-sponding to 92.9 %) followed by practical assessment (51 / 22.8%) and oral assessment (43 / 19.2 %).

Please note: For this and the following questions in this part of our report, the alternatives were not mutually exclusive, i.e. a tutor might indicate that the assessment was conducted in written form as well as orally and practically; percentages are based on the 224 responses for each alternative.

With respect to the question of where the assessment was conducted, 84 tutors (37.7 %) named the host institution, 86 (38.4 %) a designated centre at a distance, and 49 (21.9 %) a place of the student's choosing.

The tutors were given a number of alternatives which described the main objectives for assessing students on their courses and asked which of these they deemed most appropriate with respect to their own courses. Answers are given in table 3.

to test factual knowledge	71	(31.7 %)
to test understanding	145	(64.7 %)
to test application of knowledge	167	(74.6 %)
to test practical skills	44	(19.6 %)
to test problem solving abilities	52	(23.2 %)

Table 3: Main objectives for assessing students

Evidently, the tutors consider application of knowledge and understanding as the most important objectives for assessing students' achievements.

In order to learn more about tutors' motives and beliefs with respect to conducting assessments of their students, we asked them to what extent different forms of assessment matched their educational goals. The forms of assessment were (1) multiple choice questions, (2) comprehension tasks, (3) problem solving tests, (4) practical tests, (5) project file or diary, (6) oral presentation or examination, (7) long essay or dissertation, and (8) written examination.

The tutors were asked to indicate to what extent the forms of assessment matched their educational goals on a five-point scale: (1) excellent, (2) good match, (3) satisfactory, (4) poor match, (5) no opinion. From these data, we computed two indices. First, we defined the degree of acceptance (DA) as the proportion of tutors (in percent) who chose to check one of the first three alternatives, i.e. who indicated that they perceived at least a satisfactory degree of match between the form of assessment and their educational goals.
Second, we transformed these categories (degree of match) into numerical values, assigning 1 to excellent, 2 to good match etc. We then computed a mean rating (MR) for those tutors who did rate the match between form of assessment and their educational goals. A low MR thus signifies a high degree of acceptance, and conversely, a high MR signifies a low degree of acceptance.

The most acceptable form of assessment (79 %) turns out to be the assessment by comprehension tasks, marked by the tutor and conducted for formative assessment. This form is also rated highest with respect to the match between assessment form and educational objectives. These results are in line with our former findings (see table 3) that the tutors considered the assessment of understanding and the application the main objectives of their assessment procedures. Interestingly, this form is less acceptable for summative assessment purposes (55 %) or with students or peers doing the marking (38 % for formative and 22 % for summative purposes).

It seems that the question of who does the marking has a decisive influence on the tutors´ratings. For example, with respect to multiple choice questions, the best match between form of assessment and educational objectives is achieved when the marking is done by the tutor; students´ marking obviously widen the gap between assessment and educational objectives, while computers seem to be even less welcome as marking agents (the mean rating for this combination is 3.11 - formative - and 3.16 - summative assessment). Preference for tutors´ marking is also exhibited with respect to the other assessment forms (indicated by the degree of acceptance as well as by the mean ratings). Althoug our tutors are working in a new mode of teaching, they are still using very traditional approaches to assessment.

Finally, with the exception of the „classical" assessment forms of written examination, the assessment instruments are considered more acceptable for formative than for summative assessment.

7 Production of the assessment material

In this section, we wanted to know where the assessment material that the tutors are using come from. More than half of the tutors (126, i.e. 56.3 %) indicated that were using assessment instruments that were produced by course team members. In most cases (98, i.e. 43.8 %) the instruments used were the result of a collaboration of the course team.

However, some tutors to some extent (57, i.e. 25.4 %) used assessment instruments that were not produced by course team members most of which (67 %) came from commerical sources.

Concerning the type of the assessment instruments, 64 (28.6 %) of the tutors used instruments that were standardised, 80 (35.7 %) used instruments that were not, while 75 (33.5 %) did not know whether their instruments were standardised or not.

8 Delivery of the assessment instruments

While in the section on the assessment of courses we had asked for the educational objectives that were being persued in assessing the achievment of the ODE students and to what extent the instruments being used matched these educational objectives, in this section we wanted to know what kind of assessment instruments were actually being used.

When asked about the "traditional" instruments, 61 tutors (27.2 %) reported using oral tasks and 206 (92.0 %), i.e. the vast majority used written tasks. However, only in a very few cases was this assessment computer supported (in 3 cases for oral tasks and in 19 cases for written tasks).

Tutors were also asked if there existed a set interview schedule that must be followed in oral examinations. 33 (14.7 %) responded yes, and 30 (13.4 %) responded no, while 155 (69.2 %) checked the do-not-know alternative. This is another indication that oral examinations do not seem to be used frequently as assessment tools.

In general, assessment criteria do exist, however. 90 (40.2 %) tutors declared this to be true, only 10 (4.5 %) denied this, and 117 (52.2 %) preferred to check the no-answer alternative.

Finally, we wanted to know if computers were used in the assessment and in what ways. Very few tutors used computer technology for assessment. Of the tutors that did so, 7 indicated that the system marked students´ reponses while 21 indicated that it did not. At the same time, 13 reported that the system provided feedback on reponses to students while 12 reported that it did not.

Of those tutors who used telematics, 6 conducted assessment in real-time and on-line while 16 did not conduct the assessment this way.

9 Staff development

In this last section, we wanted to find out in what areas there might be a need for further advice or training, and we asked the tutors whether they felt they might benefit from advice or training in the areas given. Frequency counts of the answers are exhibited in table 4.

	Introductory training	Advanced training
Design of distance learning materials	25 (11.2 %)	51 (22.8 %)
Assessment of distance learning	11 (4.9 %)	39 (17.4 %)
Design of multiple choice tests	16 (7.1 %)	31 (13.8 %)
Design of problem solving tests	18 (8.0 %)	32 (14.3 %)
Marking of essays	7 (3.1 %)	21 (9.4 %)
Design of formal examinations	7 (3.1 %)	24 (10.7 %)
Use of computer based tests	37 (16.5 %)	39 (17.4 %)

Table 4: Areas in which advice and/or training would be appreciated by the tutors

The data show clear variations in tutors´ perceptions of their personal training needs for different modes of assessment. Few tutors felt that they needed additional help in marking, essays or in preparing formal examinations. However, significant numbers requested help in computer based assessment at both an introductory (16.5 %) and advanced (17.4 %) level. There was also considerable interest in obtaining additional training in the design (22.8 %) and assessment (17.4 %) of distance learning courses - but this need was for advanced level skills.

10 Summary and conclusions

The returns of the Course Tutor Questionnaire did not live up to our expectations. We invested a large amount of time and effort to contact ODE institutions in Europe and to distribute the questionnaire, but we received a relatively small number of responses. We only know that return quotas are in general relatively low with this kind of studies. Additional data has been received post this analysis. They will be incorporated in the year 2 report.

Nonetheless, from the tutors who did respond we received some very interesting data. It is clear that tutors aim at testing the application of knowledge and understanding when they conduct their assessments, and there is a preference for formative assessment, i.e. assessment that is done during the course. Traditional methods are being used, but tutors´ preference is with comprehension tasks, multiple choice questions, and course essays. At the same time, tutors feel they would benefit from advice and training in the design of distance learning material and in the assessment of distance learning.

With respect to the computer, the results seem to be a bit paradoxical: On the one hand, tutors indicate that their educational goals can better be reached with multiple choice tests when marked by the tutor than when marked by the computer. This is difficult to understand because it would not at all be difficult to do the marking of multiple choice tests with the a computer program in an "objective" manner. The objectiveness of multiple choice tests is in general very high because the assessment of the results is independent of the person (or machine) who does the marking (given that there is a key for the correct alternatives). We therefore conclude that many tutors still do not feel at ease with the idea of letting the computer do the assessment simply because of lack of familiarity with this possibility. We consider this assumption to be substantiated by the fact that more than half of the tutors also were relative new in their teaching jobs (with an experience of a year or less with their courses) and that at the moment, there is indeed relatively little use of computers for assessment purposes in ODE institutions.

At the same time, tutors would appreciate advice and training in the use of computer based tests. Since they also exhibit interest in getting to know more about the design of distance learning materials and in the assessment of distance learning, we assume that their somewhat hesitant attitude towards computers would turn into a favourable one if they actually were given advice and training in using computer programs to develop distance learning material and instruments to evaluate the learning processes of their students.

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An Alternative Model of Multimedia Development: Small Projects within an Academic Environment

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Abstract: The traditional method of multimedia development is characterised by carrying out a number of processes in a linear fashion. This is an efficient method of development where a number of projects are occurring concurrently, but the lack of client pressure and the flexible skills base afforded by an academic environment provides an opportunity to develop multimedia in a unique, non-linear way. A review of the literature has highlighted the paucity of research pertaining to the development of multimedia programs and reveals the inadequacies of traditional systems design models for multimedia programs. This is particularly true for an environment where the development team frequently come from disparate backgrounds and are contracted from outside the University having little understanding of each other's roles, leading to a breakdown in communications and mis-understandings resulting in an end-product at odds with the initial design concepts. Usually multimedia-based instruction is derived from a detailed preliminary analysis, but the instructional designer also brings personal assumptions to the design which are often not part of the analysis These assumptions are evident in the way in which the program is designed, but may need to be re-examined and new strategies implemented in order to accommodate the ever increasing capabilities of the technologies. Two programs which demonstrate the results of different approaches of two instructional designers will be examined to illustrate some of these points.

INTRODUCTION

A grant of $20,000 was given to a project team to create a piece of instructional multimedia which could replace or supplement existing teaching within a unit in the Faculty of Business at Edith Cowan University. A review of commercially available instructional multimedia highlighted the fact that while the programs were aesthetically pleasing, they had a dry, unengaging feel to them. Analysis of these programs discovered that they were lacking in the areas of interface and interactivity design. When the decision was made to create a self-paced learning environment for students to learn about share valuation and investment, a review of the literature was undertaken in an attempt to determine what features needed to be included to motivate the students to use and engage with the program.

The team in question consisted of an instructional designer/project manager; a content expert and a programmer. Each member of the team was also skilled in at least one other area, for example each team member contributed to the graphics, and the programmer had a strong education background so had an immediate understanding of the needs and wants of the instructional designer, he was also primarily responsible for the production of the media.

At the outset the concern was primarily with initial and ongoing motivation, rather than learning outcomes, and once the elements to be included were identified, a concept map was developed and the program was designed. The resultant program, *Principles of Financial Investment*, was a microworld giving the students realistic insights into the world of share valuation and investment—a module within the introductory finance unit in the Faculty of Business.

Ten basic elements of program design modified from those identified by Duke (1980) were used to inform the design approach, with a focus on cognitive and affective aspects of the program's scenario, steps of play, and learners' roles to name a few.

This approach dictated many of the early design and development decisions where objectives were defined in terms of the programs interface rather than learning outcomes. The use of the term interface in this paper is used to describe the bridge between the content and the participant. It encompasses the organisation of the material, the screen design and layout, the use of the space and the way in which the participants moved through the program. Because of the complexity of the program, it was decided to break it into three main domains based on Gould's (1995) model. These domains are information design (content), interface design and interaction design.

The development model is illustrated in Figure 1. It shows the various stages the development team moved through when designing the program. Analysis and implementation are shown as being fairly discrete elements, but the information, interface and interaction design were done concurrently in an attempt to create a cohesive whole. In other words the team wanted an environment where the student moved effortlessly and seamlessly, with little cognitive effort expended on working out where they were, what they were doing there and how to move around. The authoring and media were created and constantly modified in conjunction with these three design domains, the whole process being iterative.

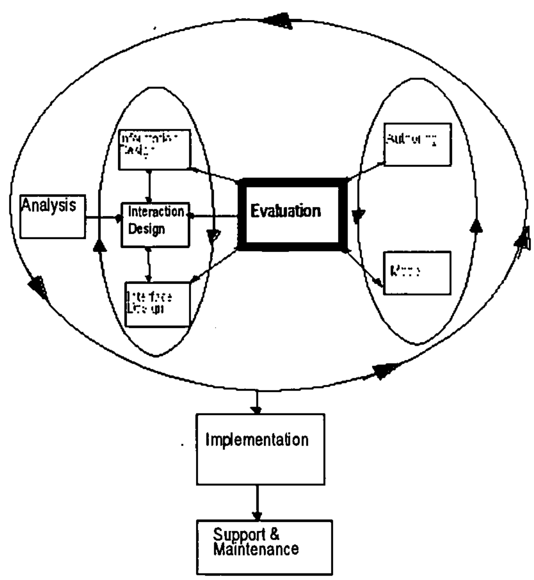

Figure 1: Model of Development Process

INFORMATION DESIGN

The first step in information design was to define the audience and plan and organise the content. A concept map was used to blueprint the content and to define the relationship between each of the elements. It was decided that a microworld would keep the context authentic while allowing the designer to incorporate some gaming elements necessary to keep the learners engaged and on-task. The potential of microworlds to combine didactic theory with simulated practice (Rieber, 1992) was viewed as advantageous in this product, and was difficult to achieve with other solutions.

A target audience analysis was conducted to determine the type of student who would be using the program and it was discovered that it had to appeal to both sexes, a variety of cultural groups, and an age range of 18 to 55. It was decided that it was important that the student be considered a participant in the process, rather than just as a user of the product. Considering the range and tastes of the participants was an important first step in the design of the program (Gould, 1995; Laurel, 1991).

Although storyboards were produced for *Principles of Financial Investment*, they were used more as a starting point. As the model shows, evaluation was an ongoing and constant process and minor adjustments were constantly made to the program. These were arranged mostly through emails rather than re-writing of storyboards. Archiving e-mail messages provided an audit trail for modifications made to the final product.

INTERFACE DESIGN

This process was guided by assumptions that best user interface demands the least learning effort" (Vaughn, 1994) and that the interface connects the learner and the content and helps to shape the interactive experience. "It is everything a user sees, hears, touches and feels. An interface must be functional and aesthetically pleasing and provide the information access and guidance that users need without hindrance" (Francois, 1996).

In this phase it was determined how the content and interactions would blend. The look and feel of the program was decided and the manner in which the content was accessed. A conscious decision was made to keep the interface simple, with cartoon style 8-bit graphics rather than realistically rendered images. This meant that the images took up very little memory and used minimal space, therefore being able to be used on fairly low level equipment. It also meant that the interface could be developed quickly and cheaply, allowing design efforts to be focussed on the educational elements of the program.

A first person approach was used, where the participant enters his or her name and they then become the "owner" of the share portfolio and the office. First-person sensory qualities are important in creating satisfying human-computer experiences and present *experiences* rather than *information* (Laurel 1991). As Laurel points out "Learning through direct experience has, in many contexts, been demonstrated to be more effective and enjoyable than learning through *information communicated as facts*" (Laurel, 1991:119). This use of the first-person also overcame the problems of gender-bias and cultural and age differences.

A key step in the interface design was deciding upon a metaphor to use. In this case the form did infer the function in that the metaphor of a stock exchange building was an obvious choice, together with the attendant industries—a securities institute, broker's office and participant's office.

NAVIGATION

The navigational map outlined the connections or links among the various areas of the content and formed an "organiser" of the content and messages. There are generally four fundamental organising structures used to navigate around a multimedia program and often they are used in combination:

- **Linear**—the learners will navigate through the program in a series of sequential steps;
- **Hierarchical**—learners navigate along the branches of a tree structure that is shaped by the natural logic of the content;
- **Nonlinear**—learners navigate freely through the content;
- **Composite**—learners may navigate in a nonlinear fashion, but can be constrained by linear presentations of items such as movies or critical data which is logically organised in a hierarchy. (adapted from Vaughn, 1994)

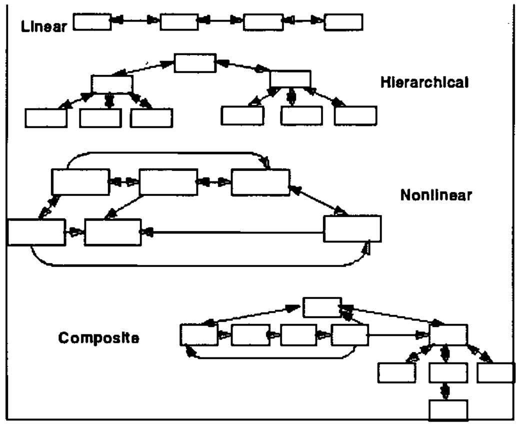

Figure 2: The four primary navigational structures for multimedia as outlined by Vaughn (1994)

Navigation is an essential component of interface design. In this program, it was essential that the students felt that they could move at will wherever they wished within each warp as "this empowers them within the context of the subject matter" (Vaughn, 1994: p 393). For this reason, a non-linear structure was implemented, allowed free navigation around the various 'rooms' of the microworld while diegesis and narrative flow was maintained by linear progression through financial quarters or 'Warps'.

Learners will often construct spatial mental models in order to move freely around a program and within the learning spaces and this has obvious implications for design (Sellen & Nicol, 1990). Designing a program which allows the learner to intuitively navigate using their mental model reduces their memory load and cuts down on the amount of time it takes the learner to learn to use the program. A navigational blueprint on the wall of each "room" in the program was used to assist in the users' construction of a mental model of the program structure and to provide an intuitive way of allowing the participants to move through the program. Clicking on doors in rooms allowed them to get into ante-rooms in a natural way.

INTERACTION DESIGN

Interactivity is the most recent component of IMM and has not yet evolved to the point where it is a communications device (Gould, 1995). Interaction design determines how the program works and how the learner acts within the program. Navigation and control are decided and outlined in the storyboard (Francois, 1996). "The storyboard is an extension of the concept map and is a rough approximation of what the end user will see and do on every screen. The objective is to keep the user oriented to the content through a system of controls and feedback" (Francois, 1996). As stated earlier, the storyboards were used initially and then supplanted by a more informal style of updating via the email. The nature of the interactions were carefully considered for *Principles of Financial Investment* and it was decided that the elements and techniques should be very different from those in mainstream computing systems. Buttons and menus were eliminated where possible as they denote a productivity device and this program aimed to keep the participant on task for as long as they needed in order to acquire the information, solve problems and make decisions; by engaging over time, the participant will experience a sense of change (Gould, 1995). Once the participants got used to the interface it was anticipated that it would become "invisible" to them so that they could get on with *experiencing* rather than *using* the program. In other words, the program should be simple but engaging.

A first-person perspective within an authentic setting provided for a more realistic and meaningful experience which encouraged users to take longer over investment decisions and problem solving, considering all the possibilities. The ability to view an expert and compare their own decisions with the experts in light of the theoretical foundations presented in the program would also impact on the nature of the interactions.

Usually in a computer system, the user must have a degree of competence in order to access the information in it. This program was designed for learners with a limited background in computing and was created to support browsing to permit a more flexible means of accessing the data. Although there was an optimum, primary path through the program, the non-spatial organisation permitted flexible browsing. Browsing is possible only if the

multimedia is interactive and non-linear. Due to the fact that the learner can move through the program in any order, they can use the simple navigation system to constantly check elements such as economic forecasts, theory elements from the Institute and company background information held in the Broker's office. This was considered to be important in assisting the students to achieve the learning objectives.
Although a microworld was selected for the program design, a way of teaching the theoretical components without having the students wade through screens of text was necessary. The theory also needed to be presented in a way which was consistent with the authentic context of the rest of the program. It was decided to simulate an internet environment which allowed the use of hypertext links and slide shows if necessary. This environment also allowed the students to save their tutorial materials to disk, print them out and use the search facilities.

PROBLEMS OF THE APPROACH

The approach to development of *Principles of Financial Investment* was informal. This worked well for the three people in the team who communicated by email rather than in regular meetings and who worked collaboratively, sharing responsibilities and tasks. This approach would not work well in a team consisting of more people, or even in a commercial organisation where the responsibilities are more clearly delineated.

This approach is also fraught with danger. Should the programmer suddenly leave the team, there is no catalogue of media or programming style guide. So, although it worked well in this instance it is not the recommended method of development.

The use of this model is very dependent on the team members working together and working consistently. Some problems were encountered when the content expert became too busy to create some of the materials. In the more traditional approach, materials are created before programming starts therefore avoiding some of the bottlenecks experienced.

A "Waterfall" approach has benefits in that inconsistencies in style or content are weeded out much earlier. The team experienced some difficulties in changing elements consistently through the program.

This approach may not work as efficiently as the "Waterfall" approach for a straight presentation style program. Different approaches tend to produce different results.

ADVANTAGES OF THE APPROACH

One of the greatest strengths of this approach was the multi-disciplined nature of the team. This allowed an exchange of ideas and spontaneous development of the program not usually encountered in a traditional development team.

The speed at which the development took place was a distinct advantage. There was no need to wait for weekly meetings—all members of the team had access to each other at all times via the email system and turn around time on solutions to problems was therefore very fast.

CONCLUSIONS

In an academic environment, the method proposed here for *Principles of Financial Investment* worked well. A working model was produced quickly and cheaply and could start being tested with students within a relatively short period of time. However, it should be noted that this method may not have worked with other projects. This approach relies heavily on the synergy between team members and their iterative approach to design. If the aim were to develop a larger, maintainable learning system, the model adopted here may have proven to be too unstructured to support a necessarily higher level of management control. But it is likely that a program such as *Principles of Financial Investment* would have lacked many of the motivational features which made it successful if it were created under a linear development model. The multidisciplinary nature of the design team and evolutionary approach to development adopted for this project allowed for a unique organic synthesis of form and content into a more cohesive whole than would have been possible under traditional development models.

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Designing an Interactive Multimedia Instructional Landscape able to Generate Motivating and Engaging Effects Among Learners

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Abstract: This paper describes a study which formed part of a larger project exploring the motivation and engagement of adults using interactive multimedia for learning. In the larger project, it was hypothesised that adult learners would be motivated and engaged by educational interactive multimedia which is able to generate specific learner effects. The learner effects that were considered to be most important in influencing the motivation and engagement of adult learners were: immersion, reflection, collaboration, play, learner control, curiosity, fantasy and challenge. This paper describes the planning and development of an instructional landscape to generate and sustain these effects in learners and the results of a study to determine the impact and capacity of the various design elements employed to generate these effects.

INTRODUCTION

Motivation is well recognised as being important to student achievement (Walbery, 1981). However, there is a paucity of research concerning motivation and technology-based learning materials (eg. Dempsey, 1994). Most IMM developers pay particular attention to the cognitive aspects of learning in their instructional design and attend in few ways to such affective aspects as learner motivation. The work that is described in this paper forms part of a large project involving an investigation of designing motivating and engaging interactive multimedia materials for adult learners.

Our inquiries suggest that for self-paced, resource-based learning materials to be motivating and engaging, they need to develop a number of effects in the learners, ie: immersion, reflection, collaboration, play, learner control, curiosity, fantasy and challenge. These elements are described in previous papers (eg. Stoney & Oliver, 1997).

THE PROGRAM

In order to test the theory that these learner effects would have an impact on motivation and engagement, an interactive multimedia program was developed. It was quite a challenge from an instructional design perspective to plan an instructional program capable of supporting all these learner effects. We finally chose the form of a microworld as a possible framework for incorporating the instructional elements needed to provide the desired learner effects. The microworld has a number of inherent characteristics which appear to make it useful in this instance.

CREATING THE LEARNER EFFECTS

The following table summarises these desired learner effects and shows the instructional design that was used to enable each to be incorporated into the microworld design:

Desired Learner Effects	Contribution of Effect to Motivation & Engagement	Program Attributes
Immersion	Students feel a sense of participation; self-consciousness and time disappear. Enhanced visual and auditory stimulation felt.	Theme based activities, microworld, simulation, realistic and relevant environment.
Reflection	Causes students to attend to problem-solving. Encourages time-on-task by requiring decision-making, aids in creating an immersive setting.	Intuitive interface design, exploratory setting, high levels of interaction, access to multiple information sources and expert performance.
Play	Students need to plan and implement strategies, goal setting, encourages risk taking, hypothesising and testing. Light elements relieve boredom and frustration.	Incorporation of humorous elements, gaming elements, flow, optimal challenge, plus competition and chance processes, mimicry and simulation.
Collaboration	Students communicate and coach each other, communicative interactions enhance learning activities, aids in creating reflective settings.	Setting for joint activity, inferential navigation, learning through guided discovery, goal-based setting
Learner control	Students make their own decisions, increases reflective activity, creates settings for higher-order thinking, increases scope and extent of outcomes.	Semi-structured, self-paced, open-ended activities, feedback to guide actions, familiar context.
Curiosity	Appeals to multiple senses, random elements increase interest levels, provides contexts for decision making .	Chance processes, authentic setting, realistic outcomes, multiple navigation paths and media elements,
Fantasy	Provides multiple settings and contexts, encourages active engagement, provides context for problem solving and feedback.	Microworld environment, metaphors, realism, authentic contexts.
Challenge	Provides opportunities and reasons to reflect and plan, encourages hypothesising and testing, provides goals to measure performance.	Gaming elements, goal based activities, feedback, performance measures and indicators.

Table 1: Features of an engaging and motivating multimedia program

The coursework that was chosen for our project was a component of an introductory finance course in a Business degree. The chosen component involved share valuation and investment. The teaching and learning in this component was traditionally supported through reading and discussion. In an IMM environment, significant learning advantages were made possible, for example, student learning by exploration and inquiry, in their own time and at their own pace. The IMM program that was planned was carefully designed to incorporate not only the learning sequences needed to bring about specific learning outcomes but also the forms of affective components leading to the planned learner effects. The resulting program was designed in the form of a microworld.

THE STUDY

Having designed and developed the microworld, we explored the impact of the various design features in supporting the 8 learner effects which were seen to be important elements for a motivating and engaging learning environment. Twelve students used the program as an instructional aid across a period of 3 hours and in that time completed the various sections of the program to their own satisfaction. The students were videotaped and audiotaped whilst using the program, and interviewed at the conclusion. The students were asked a series of open-ended questions in order to elicit their feelings on the program and to identify which elements of the program contributed to their motivation and engagement. In particular we sought to have students discuss how they felt when they were using the program and the characteristics of the program which contributed to these feelings. The remainder of the paper describes the feedback from students describing their impressions in relation to the 8 intended learner effects.

IMMERSION

The students enjoyed the realistic interface which gave them a "graphical fix" on the content and context of the program, providing a strong link between visual and auditory modalities. Students mentioned several times that the realism of the program as well as the context, gave them a sense of being in the program which led to a feeling of complete immersion and engagement:

> *We imagined ourselves in the situation, having to do something when you got somewhere...*
> *I felt like I was looking at a wall in the Stock Exchange.*
> *I could see how I'd use it in real life, I felt like I was there.*
> *The whole program immerses you, all the bits and the context. Buying shares and tutorials made it like real life.*

It is difficult to imagine how the students might have been immersed more than by the microworld setting. It was evident that this provided a strong framework for the program and created opportunities for many of the other learner effects to be developed.

REFLECTION

Reflection helps to engage learners by supporting higher order thinking and problem solving. The students recognised their reflective processes in a number of places in the program. For example, they were allowed to choose their own navigational paths and this led to thinking and pre-planning. Students found that they had clear, but implicit, goals and the program also made them stop and think at various stages. They enjoyed the conflicting advice they received and they all mentioned the ethical issues which they had been presented with by telephone. It is obvious that the students thought about what they had to do next, tried to balance the different information and make decisions on it, and related the theory to the practical aspects of investing.

> *I thought about the investment mix, ethical considerations and media releases.*
> *Worked out a logical format by flicking through the program and deciding. The company summaries made us think, deciding what stock to buy and how much—so many combinations.*
> *Analysing information before investing—using forecasts and updates. Made me think about insider trading, ethical issues.*
> *Had to think about the approach to buying and selling, investigate the companies.*
> *I had time to sit back and think about what things meant.*
> *Can see things working, so can decide how to do something and imagine what's going to happen.*

All students recognised and commented on the way in which their reflection held their attention and engagement. The reflection was brought about by the open-ended nature of the instructional setting and the high levels of learner autonomy associated with decisions and actions taken as interactions in the program.

PLAY

Play is defined as a free and voluntary activity; a source of joy and amusement. The player is spontaneously devoted to the game, of free will and with pleasure (Caillois, 1961). Play is also an uncertain activity, doubt remaining until the end. An outcome known in advance with no possibility of surprise, is incompatible with the nature of play (Caillois, 1961). If the students are to engage in play, then elements of humour, novelty and fun must be present. These were evident in many places in the program and many of the items which students saw as sources of joy and amusement. also had strong learning potential. Students' responses clearly demonstrated the capacity of the program to provide a sense of play.

> *I liked the humour, funny sounds, off-beat graphics and characters.*
> *The props, uncertainty and interface made using it enjoyable and fun*
> *I enjoyed applying my learning, the funny characters, extra elements and the thrill of making or losing money.*
> *The combination of fun and theory made it unique.*
> *A more practical use of the material. I was attracted by the program—the graphics, colours, bits and pieces.*
> *The game makes things more interesting, stops you being afraid and bored.*
> *Easy interface, good graphics, fun sound effects.*

The sense of play which students gained from the program were claimed to have been generated by the simulation and the task of share trading and facilitated by the many unexpected and chance elements associated with the microworld environment.

COLLABORATION

An emphasis on collaboration rather than competition is often seen as a supportive activity for effective learning. The program provided many opportunities for collaborative learning. Students were encouraged to provide coaching to each other when they worked in pairs which helped all parties make decisions, and using the virtual experts as coaches meant that the students were collaborating with the computer itself. Student response indicated that they saw collaboration as an important and useful component of the learning environment.

> *I enjoyed working with a partner, we explained things to each other.*
> *Helped me reinforce and remember the theory, discussed our investment mix.*
> *Group decisions are good, conflict over decisions, sharing knowledge.*
> *I like to work alone, to test the decisions, the consequences. The game let me know whether I'd done well or not.*
> *I worked alone, but I think working with a partner, I'd get to see both sides of an argument.*
> *I think working with someone would be a distraction. I liked testing my decisions and checking them against Wonda* [the on-line character].

The students chose whether they wanted to work alone or in pairs and it seems that all were satisfied with their choices. They felt that they were able to test themselves in context and receive authentic feedback. The attributes of the program that fostered the collaborative efforts were related to the autonomy provided and the goal and problem-based activities that guided the learning activity.

LEARNER CONTROL

The literature suggests that students experience a much greater sense of control when they are guiding their own learning experience and a corresponding increase in intrinsic motivation (eg. Becker & Dwyer, 1994). Important elements supporting learner autonomy were incorporated into the program by creating a semi-structured environment in which the students had full control over time and direction in their exploration. A concerted effort was made to ensure that the students did not feel pressured or hurried and the interface design was an important part of this. Students were not only able to choose their working pace, but could choose the mode of navigation which suited their particular learning style—browsing or unstructured navigation following their own path, or a more structured progression following the hints and tips included in the program. Their responses suggested that they valued the levels of learner autonomy.

> *I liked the fact that I could skip the bits I knew and repeat those I didn't.*
> *I could move around at will.*
> *You don't just learn information put to you, you get to choose your own stuff.*
> *I chose where to go for information and had to work out why something happened. I liked being in control of this.*
> *Could choose my approach, it was very clear how to do things.*
> *If you can work at your own pace it's much easier.*
> *If I was told where you had to go next it would take away a lot of the uniqueness.*
> *More individualised, don't need any help, the visual thing helps, you can just click on something and the information is there.*

Students' responses to questions about their autonomy in program made it quite clear that this attribute was seen as a critical part of the learning and the learning environment and one which contributed significantly to their enjoyment of the learning.

CURIOSITY

Arousing curiosity was sought by creating an experiential and exploratory environment which was optimally complex (not too difficult, not too easy) and which appealed to as many of the learner's senses as possible. The gaming elements contained within the microworld were intended to pique the learner's curiosity, particularly the random elements which changed from warp to warp. Once students began their investing, curiosity was instilled through a random element in the investment outcomes. Students were challenged to see if their investment strategies and decisions were successful and they were keen to explore the impact of extraneous events on those decisions.

> *I liked the uncertainty of what would happen next.*
> *I couldn't wait to see what would happen, I loved the surprise elements and the warping.*
> *I liked buying shares and seeing what happens, exciting when the theory comes together.*

We weren't sure what was going to happen next, went to TV and telephone to see what they had to say. Discovery of elements, especially information was exciting.
It felt good because I kept wanting to see what happened next. Makes you make decisions.
The phone made you feel involved in a small circle of people.

Personal curiosity was seen by students as an important part of the learning environment. It was supported strongly by the open-ended nature of the microworld and the authentic and realistic setting in which they were immersed. Other components which held their curiosity included the chance processes, the realistic outcomes and the referential and open navigation structures.

FANTASY

Having a realistic metaphor for the instructional landscape was intended to allow students the fantasy of believing that they were investing their own money. Many students of business traditionally have a fantasy of being financially successful. This program was designed to indulge that fantasy. There was also the added benefit of having an "autotelic" experience in which the students were able to prove their skill at forecasting future trends (Csikszentmihalyi, 1992). This was seen as an important component of the program as successful share investment depends very much on forecasting future events and trends.

Once again students' responses confirmed our expectations that the realism of the microworld combined with the authentic task of share trading would create a learning environment where aspects of fantasy were present.

We imagined ourselves in the broker's office or stock exchange. The program was great because it went further than reality which made it enjoyable. We had butterflies!
I liked being able to gaze into the future and second guessing prices.
Had to try to work out how to make a profit and avoid a loss. Better, easier way to learn.
The game had all the relevant and necessary things.
We spent time trying to decide if things were real or not.
Like real life. Having to pay for tutorials made you more determined to get your money's worth.

Like curiosity, the microworld provided a strong setting for creating elements of fantasy in the learning which helped to guide and encourage students' exploration and use of the various elements of the program. The fantasy was supported by the metaphors employed to represent aspects of the authentic setting and the realism carried in the feedback and outcomes to decisions and actions.

CHALLENGE

By creating a program which necessitated a high degree of problem solving and higher order thinking with an appropriate level of difficulty, it was intended students would feel a reasonable degree of challenge. The reward structure was authentic and appropriate to the context and all students instinctively knew the goal of the program. Through a review of their strategies (by comparing with the experts and by reviewing their own portfolios) students could instantly identify whether their goals were being met and how successful they were at meeting the challenge. The students reported facing and dealing with a number of events they saw as challenges in the learning environment.

The conflicting information, strategies challenged—working things out make it stick in the mind.
The tutorials got progressively more difficult.
Lots of information, we had to discover what to do without having a hierarchy. Had to experiment which added to our learning.
In the tutorials, the challenge helps to retain the information.
Applying the theory, making decisions and solving problems concentrated me.
You can choose your own level of challenge.

There were many challenging aspects in this program and students recognised their presence and the ways in which they encouraged their activity. The use of personal goals through the various gaming elements in the microworld were perhaps the most significant aspects influencing the challenge faced by the students. Once again the feedback and performance measures supported the challenge by providing the cues needed to assess performance and to support further action.

CONCLUSION

The purpose of this study was to explore the potential and capacity of a microworld learning environment to support and create such particular learner effects as immersion, reflection, a sense of play, collaboration, personal autonomy, fantasy, curiosity and challenge. A program was developed in which the instructional design specifically considered these elements. The program was trialed with students to assess the extent to which it generated these effects among learners. Students were interviewed after a session using the program in which they completed the various learning activities and exercises.

The student responses indicated that all experienced each of the various learner effects in some way or another while using the program. It was evident that the microworld was a very suitable design strategy for our purposes and provided a strong setting for our study of the affective learning environment. Having established that the various design strategies can in fact create the various learner effects, the next phase of our study will be to assess the relative impact of the various affects on learner motivation and engagement. Tentative findings from this first implementation lead us to suspect that some of the effects possibly contribute more to engagement and motivation than others; further studies will look to see relative impacts of each of the learner effects.

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An Intelligent Advisor for an Interactive Learning Environment

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Abstract: This paper presents an intelligent advisor for a discovery learning environment. The educational objectives of the learning environment are to learn fundamental rules of physics and to acquire ability of applying these rules to complex systems. In order to support the learning, the advisor has the student model that distinguishes between what a student knows and to what extent of complexity of physical systems the student can apply rules. The advisor provides assistance for the student according to the student model and the system structure that the student built freely.

1. Introduction

A process of the discovery learning consists of the following steps[Otsuki 1993]. Students learn a new concept inductively by observing an instance. Then they generalize the concept by observing several instances. Students examine characteristics of target objects by manipulating the objects through experiments in these steps. They may also solve problems by manipulating the objects. After that, the concept is generalized to a symbolic level and they acquire symbolic knowledge, with which they can solve problems by symbolic manipulation. In some cases, they may be taught symbolic knowledge, and then they understand meanings of the symbolic knowledge by trying to make correspondence between the symbolic knowledge and the instance objects through experiments.

Elementary physics is one of fields that students acquire knowledge by this scenario. For example, students learn concepts of gravity, velocity etc. by experiments, and try to find relations among physical parameters like forces and expansion of a spring. Or they confirm the Kirchhoff's Law by measuring electric currents of circuits.

There are three kinds of knowledge involved in solving physics problems[Anzai 1986].

(1)Knowledge of fundamental concepts of physics like gravity, acceleration etc. and rules like Newton's Law.

(2)Knowledge for applying fundamental concepts and rules. By using this knowledge, we understand the physical structure of a given system, and derives a set of equations that represents relations among physical parameters.

(3)Knowledge for solving equations.

While the first and the third knowledge is thought as formal knowledge, the second one is empirical knowledge. Students will acquire fundamental concepts and rules by learning well-ordered materials step by step. Application knowledge will also be acquired by a systematic way in some degree. However they need training to apply fundamental rules to complex systems in order to develop their abilities.

Simulation based learning environments are effective for discovery learning of fundamental concepts and rules. However, because discovery learning costs burden on students, they sometimes reach an impasse. Hence we need an advisor to guide students. Simulation based learning environments are also useful to understand complex systems. When the purpose of learning is merely understanding a system structure, diagnosis and explanation by using qualitative reasoning plays an important role [de Koning 1997, Forbus 1994]. However when the purpose is to develop student's abilities, we should not simply provide explanation but provide a clue of understanding systems so that they may overcome difficulties by themselves. Students will polish their abilities during this process. The advisor should also provide this kind of assistance.

This paper presents an learning environment with an intelligent advisor. The advisor recognizes given physical systems and student's understanding states. Based on these information, the advisor proposes suitable learning objectives and gives advice tailored for each individual student. We first present the learning style in our environment and functions of the intelligent advisor in section 2. Implementation is described in section 3. In section 4, we present a result of evaluation. Section 5 concludes the paper with some discussions.

2. Characteristics of Intelligent Advisor

2.1 Learning Activities in the Learning Environment

Fig. 1 shows the user interface of our learning environment, which consists of a workbench, a parts box, tables and a dialogue box. Similar to many other learning environments, a student goes around the cycle of observation, prediction and verification for discovery learning. During the process, the student carries out experiments and collects data in the table. Student's activities in this learning environment are as follows.

(1)To construct a physical system by using parts prepared in the parts box.

(2)To decide physical parameters to observe and to fill the first column of the table with their names.

(3)To carry out experiments by changing the value of independent physical parameter of the constructed system.

(4)To fill the table by measuring values of physical parameters.

(5)To make a hypothesis and to predict values of dependent physical parameters for a value of the independent parameter after repetition of step (3) and (4).

(6)To verify the predicted values by carrying out an experiment.

(7)If the prediction doesn't match the result, go back to step (3).

The learning environment has two modes of learning; concept leaning mode and training mode. In the concept learning mode, learning proceeds step by step according to a curriculum defined by a teacher. The curriculum restricts the complexity of systems that the student can construct. Hence a simple physical system is given to the student firstly, and gradually complicated systems are given. For example, when the student studies the domain of springs, a single spring and some weights are firstly given in the parts box. The student, therefore, has no other choice than building a system of one spring. The student will acquire concepts of the spring coefficient, Fuck's Law etc. in this first stage. After the lesson, lessons of parallel and serial springs follow. The educational objective of the following lessons is to generalize knowledge about springs and to acquire the ability of understanding complicated systems. The student follows step (1) to (7) in the concept learning mode.

In the training mode, students are allowed to create physical systems of arbitrary complexity. They challenge to understand physical structures of systems and they polish their abilities of applying physics rules during the process. Learning in the training mode basically starts from step (5) by solving a problem posed by the intelligent advisor. If the answer is incorrect, the student examines the reason by experiments.

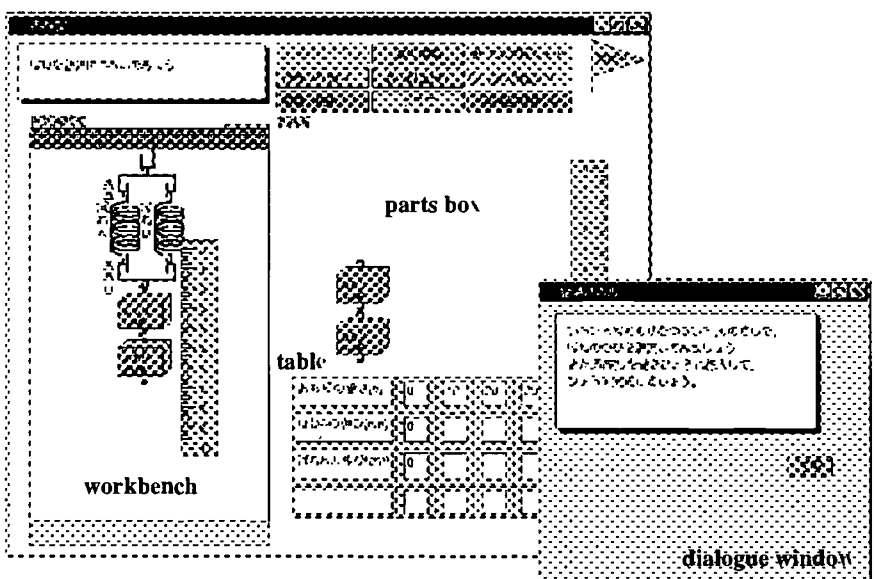

Fig. 1: User interface of the intelligent learning environment.

2.2 Assistance of Intelligent Advisor

Because discovery learning is not an efficient method of learning, students need trial and errors to achieve learning goals. Therefore, it is not adequate that an intelligent advisor helps students soon when they encounter difficulties. If students cannot achieve the goal after several trials, our intelligent advisor provides the following assistance.

(1)In step (2) described above, the advisor proposes physical parameters for measurement that are relevant to the goal. The advisor basically allows the student to experiment freely. However the student doesn't pay attention to goal parameters after several trials, the advisor proposes to observe values of relevant parameters. When the student failed to predict values, this advice is also given in order to collect more data that are relevant to infer functional relations of system parameters. Parameters to observe are decided according to the structure of the physical system and the student model. The system structure is used to recognize functional dependencies of system parameters and the student model is used to find a suitable level of difficulty for the student.

(2)In step (4), the advisor points out incorrect values in the table. Mistakes are mainly caused by misreading indication of measurement tools or confusing different physical parameters. Because the former error is not serious and this kind of errors usually occurres only a few entries of the table, the advisor points out the error only when the student failed in the prediction phase. It advises to check the value by experiments. The latter error is detected by matching the value of the table with values of other system parameters. The advisor directly indicates what the student confuses.

(3)After repetition of step (3) and (4), if the student doesn't try to predict values of system parameters, the advisor asks the student to predict values of dependent parameters without doing experiment by giving values of independent parameters. This advice persuades the student to think and to generate a hypothesis.

The following two assistance methods are used in the training mode.

(4)The advisor generates a problem that asks a value of a system parameter. This is a trigger to start the training mode. The problem is generated according to the system structure and the student model.

(5)The advisor proposes a system that is suitable to the student's understanding state. This advice is given when the student failed to work out the correct answer of the problem. The system that will be given to the student is generated by simplifying the original system that the student failed to understand. The purpose of the generated system is to bridge the gap between it and what the student has understood. The student will acquire the ability of applying physics rules to generalize cases by thinking about similarities between two systems. The level of simplification is decided according to the student model.

3. Inside of the Intelligent Advisor

3.1 Outline of the Learning Environment

Fig. 2 shows the structure of the intelligent learning environment. Parts that are available for students to build a physical system are prepared in the parts library. As shown in table 1, parts are accompanied with rules that defines their functions and buggy rules to identify students' error origins. A model of the physical system is represented by a network called causal network. The causal network generator generates the causal network from a given system structure that the student built on GUI and parts definitions. The table manager interprets student's input in the table. In order to measure progress of learning by using the table, the table manager labels each entry of the table correct/incorrect and experimented/predicted.

3.2 Causal Network

The causal network represents functional relations among system parameters. Fig. 3 shows an example of the causal network. It is generated by connecting functional definitions of parts according to the system structure. Values of constants like mass of weights and natural length of springs are given in the network. Values of unknown variables are worked out by propagating known values. Causes of student's incorrect answer about a value of a system parameter are identified by replacing correct functional definitions with buggy rules.

The causal network is used for the following purposes.

(1)To calculate correct values of system parameters.

(2)To identify student's error origins in order to infer the student model.

(3)To decide educational objectives.

(4)To explain causalities of system parameters.

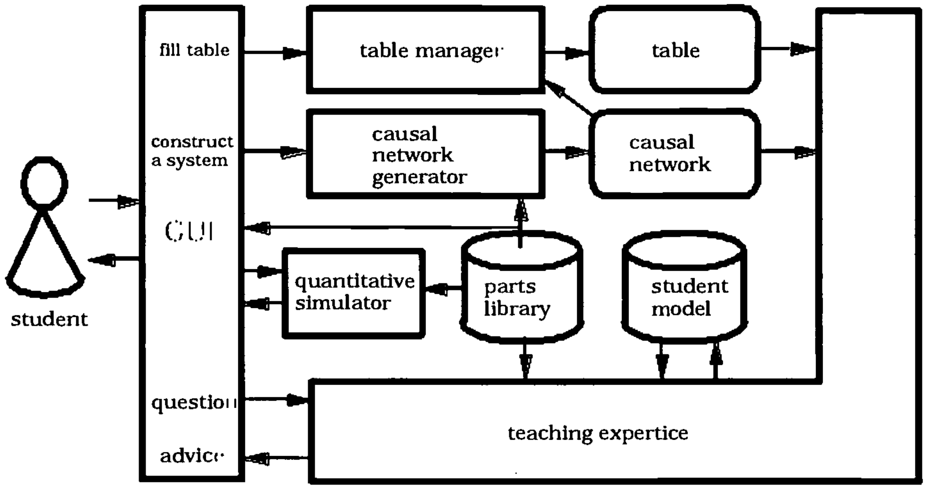

Fig. 2: Outline of the intelligent learning environment.

parts name	attributes	functional definitions
spring	F1, F2	F2 = F1
	DL1, F	DL = K * F
	L, NL, DL	L = NL + DL
weight	F, W	F = W
intermediate weight	F1, F2, W	F2 = F1 + W
branch	F1, F2, F3	F1 = F2+F3

Table 1: Excerpt of parts definition.

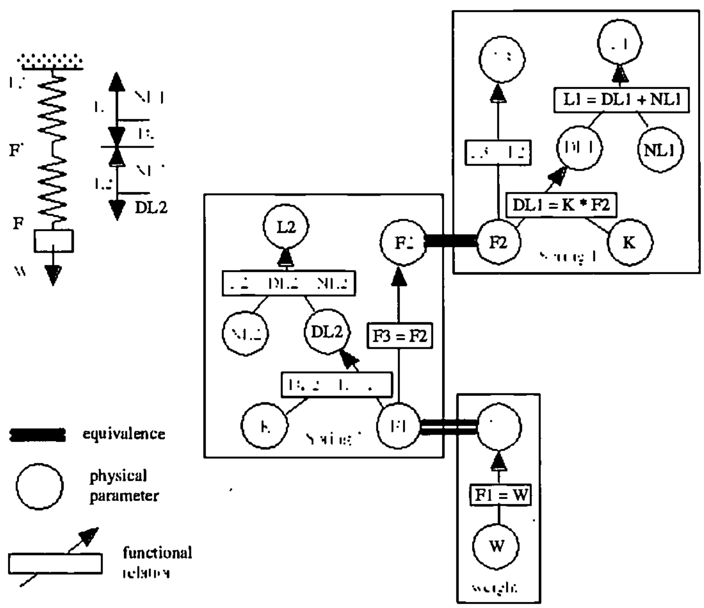

Fig. 3: An example of the causal network.

3.3 Student Model

Even if students know fundamental rules of physics, they may fail to apply them to complex systems. One of the purpose of the learning environment is to develop their abilities to apply these rules. The student model, therefore, should represent not only the understanding state of each rule but also generality of applicability.

Our student model is represented by a n-dimensional coordinate system. Each coordinate corresponds with a measure of generality of a domain. For example, the student model for the domain of springs is represented by a 3-dimensional coordinate system as shown in Fig. 4. Measures of generality are a number of springs connected in series, a number of springs connected in parallel and a number of weights inserted between springs. Understanding level of each physics rule, which is equivalent to a functional definition in table 1, is recorded at the point that corresponds to the generality of a physical system where the rule is used. The extent of generality that the student can apply rules is represented by a surface in the coordinate system that covers points of good understanding levels.

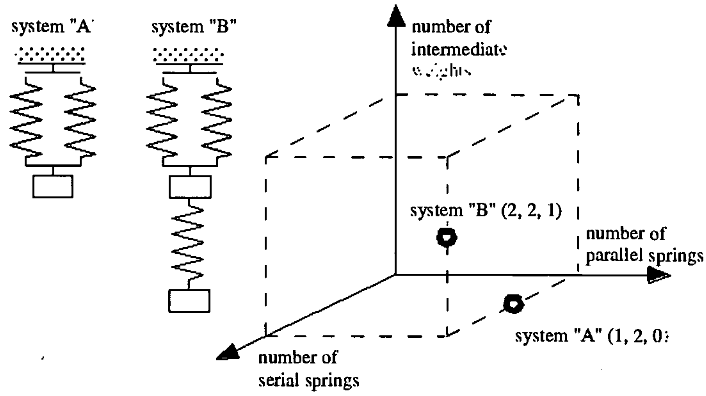

Fig. 4: Generalization space for student model.

4. Evaluation

We evaluated effectiveness of the intelligent learning environment by a pre-test and a post-test in a junior high school. Problems of both tests were the same. Students in three classes participated the evaluation. After the pre-test, students in two classes used the learning environment. They learned at least four physics systems, which appeared in the pre- and post-tests. Students in another class used a real equipment for experiments, and they conducted experiments on the same four systems. A teacher instructed what to do before starting experiment in all three classes. Students carried out experiments freely after teacher's instruction.

Fig. 5 shows the result of the evaluation. These graphs show percentages of students in four categories; "o->o", "o->x", "x->o" and "x->x". The left of the arrow "->" is the result of the pre-test and the right is the result of the post-test. "o" means correct and "x" means incorrect. Students who answered correctly in both pre and post tests are categorized into "o->o", and students who answered correctly only in the pre-test are categorized into "o->x". Four graphs show the following.

(1)Most of students in all three classes answered problem 1 correctly in both pre- and post-tests. They therefore know Fuck's law before the pre-test. But about a half of students had not been able to apply the law to systems in problem 2 and 3, and a few number of students could solve problem 4 in the pre-test.

(2)In case of problem 2,3 and 4, percentages of "x->o" in classes "A" and "B" are higher than the in class "C". Note that the percentage of "o->x" in class "A" is higher, because time of the post-test was shorter.

These facts indicate that the intelligent learning environment worked well for students to acquire application knowledge.

5. Discussions and Conclusions

This paper presented an intelligent advisor for a simulation based learning environment. The advisor helps students to learn fundamental physics rules and to acquire ability of applying these rules. In order to model the student's ability, we proposed the n-dimensional generality space. It can represent student's state that the student knows a rule but cannot use it for complex systems.

Learning environments for discovery learning have been investigated for long. [Reimann 1991] focused on hypothesis generation in his work. His learning environment was well-designed for students to make a 0.hypothesis and to receive feedback by using a graphical interface. But it doesn't have capability of diagnosing students, hence the feedback is not adaptable to states of students. [White 1990] proposed a method of progressive learning of

What expertise do teachers require to facilitate pupils' self-expression with multimedia?

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Abstract: This paper describes the expertise that teachers need to acquire in order to facilitate pupils' self-expression with multimedia. The central idea behind the argument is that multimedia is a creative tool for children and that multimedia learning in the near future is expected to be "Learning by Producing". In such a context of creative learning, pupils need to be recognized as multimedia producers. In order to achieve this situation teachers need to know how to become learning supporters, curriculum developers and multimedia coordinators, not just instructors. The necessity for teachers to know the typology of multimedia expression, the features of multimedia expression and program evaluation is also discussed with some suggestions.

1. MULTIMEDIA PRODUCTION BY CHILDREN

Before addressing the aspects of expertise teachers need to acquire in order to facilitate pupils' multimedia expression it would be very important to describe a new image of children learning, namely, children as multimedia producers and also what literacy they are expected to obtain in the process of producing multimedia products.

1.1 Children as multimedia producers

In IT education there has been a slow but steady shift from CAI (computer assisted instruction) to MACP (multimedia assisted communication and production) (Jacobs, 1992; Tanaka, 1995). This means that multimedia is becoming not only a teachers' instructional tool but also a creative tool for children. With the help of many user friendly software packages children are now using multimedia to express their ideas and the information they obtain during their studies. Thus it has become possible for children to experience the role of multimedia producers (Turner and Dipinto, 1992; Kenneth et al., 1994; Tanaka, 1995).

In addition, the collaboration between children is very important because multimedia production requires students to take diverse roles, for example, a writer, a painter, a video editor, an audio mixer, computer programmer and so on (McMahon, 1990; Crook, 1994).

For these reasons teachers need to acquire expertise which is different from traditional methodologies of instruction. These are discussed in the following paragraphs.

1.2 Multi-mode expression

Multi-mode expression is a comprehensive way of self-expression which integrates sound, pictures, videos and text. A good example of this is a musical. A musical incorporates music, singing, scenario, choreography, dancing, stage lighting, stage set and so on. Thus it can be said that multi-mode expression as actualized in a musical or a drama has much similarity with multimedia expression (Trowsdale, 1995). When multi-mode expression is done with multimedia, it results in multimedia products in the form of an electric slide show or an animation.

The potentials of multi-mode expression are very difficult to develop because of the subject barriers in the current school curriculum. But these potentials seems to be important in terms of self-actualization and talent development in a society where a visually persuasive and entertaining presentation is more and more required.

When multimedia production (a typical way of multi-mode expression) is introduced into the classroom, students are expected to acquire multimedia literacy in the process of producing multimedia programs.

1.3 Multimedia literacy

Table 1 shows a tentative set of multimedia literacy items. These ten literacy items can also become educational objectives in the instructional planning.

Table 1 Ten items of multimedia literacy (Tanaka, 1995)

Multimedia literacy requires an ability in the following items:

1. To understand the characteristics of multimedia, the various modes of information and their combination patterns.
2. To have a basic command of multimedia
3. To select appropriate media and to collect various pieces of information and find the relations between this information using those media
4. To operate data input and information retrieval with a variety of computer peripherals
5. To acquire learning methods and computer literacy through simulated experience with Hypermedia
6. To give a multimedia presentation making good use of the features of each medium
7. To convey multimedia products made with various computer peripherals to others by computer telecommunication
8. To produce a handmade TV program using a video camera, a video editing system, a sound effecter, a sound mixer, a multimedia computer and so on
9. To make presentation materials with an interactive video system or Hypermedia
10. To create multimedia products which integrate knowledge, images and emotions

2. CROSS-CURRICULAR MODEL OF MULTIMEDIA LEARNING

In most in-service training courses for the IT use offered by the local boards of education the main topics would tend to focus technological aspects of IT education more than pedagogical considerations for it. However, considering that IT coordinators are now being recruited in several technologically advanced countries like the United States, the United Kingdom and Japan, the classroom teachers' role could be changed from that of a technician to that of a pedagogical facilitator in the process of developing the IT curriculum and learning projects (North, 1991; Owston, 1995).

2.1 Isomorphic structure and cross-curricular model

Recently several books advocating cross-curricular practice have been published responding to the National Curriculum, which suggests five cross-curricular topics in the school curriculum (Webb, 1996; Radnor, 1994; Morrison, 1994). Before this Anderson (1991) had pointed out the importance of IT education as a cross-curricular element in terms of the availability of IT to all pupils and the possibility of improving the quality of learning through enhancing common information skills.

Similarly Fox (1996) discussed some effective ways to incorporate media education (one form of IT education) as cross-curricular catalyst into the school curriculum. Also analyzing twenty three case studies on innovative educational projects in science, mathematics and technology Black and Atkin (1996) reported that there had been some arguments for the curriculum connection in their discussion of summarizing their analysis. Thus the need to promote IT education as a cross-curricular theme has been gradually recognized.

However there has been little literature so far which discussed the potential similarity between multimedia learning and cross-curricular activities. In figure 1 such a similarity between the two is illustrated.

The similarity stems from the feature of educational multi-mode expression which is a common activity to both multimedia learning and cross-curricular activities because multi-mode expression needs both contents to include and means to produce with. Such a combination of the contents and means of multi-mode expression is a typical feature of cross-curricular activities. Thus when pupils perform multimedia production, a cross-curricular learning context could be helpful to them through providing pupils with both the aspects of expression which are integral elements of multimedia production.

This cross-curricular model illustrating the isomorphic structure of multi-mode expression would also be useful to teachers to develop an integrated learning unit for pupils' multimedia production through combining different subjects (Figure1).

2.2 Learning unit model

In order to foster the quality of learning activities and multimedia products, a guideline for the sequence of productive activities is necessary. After examining the learning unit models adopted in the two classroom implementations (Tanaka, 1995), several common features were found and a cross-curricular unit model was constructed according to these features.

The five common features are as follows:

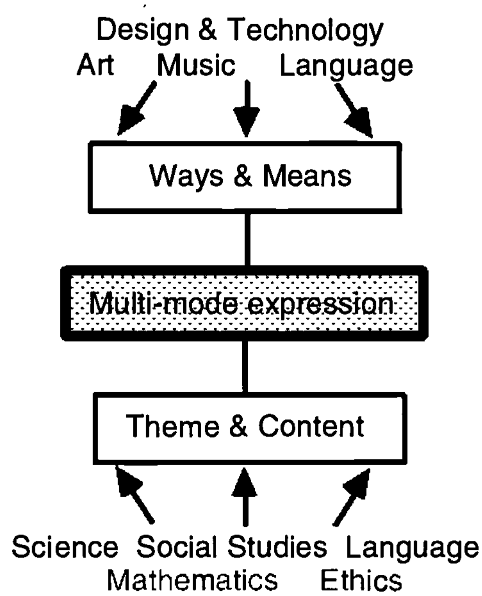

Figure 1 Cross-curricular model for multi-mode expression (Tanaka, 1995).

1. The model includes a comprehensive sequence of activities, i.e. an appreciation of various multimedia products, image construction of multimedia products, image enrichment by analysis of previous products and research outcomes, creation of scenario and design blueprint, production of parts, assembly of parts and a final stage, i.e. presentation, performance and appreciation.
2. At the fifth stage 'Production of parts' various expression modes, e.g. sounds, pictures, stories are integrated to produce moving images.
3. The first activity stage 'Appreciation of various multimedia products' simulates students' interest and the third stage 'Image enrichment' provides them with good examples of multi-mode expression.
4. The third stage is inserted to enrich the motif or theme with empirical data for students.
5. This model accommodates collaborative production and role assignment.

Figure 2 illustrates a cross-curricular learning unit model developed in this process. Naturally the model is based on the idea of combining the investigation phase which supports the contents of expression and also the production phase which supports the means of expression. This idea of combination is not original in the recent literature of multimedia learning, but it was already discussed by Innocenti and Ferraris (1988), who made a combination model of the instructional use of a database by showing the necessary linkage between the database creation phase and the investigation phase.

2.3 Typical multimedia learning projects

The provision of pedagogical ideas about typical multimedia projects would make it easier for class teachers to acquire expertise in developing an integrated learning unit with cross-curricular activities for multimedia expression. Here are some examples of project ideas which could function as scaffolding for the effective curriculum development.

Let's produce a CD-ROM encyclopedia

This project could include both investigation about the topics which pupils have in mind and multimedia expression with CD-ROM facilities. These topics might be related to one or some of the several subjects like language, social studies, science, music and art. Pupils' multimedia production would result in a variety of multimedia CD-ROM titles like a multimedia slide-show, a home town database, a botanical database and a computer art gallery respectively.

Let's open our children's TV station

As described earlier in this paper the production and delivery of TV programs are a typical cross-curricular multimedia work. When children select a drama program as a production task, the combination of a language class (in charge of producing scenario), a social studies class (ethics and related laws of broadcasting) and a art and design class (multimedia production) would be very useful. In contrast when they select a news program, the integration could be between language, social studies, art and design, science, etc.

Let's produce an Internet newspaper on the WWW

Nowadays multimedia production in this information society is rapidly expanding into an international telecommunication world. A tremendous amount of information is being exchanged through Internet. Therefore it could be considered as meaningful for pupils to experience cross-curricular activities related to multimedia newspaper production and to obtain communication skills which could be applied to their future career or everyday community services.

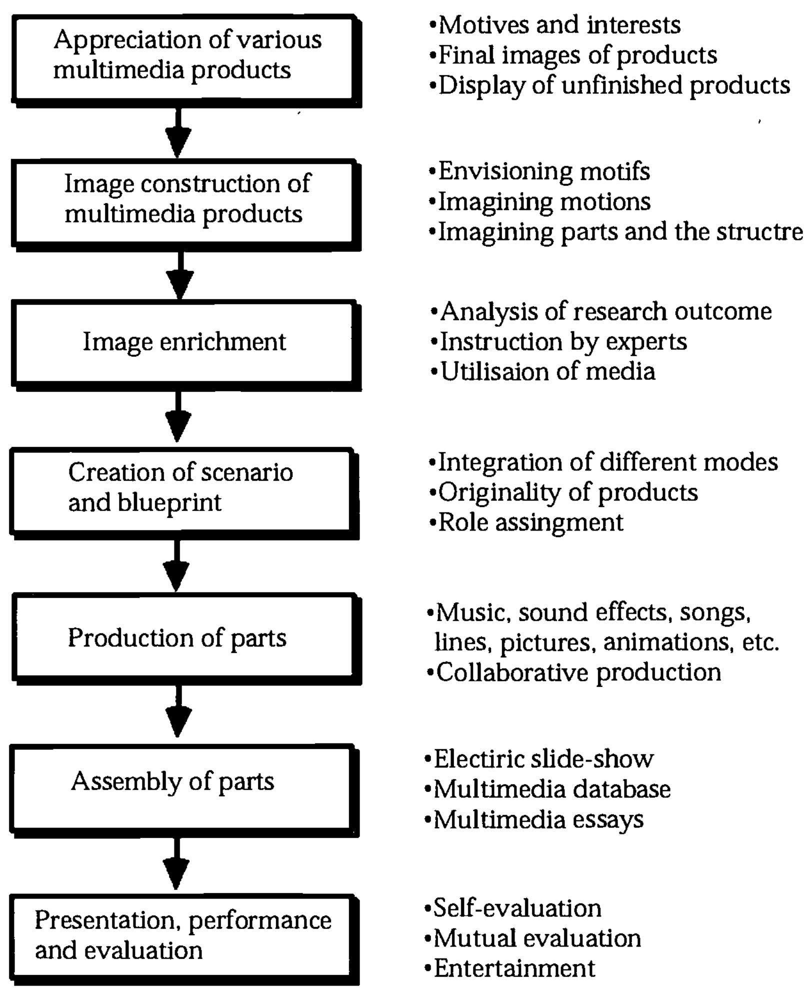

Figure 2 Learning unit model for multi-mode expression

3. FACILITATING ROLES OF TEACHERS

Pedagogical considerations at the level of curriculum development and project construction have been discussed so far. Then focusing on these two points specifically from the aspect of teachers' roles will be another important task to clarify what expertise teaches require.

3.1 Learning supporter

Considering that multimedia is not only a teacher's tool for efficient instruction but also a learner's tool for creative learning, it is important for teachers to note that their role is no longer that of an instructor but more that of a supporter for learners.

The objectives of a teacher as a supporter could be categorized into the following ten points.

1. To praise what pupils have done well in order to activate their motivation towards further learning
2. To provide them with good examples of products and research findings
3. To offer alternatives for the learning themes and the methodologies
4. To provide pupils with opportunities to utilize a variety of learning materials and multimedia
5. To prepare open space as a flexible learning environment in which to foster diverse activities
6. To prepare learning aids such as a guidebook, an activity sheet, an orientation leaflet or a promotion video
7. To care for pupils' learning difficulties and answer their questions
8. To make appointments with institutions and human resources outside the school to enrich pupils with as much direct experience as possible
9. To describe the sequence of learning activities
10. To give advice which fosters a collaborative atmosphere in the working group

3.2 Curriculum developer

Some teachers in practice might think that it would be a good idea to wait for new curriculum resources to be developed by researchers and publishers. But what is more valuable for professional development of teachers is that they experience a workshop to develop curriculum by themselves. It will inevitably profits their creativity and curriculum knowledge on IT education. The role of a curriculum developer facilitating pupils' multimedia expression would include the three aspects described below.

1. Curriculum development for basic training of media literacy
2. Development of a cross-curricular learning unit
3. Emergent curriculum development

3.3 Multimedia coordinator

In multimedia learning it is also important for teachers to equip pupils' learning environments with multimedia rather than just to use the media for the delivery of information to their pupils. The idea behind this is that pupils should be encouraged to take advantage of multimedia on their own. What is indispensable in relation to this idea is a 'media-mix' approach which encourages pupils to think of and put into practice meaningful combinations of different types of media. Typical factors which teachers would need to consider are as follows:

1. Preparing media-corners space
2. Setting up a multimedia studio
3. Offering opportunities to use an intelligent library
4. Providing cooperative keypals and human resources for networking

But it is always difficult for pupils to find people who cooperate on a regular basis. Thus teachers will have to play another important role in making connections with keypals on the net or local volunteers in the school district. After establishing the connections, it is again the role of the teachers to act as a learning supporter as described above in order to encourage collaborative learning.

4. SPECIFIC KNOWLEDGE ABOUT MULTIMEDIA PRODUCTION

Furthermore it is another requirement for teachers to have some specific knowledge about multimedia production. With this knowledge teachers could guide and evaluate pupils' multimedia products and presentations.

4.1 Educational typology of multimedia expression

At first teachers need to know what types of multimedia expression can be done by their pupils. Typical multimedia expressions by pupils would be categorized as follows:

1. Multimedia production
2. Multimedia presentation
3. Multimedia debate
4. Multimedia telecommunication

4.2 Features of multimedia expression

Teachers need to have an overall understanding of the features of multimedia expression to facilitate their pupils understanding. This understanding should cover the seven points described below.

1. Expressing how you have reflected your personality and the originality of your investigation on the program
2. Combining various modes of information, i.e. multimedia materials
3. Adding interactivity to the program
4. Designing an information structure which is easy for users to understand
5. Designing an interface which facilitates information retrieval
6. Combining logical expression and emotional expression
7. Reflecting the merits of different roles within a group to achieve collaborative production

4.3 Creativity and spontaneity necessary for multimedia production

In order for teachers to evaluate pupils' productive activities with multimedia several symptoms of creativity and spontaneity which pupils would show during their multimedia production will be helpful.

1. Sharing of different skills needed in multimedia production
2. Construction of a role structure and role assignment
3. Needs assessment aimed at the audience
4. Collaborative information gathering beyond the National Curriculum
5. Mutual teaching and learning

5. Conclusion

The forms of expertise identified above, to be included as a knowledge base in in-service training program, is necessary because pedagogical knowledge relating to the educational use of information technology is as necessary as technical knowledge and skills. The subsequent research tasks needed will be to develop effective training methodologies to make this knowledge available for practice. In training workshops it will be important that this knowledge base be utilized with a great deal of flexibility so that teachers can adjust the content to meet the needs of each classroom context. In order achieve this, a comparative study methods using several cases of implementation would be one effective way of identifying and producing possible means of teacher training.

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Collaborative Internet Learning

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Abstract: My pioneering in the area of telecommunications and the use of the internet across the curriculum in Australian schools has been achieved through involvement with the I*EARN (International Education and Resource Network) network. I have initiated a number of very successful international collaborative projects. This is a very exciting time to be involved in education! For the first time as classroom teachers, we a have the capacity to harness technology to curriculum creativity and on a global level. This type of learning experience cuts across the traditional borders and barriers of our educational systems. It links like-minded teachers globally and allows curriculum development to become a flexible, collaborative process that tackles a broad range of immediate issues and needs. Primary, secondary and tertiary institutions can mobilise combined teams of human resources that challenge our traditional employment bases and concepts. This type of curriculum design extends effectively into the general community and invites interest from business and corporate bodies keen to encourage a technology smart workforce.

Changes to the Traditional Learning Approach and School Structure

1. The Role of the Teacher

When embraced at the classroom level, collaborative learning will accelerate the changes in the role of the teacher that have been occurring over the last decade. These changes include the shift of role to facilitation for the teacher, rather than the teacher being the source of all knowledge. The teacher will be needed to guide the learning process and to assist with the location of information in the labyrinth that is the internet. In a collaborative project, teacher time is also spent for example on establishing working partnerships on the net, seeking links with outside organisations and resources in the community, looking for new ways of utilising the technology in the project, presenting students with information on protocols and design recommendations for WWW page writing and collaborating with other teachers involved in the project. Collaborative learning means that teachers must be prepared to really work across the curriculum in a spirit of cooperation. There is no room for single minded approaches to subject areas or the inability to be flexible in course design and planning. The linking together of subjects through collaborative projects provides students with a holistic educational pathway and can lead to the development of real problem solving skills. Using the technology, educationalists can develop powerful networks of contacts and resources to draw upon outside of the school boundaries. It is important to maintain suitable levels of communication and protocol within these networks. These partners can often become long standing colleagues, involved in future collaborative projects and providing links to other global resources.

2. Resource Equity

Heavy school financial commitments in the area of technology mean that the issue of equal access across the curriculum is paramount. It is to be expected that subject areas with a comparatively small budget would resent the vast amounts of money that are put into the school computer lab if they can see no real use for their subject area or if they cannot gain physical access due to traditional computing subjects blocking out the timetable. For collaborative learning experiences to occur schools need to be working towards a model where enhancing technology is inherit in each subject area and staff and students look to it appropriately as an accessible tool. Technology must not remain the property of the (traditionally) privileged few staff in an educational setting; disseminate the knowledge throughout your staff workforce. As networking in schools becomes more common, it is an individual and often financial decision as to where the technology platforms will be located. Given that most school still find the traditional one or two room lab the most practical solution, I would like to suggest that schools at least trial the ACOT (Apple Classrooms of Tomorrow) model in one or two general purpose classrooms if possible. A cluster of 3 or 4 machines are stationed in the room to be used as required. Keep a log book of use and timetable a range of classes into the room a range of subject areas. See what happens, then move on from there.

Positive Spin Offs From Collaborative Projects

*Increased connectivity for real cross-curriculum based work amongst schools
*Experience in the use of new age technologies for communication with a purpose for staff and students
*An enhancement of the trust relationships between Australia and other countries
*The publication of student work in a booklet is concrete evidence of the bonds of friendship and understanding built during the project and continuing through telecommunications long after a project's successful completion
*Other schools take up the model for this method of communication
*Developed appreciations for the unique elements of our own culture and the culture of others
*Heightened awareness of Australia's identity in the global community
*Imparting of critical technological skills to participating teachers and students, providing valuable training for global competitiveness in the 21st century
*Potential for multimedia applications with real purpose for the students
*Involvement of traditionally technology resistant subjects

Real Outcomes

It is important that when we are using a medium as intangible as the internet that we plan to have outcomes for students that are real and tangible. The possibilities are endless, but some that I have found successful are:

*Global magazines that put into print a selection of writing and artwork collected during the course of the project. These magazines utilise other aspects of the technology through desktop publishing. It is important that all participating schools globally are represented in the publication, and that they receive copies. In many cases this will assist them in convincing their administration of the value of the students involvement and of course is a great thrill for the students to receive. We presented copies sent from New York for one project our students had been involved in at a general school assembly - it made a nice change to sporting awards! A magazine is a lasting document that can be read in more places that a computer monitor!

*Global art exhibitions that commit schools to producing a number of pieces of work on a central theme by a particular date. Samples are sent to all participating schools from each base school. Exhibitions are set up in the school and comments on the work are collected from art classes and emailed to the artists who have sent the pieces. We have always organised an opening with guest speakers on the theme, and had students read out related theme based written pieces from representative countries at the opening. A virtual gallery gives interested students a chance at designing a WWW page of immediate interest to participating schools.

*A composite quilt made up of appliqued squares that represented the project theme is a great tool for bringing in the materials technology subject area and for involving a large number of interested schools. The National Identity Quilt, toured Russia, Budapest and Canada.

*A video resource of suitable materials uncovered in the project for general school use. Students see feedback on processes such as interviewing that they have been directly involved with. This is a lasting resource for school use.
*A CDROM disk resource of suitable materials uncovered in the project for general school use. Once again a lasting resource.

Associated Problems

The problems encountered come back to basics; time, money and access to equipment and login facilities. With determination, despite your school's resource situation, you can overcome these and be involved in major collaborative learning experiences. At Lake Bolac Secondary College all the success stories mentioned in this article were achieved with one phone line and modem linked to a single machine. It may fall back on a few people to download student writing prepared on other machines, at convenient times, but don't let the promise of next year's technology budget deter you from launching into current projects now. Great opportunities arrive daily through your email and networks. My problem is how can I involve my school in all that is available with limited hours in the day!

Other problems encountered can be overcome with careful and flexible initial planning. These include for example, conflicting international school holiday calenders and receiving firm commitment from participating schools. Don't expect to get other schools immediate involvement, remember we all have our administrative, curriculum and teaching commitments to juggle and negotiate. Be prepared to plan a year ahead when launching a collaborative project of large proportions. Raising money is never easy. There are certain organisations interested in this type of project support, such as the Australian Foundation for Culture and the Humanities. By meeting their annual criteria with your project description you can gain access to the necessary funds to support projects. Be ready for some disappointments, but roll with the punches and look in other directions that may be suggested to you. Be sensitive to the fact that in many countries teachers are meeting the costs of telecommunications personally for their students. They will not appreciate being asked the same questions time and again if the information has been supplied and is available in say a virtual conference on the I*EARN network for all to read. In many countries the approach to computers is still very much traditional programming. We need to support our pioneer colleagues who will be fighting odds, curriculums and administrations less sympathetic than our own. Treat your international contacts with respect.

Industry And Organisation Involvement

My first experience in linking technology students with industry was when I approached the International Wool Secretariat about putting all their educational materials on the WWW. This project allowed students to gain a first hand understanding of the protocols of industry and the processes involved in developing a prototype and working with a professional digital designer. The wool industry was of course close to our hearts being from the Central District of Victoria. We were able to compare the end product with the professionally developed American version that was being developed simultaneously. At this stage the students and myself had little experience with the use of HTML and this was a positive introduction to what was to become a new multimedia inclusion to the curriculum. We are still receiving emails and enquiries about the page from a wide range of internet surfers. We went on to visit and prepare a simple Web page for the National Wool Museum. This meant the school needed to invest in a digital camera so we split the costs with the nearby Primary School. As the students' skills developed in HTML, they have written pages for organisations like, the Grampians National Park and the National Trust Property, 'Mooramong'. Our text based work in the I*EARN virtual conferences can now be complimented by Web page development on the project. At this point in time students at technology conscious schools are rapidly developing advanced skills in this area. In many cases industry is keen to have a Web presence, but uncertain how to obtain this, opening up a perfect partnership for real outcome curriculum work. The possibilities are endless for all key learning areas as many previously closed doors open for industry research prior to Web page development. Other organisations like the Asian Education Foundation are pleased to involve students in Web work in their efforts to improve the studies of Asia in our curriculums. Recently, one of my students launched her page detailing the International teaching fellowship to India at the Education Victoria Conference. The Melbourne Holocaust Museum has been a wonderful resource and partner for collaborative project work.

Equity And Access

The collaborative approach has proved a very attractive use of technology for female as well as male students. Female students enrolling in senior technology courses are electing to use HTML as one of their software types and looking to community based projects that interest them. The percentage of female students electing to take these courses has increased dramatically at our school. Working in a team to develop an appropriate, creative solution to a real life problem is an attractive way of utilising new technologies.

Three Success Stories

1. War and Peace 1995

With nuclear testing hot on the media, students were keen to use the internet to make a statement about the issue. This statement met with over 2000 supportive responses across the I*EARN network and was teased out to become a collaborative project that examined the issues of war and peace in general. This was my first experience in how technology based cross curriculum ventures could produce impact on the whole school in a number of ways:
English

*The issue of Peace was taken up through text studies and by addressing the question of whether the A-Bomb should have been used in WW2. Finished pieces were posted into the electronic conference. Needless to say, the Japanese students had a different view on the A-Bomb to some of our students!

*Studies related to senior texts on the Holocaust were conducted and resulting writing sent into the conference. A visit to the Holocaust museum resulted. Student worked in a second I*EARN conference here, specifically on Holocaust issues. They were able to contact survivors personally over the internet. Some heated discussion was generated with New York students over one controversial essay!

*In history students were examining WW2 and propaganda and wrote up some interesting pieces on Hitler

*The Art department recognised the power of the technology and the first global art exhibition was organised, with school from 7 countries participating and a real and virtual exhibition resulting.

*The Regional Rotary Public Speaking Competition saw a student representative win with a speech on World Peace that she had prepared for her Year 12 Writing Folio and the global audience.

*The launch of the art exhibition occurred in a whole school Peace Week. Guest speakers from the Holocaust Museum addressed the whole school. Live phone calls from the US and Israel were put over the speaker system. The broader school community was invited to attend and much media attention was attracted due to the death of Prime minister Rabin the day before. Students elected to represent various countries and read out messages of peace that had been sent into the conference.

*A Peace Garden was created by the History students, and a commemorative plaque opened by a Holocaust survivor.

2. National Identity 1995-1996

This project was interactive and cross-curriculum by nature. It relied on the use of technology to maximise global participation, access and input, and focused on The Arts, Culture and Humanities and the Sciences within its content. It examined the myths and realities of the National Identity and our emerging image globally. It allowed students to explore the impact of multiculturalism, the Arts , politics, economies, technology and history on the dynamic, evolving society we have today. Students participating came closer to knowing what it meant to be Australian. Particular emphasis was placed on symbols and events, and their implications and interpretations.

Written component

Global surveys, focusing on the range of subject areas mentioned above, collected data from I*EARN youth though the internet. The focus was on involving as many subject areas across the curriculum as possible. Interactive responses to clarify issues and discuss interpretations between students was achieved using email and the project conference topic. The key schools took on the responsibility of forming a joint editorial team, working across the internet to organise all editorial functions and decisions for a global magazine publication containing student writing collected throughout the project. Illustrations for this publication were taken from student entries in the project's global art exhibition based on the same theme.

Global Art Exhibition

The global art exhibition organised over the I*EARN network, established a number of global sites to display Australian students' work on the theme. The Australian sites received in work from other participating schools in Australia and Internationally. An interactive feature of this exhibition was email discussion between the artists and student body, during the exhibition periods. A virtual gallery of the art work was constructed on the World Wide Web. This allowed all schools to access work on display at other sites internationally.

The Study Tour

An exchange of students with two schools in Moscow for a three week period, allowed representative global classroom students to experience another culture and lifestyle in contrast to their own. Intensive interaction using the I*EARN network's bulletin board conferences, before, during and after the trip, allowed this visit to have broad benefits to I*Earn students Australia wide. In other words, the number of students and teachers involved in and impacted by this component of the project was dramatically larger than the number of persons who actually participated in the exchange. Students prepared materials emerging from the project and draw upon conference entries from other students Australia wide, to present what they believe to be a realistic view of Australian society today to the students in Moscow. Comparisons between the identity of Russian and Australian Society formed a special section of writing by participating students were included in the Project's publication which was launched and distributed at the I*EARN international teachers' conference in Budapest in 1996.

3. Faces of War 1996-1998

(http://www.araratcc.vic.edu.au/users/iot/fow/faces.html)

This project opens up the possibilities for education to use new communications technologies effectively and creatively in the study of life experiences of ordinary people in traumatic and global circumstances. This project creates an opportunity to reconsider history and scale it to the dimensions of people rather than politics, ideologies or national movements. It binds generations and cultures through sharing. The project marks the first edition of an ongoing commitment by a team of schools to produce a globally distributed magazine. The 1997 edition of 'Faces of War', commemorates the victims of Wars since 1938 (veterans, P.O.W.'s, refugees, Holocaust survivors). In consultation with National Returned Soldiers Leagues (R.S.L.) and Holocaust Museums, Australian students are invited to join the project, conducting taped interviews with relevant individuals, which will then be presented as transcripts to be published on the internet, in a global magazine and in an oral history resource on video and CDROM. International students conduct similar interviews and transcripts and this serves to stimulate electronic exchanges with Australian students globally. Subsequent responses to the transcripts, and related theme writing sent into the internet conference from National and International schools were published in the global magazine which was sent to all participating schools and every Victorian school. A large vibrant web site was established in 1997 to supplement the original bulletin board conference (I*EARN network). However, the bulletin board continues to enable schools with low level technology to participate in the project. Selected Australian interviews were video taped professionally and edited to create an oral history CDROM resource made available to Victorian schools, and educational institutions. This was distributed by the Directorate of Education and sponsored by the University of Ballarat who involved some of their students in the design. This CDROM also published for the first time an original WW2 prisoner of war diary with teaching and learning materials developed across the curriculum and linked to each diary page.
A global art competition and exhibition was held. Australian and International Schools were asked to send in work on the theme for a central Metropolitan exhibition. Samples of this work were entered into a virtual gallery on the World Wide Web site and constructed by students. Visitors to the Melbourne exhibition were asked to make an entry into a virtual visitors' book on the WWW page. The work clearly shows the difference between the experiences of war for each cultural group of students. After the Australian exhibition, samples from the exhibition are mailed to participating schools for exhibition Internationally. The gallery can be accessed from the web site. Students undertook to construct the Victorian R.S.L. web site as part of the project. This major undertaking was launched in conjunction with the opening of the art exhibition at the headquarters of the Victorian RSL. Major educational leaders and veterans attended this gathering and it was held on one of Australia's commemorative days, the 11th of November. Mr Peter Copen (I*EARN U.S.) has worked on organising feedback from students involved in the project and the evaluation of these comments. In 1998 the project offers students globally a number of literary and art competitions and has attracted funding from the Department of Veteran Affairs. We will focus on setting up

teams of human resources in 1998 to answer student questions on the the theme of 'War', thus utilising the grey workforce and their living experience. Problem solving using the technology takes on a new dimension when a student has to present memorabilia or original letters and diaries to capture the atmosphere of time and trauma. A large number of teaching and learning ideas are available for teachers on the web site and reach across the curriculum.

In Conclusion

The rewards available in teaching and learning through the collaborative approach will outweigh the extra effort that may be involved as you get deeper into working with networks outside the school boundaries. It is important that we all strive towards establishing a working environment and curriculum that allow us flexible access to the opportunities now open to education. The technology in our schools is only as good as the curriculum innovation and enhancement we achieve with it.

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An Authoring Tool for CAI for End-User Modification using Feedback from the Learning Process

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1. Introduction

When educators evaluate teaching materials and methods, they tend to measure the knowledge acquired by students from teaching material by using results of examinations. We propose that they should evaluate the courseware based both on the results of examinations and the log of student learning behaviour.

The methods that Sakamoto has reported only involve how to obtain data for evaluating courseware, describing in particular the actual questionnaire.[1] The data gathered after a class may include uncertain as well as intentionally inaccurate information. Oda has reported that HyperClassroom records student learning behaviour, i.e. practice, references and communications, in order to build the student model [2], but he has not mentioned courseware evaluation. However, there are some research results on authoring tools.[3][4][5] The focus of current authoring tools has been on supporting the teacher creating the courseware.

We propose a method for collecting data for courseware evaluation. That is, the data to evaluate the courseware is acquired by itself in parallel to the student learning process. When the student stops temporarily or finishes a learning session, the system sends data to a computer server. In order to put the idea into practice, authoring tools should support not only the creation and development of courseware but also the acquisition and analysis of data for evaluation.

In this paper, we describe how to gather data in order to evaluate courseware and give parameter for improving the courseware for educators based on the records of students' learning history. These functions should be included in the authoring system. We focus on how to obtain the data but do not mention statistical methods.

2. Courseware and its evaluation

In this section we describe the structure of our authoring system in order to realize the above mentioned idea. The system gathers information concerning interaction between the lessons and students as learning history. The data is transferred to the computer server and analyzed. Fig. 1 shows a model of our idea.

Fig. 1 Aquiring and analyzing learning histroy

2.1 Student behaviour in learning

Fig. 2 depicts a state transition diagram during student interaction with the courseware. In the learning mode, while the student works through the lesson, the LSLP (logger of students learning process) simultaneously records the interaction. For example, a student's referencing page, study time, keyboard typing and mouse clicking. In the quiz mode, the LSLP records right/wrong answers, unexpected answers and expected wrong answers for each question and each attempt. In reviewing pages, the LSLP records the students' referral to help or regular pages.

Fig. 2 State diagram in studnets learning

2.2 Assessment of courseware

The ALSLP (analyzer of students learning history) extracts two data sets from the data recorded by the LSLP. One is an assessment education. The other one is a assessment acquisition for mastering the use of knowledge. The instructor can evaluate each section of the courseware and ways of mastering the implementation of knowledge from each data set.

2.2.1 Mastering the use of knowledge

When we estimate mastering the use of knowledge of each student, we may define it as study time in obtaining the correct answer of each question, a ratio of the time to the number of referenced related pages, the number of referenced help or hint pages and the number of unexpected wrong answers. These items are extracted by the ALSLP.

2.2.2 Assessment education

Assessment education is closely linked to the evaluation of courseware. We use an expanded version of Sakamoto's methods. ALSLP extracts the following items from the data recorded by LSLP for the class and each student.

(1) study time : maximum, minimum, average in class, actual study time of each student

(2) the number of right answers, wrong answers

(3) the total number of referenced pages

(4) the number of unexpected answers

(5) the ratio of the total number of referenced pages to the number of correct answers

3. Design and Implementation

The software system discussed in section 2 has been developed as expanded Tsumiki. [4] [5] Courseware created by Tsumiki consists of Tsumiki pages, pasted objects on a page with hyperlinks to each another. Tsumiki Executor interprets and executes the Tsumiki script in the courseware. The system that we have developed consists of clients for students and teachers, and a Tsumiki server as shown in Fig.3.

Fig. 3 System Configuration

3.1 Tsumiki server and communicator

The Tsumiki server has courseware files, SQL database files to keep each student's learning history and ALSLP.

Students can transfer specified courseware from the Tsumiki server to their own computer using the Tsumiki Communicator. At this time, the Tsumiki server sends the selected courseware, executor and LSLP. The data recorded by LSLP is transferred by the Tsumiki Communicator and stored into SQL database.

Fig. 4 shows the relationship between four schemes of the SQL database and their data structure. We call this database DHL (Data Learning History).

Relation among the tables

Fig. 4 Data Structure of DLSLP

User

Name	ID	Password

Courseware Table for Each ID

No.	Title	Done or Suspend	Score

Student Learning behavior log for each ID

Time1	Time2	Page No.	Item	State	Answer

Answer to question

Right/Wrong	Unexpected Wrong Answer	Forecasted Wrong Answer

Definition of each table

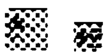
Fig. 4 (b) Data Structure of DLSLP

3.2 Tsumiki executor

Tsumiki executor requires an ID and Password for users and queries the ID and Password on the Tsumiki server. After checking them, executor starts to transmit the courseware to the client. If he/she is a new user, the Tsumiki server creates a new database file. If he/she is a registered user, the Tsumiki server checks whether he/she has an interrupted or incomplete lesson.

3.3 Creating questions wizard & User interface

The Tsumiki editor provides a Creating Questions wizard for teachers to formulate questions. This enables LSLP to easily ascertain a student's current state. Furthermore, it facilitates the development of selection and descriptive questions by teachers. The creating questions wizard guides the teachers to initialize style questions, a number of question hyperlinked hint pages. The wizard automatically provides a standard question model for teachers.



(a) Inputting a number of page and choosing mode (b) Actualy making a question(type of descriptive)

(c) Actualy making a question(type of selction) (d) Seting reference pages

Fig. 5 User Interface of Creating Questions Wizard

Fig. 5 briefly shows the method of creating questions attached to courseware using the Creating Questions wizard. A number of page is typed in the box. Teacher can chose the way showing questions and answer by mouse clicking. Teachers inputs a number of queation page and choses mode of question. Page No. is typed in the box. Teacher can chose a kind of question, descriptive or choices. Teacher set up text of question, answer and forecatsed right answers. References pages for reviewing to get right answer would be chosed from list of all pages.

4. Implementation

The various parts of this software system have been implemented using Visual C++ and Windows 95. The ALSLP and database files in the Tsumiki server have been implemented using MacPerl and Buttler on Macintosh. Users access the Tsumiki server via the Tsumiki Communicator which has been developed in Visual C++. The reason for not using a Webserver is that the target users are relatively naive with regard to computers, as many K-12 school teachers are computer novice users.

4.1 User interface for students

After checking a user's account file, the Tsumiki Communicator shows the list of courseware on the student's computer screen. The student can choose one lesson from a menu by mouse clicking. The Tsumiki communicator starts to download the courseware. After loading the courseware, it is immediately ready for use.

Although the student can begin the learning, they don't need to know the mechanism of the system at this point.

4.2 User interface for teachers

The teacher also communicates the Tsumiki Server with Tsumiki communicator. The teacher can not only download any courseware lessons for editing, or obtain results of analysing the students learning history but also loadup the courseware. Of course the teacher can also use the ALSP for extracting various data from DHL.

5. Conclusion

In this paper we have described the design of a networked authoring tool which obtains a data set for the assessment of courseware. Furthermore, the editor component of the authoring tool provides a creating question wizard mode for teachers.

The features of this system are to provide indexes of assessment for teachers and to allow teachers to easily include questions in courseware. Teachers can evaluate courseware developed by themselves using extracted indexes. The data for assessment is acquired by students' interaction with courseware.

Through developing the system and experience, we have identified two issues to be solved. One is that instead of using teachers to assess the courseware, we have to develop an expert system. The other is that the data set should be collected not only by recording and measuring interactions but information regarding student concentration on courseware should be also be gathered. About later issue, we have developed a measurement system using face image processing.

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USING THE WEB TO EMPOWER A CHILD'S INDEPENDENT LEARNING

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Abstract: Today's children can adapt and respond far more rapidly to the dynamics of the information age than their parents or tutors. Consequently educationalists aim to foster independent learning, where the child's own explorations are facilitated rather than constrained by the knowledge of the tutor. The Web assists this process, as it offers a vast learning arena for children to embark upon their search for knowledge.

A study was conducted using a Web browser involving what could be termed as a particularly representative computer literate child. By browsing the Web and email, the child independently augmented a task set in her class on the topic of the European Union and its member states. The child was thereby empowered, unlike the other children, to find out more about the task rather than being restricted to relying on the teacher's knowledge, one or two books, or on a CD-ROM.

Introduction

The 'Information Society' is visualised as being an essential requirement for a modern age, but its current drive is focused on information consumption rather than the quest for knowledge. If this notion is correct, then Aldous Huxley's statement that "life is short and information endless; nobody has time for everything" [Huxley] has considerable insight for a society ready to embark on what can be termed now as the "society of mass media and unlimited communication" [Tyrell & Tvedt 1998]. Similarly the Rt. Hon. Michael Heseltine, the then British Deputy Prime Minister in his speech "Communication in a Fast Changing World", declared that "the information revolution is about people, not machines", and that teachers "should face up to reality by acknowledging the inexorable advance of new technology" [Heseltine 1995].

Clearly then, along with many of the enlightenment and post-modern philosophers, we must remember that information itself is not synonymous with education or knowledge. Moreover, today's children can adapt and respond far more rapidly to the dynamics of the information age than their parents or tutors [Ultralab 1993]. Therefore, educationalists should encourage independent learning, where the child's flexible, creative and critical thinking is facilitated, rather than constrained by the knowledge of the tutor [Tyrell 1996].

From the network learning concepts of [Schon 1971] and the 'learning webs' of [Ilich 1973], it is reasonable to suggest that the Web will be a natural progression through which independent learning can take place. However, it should be noted that this concept remains to be fully evaluated. Therefore, the following study was conducted in order to gain an initial insight in to the use of the Web as an educational tool for children.

Study Task

The research that this paper is based upon was conducted in 1996. A computer literate school child was facilitated in order to obtain information from data repositories, employing the Web. The task involved the child using the Web to augment a typical school project. The project, set for her entire class by the teacher, was about the European Union and its member states. The objective of the study was to observe the anticipated learning, intellectual and engagement issues of the child, prior to mass popularisation of the Web.

The School

The school is situated in a small village in suburban Kent, South East England, for children aged from four to eleven years. Two hundred children attend the school, with an average of thirty children per class. The school is highly sought after by parents and children alike, for its traditional educational values and teaching methods.

Access to computer equipment at the school has been limited to five low performance PC's. However, recently two new multimedia Pentium® based machines have been purchased by the Parents Teachers Association (PTA). At present, these new machines are not fully functional due to the teachers inexperience in the use and deployment of computer based activities. This typifies British primary schools, where teachers inexperience with information technology is commonplace [Heseltine 1995].

The Class

The class under discussion consisted of thirty mixed ability children aged ten to eleven. The children were set a project on the topic of the European Union and its member states as part of their normal schooling. They had already started work on their project using reference books and photocopied hand-outs, and so knew the boundaries of the project. The method of constructing their topic book to display their findings and other additional ideas for each country had also been covered by the teacher. Groups of children were assigned a particular country within the union and they then worked singly or collaboratively, to produce the research information to be displayed in their topic books.

Study Child - 'Amanda'

The study child, Amanda, a ten-year old girl in the class, was also subjected to study in previous work [Tyrell 1996]. There, Amanda demonstrated her skills in the genre of computer mediated communication (CMC) [Kress 1994] very effectively. Amanda's academic standing in the class was within the top twenty percent and, surprisingly, was one of the few children in her class who employed computers to support and supplement her learning. From the prior CMC study, it was considered that Amanda would rapidly be able to browse the Web and appreciate its potential. Although her computer literacy makes Amanda somewhat distinct at present, she could nonetheless be considered to be particularly representative of children in the near future who will be educated with an awareness of telematical concepts [EU 1994].

Experimental Design of the Study

In line with the technique adopted by [Tyrell 1996], Amanda was both observed and facilitated by the researcher. These functions were nevertheless kept separate, and Amanda was facilitated in her ventures through cyberspace.

Training Event Prior to Actual Study

One week before the study itself, the Web was demonstrated to Amanda. She visited the 'Walt Disney' site http://www.disney.com, and navigated the on-line pictures of 'Pocahontas'. These were then saved on local disk in a way still accessible by the Netscape browser. From these saved results Amanda subsequently demonstrated her findings to three class colleagues, and her five-year old sister, using her home computer during the week prior to the study.

The use of a training session was considered essential as it removed the possible novelty and potential fear factors of the Web. From this interaction it was hoped that Amanda would gain an insight into how the Web may serve both her current school project and future educational activities.

Actual Study

As explained earlier, the appropriate computer and associated technical resources were not yet available at Amanda's school. The study was instead conducted in the Library at Mid-Kent College, Horsted Campus, in Kent with a direct ethernet connection on a Windows® based 486 DXII-66 computer, running Netscape® 1.1.

Amanda was given a previously recorded URL http://www.cec.lu from which she accessed the Web for three hours. She had been instructed to access information that would aid her project and then to explore further avenues of interest to extend her knowledge of the subject area. The primary objective Amanda was given, was to search for a choice of selected member states and from there, to explore and retrieve facts for reference and inclusion into her own work.

This was achieved by clicking on links, images, the forward and back buttons, and the history and bookmark menus. Where necessary, guidance and direction was provided by the facilitator to help the child develop her skills, with helpful clues being administered to prompt for other avenues of research and why the data she had found was of relevance to the project.

The next stage of the task was the use of a search engine to locate information. This was prompted by the limited educational value of the information found using the above techniques. The standard Netscape search feature, 'Net Search' was used as the starting point, as this was the most likely place that users would first try given Netscape's popularity and that 'Net Search' is part of Netscape's main toolbar. Once the list of site matches were displayed, Amanda tried to interpret the associated short descriptions for relevance to her task. By clicking on the more promising sites, she investigated the subject and then returned to the search list for further investigations. Whilst engaged in the search and review mode, Amanda recorded bookmarks or saved the page as a HTML file, if she valued the information found. From this cyclic process, Amanda found some information of relevance to the class topic, although again she found the results were of limited educational value.

Summary Findings

The study demonstrated that Amanda's ability to interact with the Web browser was not an issue. She adapted to the environment, due to her prior knowledge from [Tyrell 1996] and the previously discussed demonstration at the Walt Disney site. She negotiated the hypertext links and valued the Web's dynamics, its breadth of information and, in her words, the Web's 'brilliant graphics'. The interface therefore presented no difficulties for Amanda, as it enabled the summary findings to be examined without the use of the Netscape browser, the Web's novelty, or fear of the computer task itself being considered as confounding variables.

Amanda did find many interesting graphical images, including detailed maps, country flags and vast quantities of untargeted information and statistical data. Other than this, Amanda quickly became frustrated with her inability to find good targeted information, which she could understand and retrieve at a speed which was acceptable to her.

The data and bookmarks she did find were collected on disk for transfer to her home computer. When she used the findings many of the graphical images and hypertext links would not work, unless she was re-connected to the Web. Given the expense of dial-up connections in the UK, and the Internet's retrieval speed limitations, it was felt that this method would be uneconomical in terms of both time and money. The loss of live hypertext and graphical links could be a further avenue of frustration that might undermine novice surfers interest in using the Web in the long term.

Even allowing for these difficulties, Amanda found the quality of the information she retrieved was complex. She was thus forced to assimilate material beyond her scope, and to extract the information relevant for her topic book. Under these circumstances this proved problematic, as the data was too far in advance of Amanda's current capabilities. However, this may not always be he case, and it is possible that the Web could be used for a Vygotskian method of learning, with the child striving "just beyond the psychological horizon" [Fortes 1976]. One of Amanda's most successful achievements was her ability to produce and reproduce graphical images of flags, country maps and other topical images. This enabled the project work to be a collection of multiple objects, gathered from a global environment and, therefore, met some of the objectives for a visual composition as described by [Kress 1994] and that of the underlying concepts from [Tyrell 1996].

The information retrieved, when presented in printed form, was welcomed by her teacher who, we later discovered, had asked Amanda if she 'could borrow the CD-ROM'. This remark typifies the general misconception of teachers about new media, and Web awareness.

Email Activity

An email task was omitted at the time of the study, due to the frustrations experienced by Amanda and the study's primary objective becoming too difficult to fulfil. An email was nonetheless written and sent by Amanda a week later, allowing for reflection of her findings, with a brief of the her project and was directed towards the EUROPA European Commission, <"Maruja.GUTIERREZ DIAZ"@DG10.cec.be> the re-directed contact address on the European Union home page. It took approximately two weeks to gain a reply from the London office. The reply admitted that they could offer no further assistance, were themselves seeking help, and asked Amanda that should she be successful, they would be grateful to receive her findings.

Reflection and Concluding Remarks

Whilst engaged on the project, it became clear that the Web was not the enlightened vision for Amanda that it had at first seemed. Within a short space of time she complained incessantly about the access speed, the sources structure, complexity, relevance and commercial bias and the inability to find exactly what she really wanted. She was released from the study to complete her project just like the rest of her class, albeit with some additional facts and graphical images to add to her project, and a new insight into the power of global communications.

From Amanda's correctly understood views of the Web as a window to the World's information sources, she rapidly unearthed its restrictions and limitations. Amanda continues to be highly interested in global communication strategies and the Web and still requests access to the Web for extra materials for class topic work and discussions.

Discussion

The study did not progress beyond this trial stage. The passive and time consuming modes of engagement with the Web, and the overall educational value derived from the information located were considered to be of only limited use under the current circumstances.

A parallel can be seen elsewhere. Recent research within commercial organisations found that respondents admitted spending an average of four hours a week hunting for 'basic business information' [Computing 1995]. This in itself contributes to the described passivity, reinforced by a key businessman [Beales 1995], who believes that commercial users require a more structured approach to the Web rather than just search and filtering tools.

Returning to education, [Freire 1975] worried that learning would end up merely pouring untargeted information into the "empty vessel" of the learner's mind. Heppell's technology-based studies in education [Ultralab 1993] similarly demonstrate a concern for the "passive victim". Thus when popularising the Web as an independent learning resource amongst children, we should avoid turning them merely into 'couch potatoes' who browse the Web without intellectual motivation. This view may be considered marginal. However, problems of information anxiety stemming from the explosion of publications and e-media have recently come to the fore of contemporary thinking. The fact that there is so much information on any one subject or key word on the Web means that feelings of frustration and impotence similar to those experienced by Amanda in the study may be elicited. This reflects back to the point made in the introduction that information is endless, and as such we need to find a coherent and above all usable way to select only that which is of relevance to us. Future incantations of the Web may prove to be such a method.

Further research should be encouraged to investigate the educational use of the Web before it is incorporated into mainstream education as a principal research tool. If the reservations of this paper are to be overcome then the Web will be required to take on a more structured and coherent framework which removes the time-consuming and passive tendencies discussed earlier. However, the view is taken that the Web will be a valuable tool for education if given the correct philosophical and structural underpinning. Should these suggestions be incorporated this will prevent the Web from becoming a 'highway to hell' [EU 1994] and a dividing entity in our society [Handy 1994].

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The Internet and Its Importance for Those with Disabilities: An Example

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Abstract: This paper presents a generalized solution to the problems associated with accessing the Internet by people with disabilities. Of particular interest is the way in which the authors' paradigm [1] allows for enhanced interaction with information resources, which we take to include distance learning and education in general. We provide here a basic overview of our approach to serving the WEB accessibility needs of the disabled community. In addition, we present as an example of the unique features of our disability resource web site, a customizable lightweight voice recognition / PC control module for speech impaired users.

Introduction

For many years people in the technology area, specifically engineering, have attempted in a variety of ways to make the lives of those with various disabilities easier and to give them access to the wider variety of activities and facilities that most of us take for granted [2-5]. Depending on the nature and severity of their disabilities, these people may have communication problems (hearing loss, lack of speech, blindness, et cetera.). In addition, they may have mobility problems that limit their access to telephones, light switches, computer keyboards, et cetera. Physical travel, entrances to shopping malls and libraries remain difficult, if not impossible for some of these individuals. Disabled students face an additional burden if their study materials are not in a form that they can easily work with. Students with sight limitations need tools that can read their books and notes to them and/or enlarge the text to a readable size. Science and math students with sight limitations currently have very few options when it comes to reading complex math equations. Individuals with speech and/or mobility problems experience a different set of challenges. But in each case, we believe enhanced access to a computer (and hence the vast resources available through the computer and the World Wide Web) is possible. When one attempts to do something in this realm one has to be intimately aware of the fact that the over all impact will be minor. Never the less, the endeavor is worthwhile, since the impact on the targeted subset of the disabled community may be quite significant especially where improving education is the goal.

Educators, family members and special assistants face their own set of challenges when working with disabled students. They need to prepare both a special environment and class material in a form accessible to each disabled student. In addition, they need to evaluate the performance of the student. Many times, the disabled student will have trouble taking tests in the standard time. Allowing extra time helps with part of the problem. But if an assistant is required to help the student with taking the test, it can be hard for the instructor to assay the difference between what the student understands and what the assistant inadvertently added. Most of these problems imply greatly increased effort and expense on the part of the facilitator. A properly configured WEB solution can alleviate many of these difficulties [6].

Basic Problem

The convergence of cheap miniaturized computers with the evolution of many other technical innovations has finally become focused to the point where a realizable impact can be made in the many areas just described. One might speculate that much of what is happening today in the United States is the result of recent U.S. legislation, in particular, the Americans with Disabilities Act of 1990 (ADA) [7]. Many of the products and capabilities now being developed may well have occurred without this impetuous. But the publicity and media focus [8] on disability generated by this Act has enabled much of this effort to become public where as in the past, it might not have been.

A problem with many currently available assist devices is that they tend to be quite expensive and they only work with a very narrow range of disabilities. Many times, more than one special device or software package is required to meet the needs of the given individual. What will work for one will not work for another. It has also been found that separate packages/devices don't work well together. Thus educators and families face a difficult problem in selecting and configuring a PC to deal with their child's/student's problems. These solutions also become obsolete in a few years as the child grows up and their needs change and as technology advances. Lastly, these solutions deal with only a portion of the problem; namely the human to computer interface (HCI). They do not address human to world interface issues at all.

Consider for a moment the individual who has very poor eyesight and can only read large letters. This might include the inability to focus on a single letter or worse yet, to see multiple overlapping images. Consider further an individual with cerebral palsy in conjunction with a vision problem. Thus, there is a very limited ability to input information into a computer in the same way or with the same dexterity that a non-disabled person would have. How does one go about helping this person?

A Solution

Clearly what is needed is an inexpensive, yet comprehensive system that works on the wider range of computing platforms and which can adapt both to changes in the student's needs and to advances in the underlying hardware and software. The Internet provides an excellent starting point for such efforts. It works seamlessly over a wider range of platforms, gives access to the World Wide Web (WEB) and is essentially free. Through the Internet and the WEB in particular, a wealth of documents, search tools, news, special interest sites, shopping opportunities, travel information and booking services as well as resources for education can be made available. Teachers are now beginning to put full-blown courses on the network along with live sound video, problem solutions and interactive sessions. In a sense, the Internet can serve as the human to world interface. It can be easily extended via a local web site to allow access to scan textbooks etc. Many educators deem this interaction, which may be limited for disabled students, essential.

Because users with special needs do not fit standard interfaces, there needs to be an intermediate interface or adaptation that acts as a "prostheses" to make the original interface accessible to users with disabilities. If the adaptation is well suited to the user's requirements, it provides a better interface to the application. Much thought has gone into the development and implementation of these adaptations and intermediate interfaces [1-6]. For the past two years, the above investigators have been working to develop a general solution to the many problems that students with disabilities experience as they try to obtain an education at the University/College level. We have developed a paradigm that should prove effective for this class of students and which can provide a framework for solving many of the difficulties that presently are encountered. We believe that the solution that we have put forward will resolve one of the most serious problems in this area. Namely that each student with a disability is unique, and requires a unique solution to his/her specific set of disabilities.

The thrust of the project consisted of developing an Internet site that functions as a central location for computer resources targeted at the disabled. The site acts as an easy way to distribute new software that has been developed, as an online collection of documentation related to disabilities, as a pointer to other Internet sites containing relevant information and as an interactive tool for distance learning. Most importantly, since the people with disabilities will presumably be the primary users, the web site was built with them in mind and it is customizable to accommodate their disabilities.

When a user first accesses the site, he or she will be offered a chance to work with an online configuration wizard. The answers that they provide to the wizard will allow the site to dynamically alter its appearance and will pre-select the subset of software modules that will most likely be of interest to this user. The user can play with and pre-configure many of these modules prior to adding them to their local system. The ability to track users and maintain a profile of their unique preferences is built into the site through the use of a database. The idea of centering the site around the needs of the disabled is continued by allowing users to add links to external Internet sites as well as to receive updates by e-mail of when the site has been updated. The included built-in search engine facilitates finding specific software modules and information.

From a site administrators view point, incorporating additional software components is as simple as filling out a form and

copying the necessary files to the server. The framework for future growth of the site has been established. Because the site is simple to use and interact with the user, the likelihood of a user returning is greatly improved.
As a general solution, it is an inexpensive, comprehensive system which works on a wide range of computing platforms and can adapt both to changes in the disabled individual needs and to advances in the underlying hardware and software technologies. This system functions to more fully integrate the person with the rest of the world without the addition of extensive additional human assistance. This concept is shown more clearly in Figure 1.

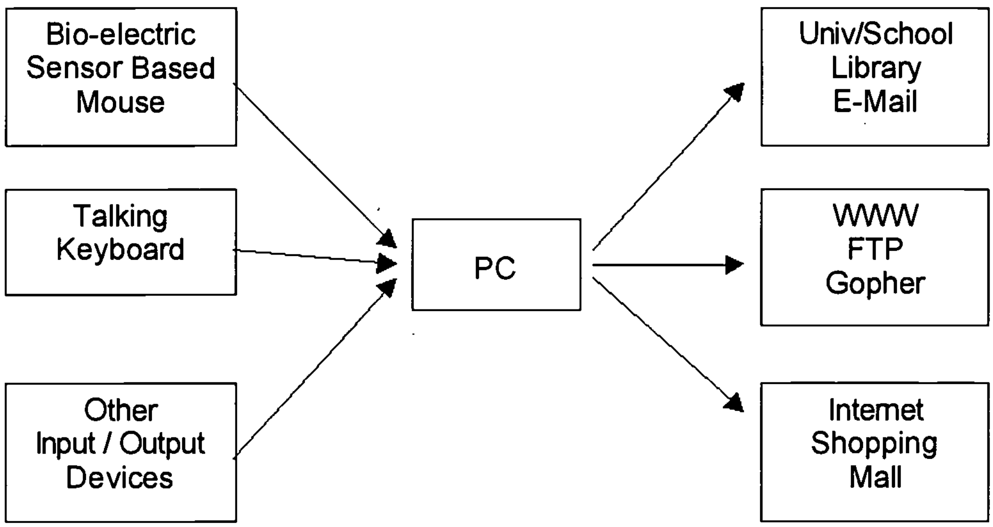

Figure 1: Using the World Wide Web to provide access to the world.

In addition to the web site, a number of specific interface modules have been developed. These include several virtual keyboards, a voice controlled mouse, an acoustic output mouse, a joystick based mouse, and a variety of other acoustic PC navigation tools.

Example: Speech Control of the Computer

One module currently under development is a lightweight non-verbal recognition engine that can map reproducible utterances to specific PC control functions. Our initial application was the implementation of a voice-activated mouse (VAM). The VAM is a complex module, which requires training before it can be used. A setup wizard walks the user through a series of steps which gives the user vocal control the mouse on the screen.

Such a system is implemented through an Automated Sound Recognition System (ASR). There are a variety of techniques available that do voice-to-text fairly well. These are incorporated in many of the commercial products available, such as IBM's "Via Voice Gold" and Dragon System Inc.'s "Naturally Speaking" both of which allows for continuous speech recognition and conversion into text. Thus, it is possible to take some individual words and convert them into symbols, which ultimately can control the movement of the mouse. Coupled with this idea, is the possibility that some individuals might not be able to speak clearly and distinctly. The commercial packages listed above can not deal with this scenario. However, if the user can reproduce a small set of distinct sounds with some fidelity then these sounds can be mapped to control functions. Clearly, the larger the set of distinct utterances, the easier it will be to control the multitude of PC / browser functions. However, this technique can work with as few as one reproducible utterance.

Our example is very simple in as much as we chose to use the four letters L (left), R (right), U (up) and D (down), respectively to develop the concept. Any substitute for a clearly spoken articulation of these letters would be equally acceptable. Required are the use of an FFT algorithm and the development of a simple template for each letter (word). The process is simple in concept. A flow chart is given in Figure 2.

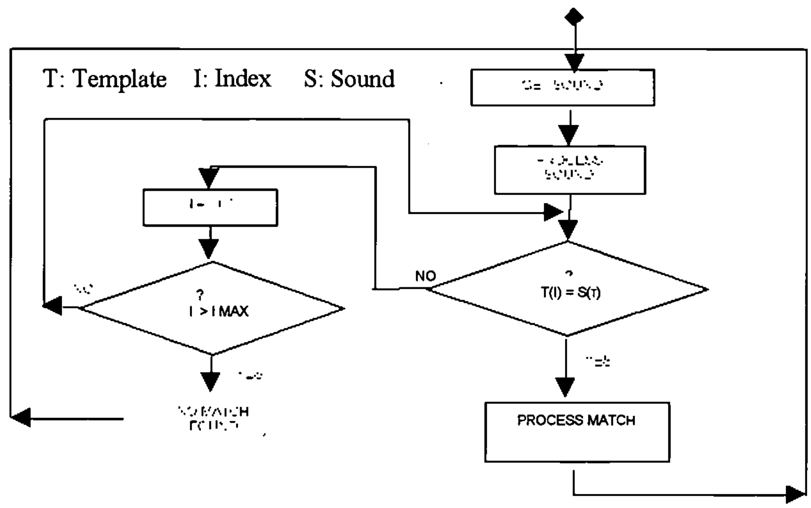

Figure 2: Discrete non-verbal utterance recognition process flowchart.

In our example, the articulation of each sound is first frozen in a window. Then the Fast Fourier Transform (FFT) of the sound is taken to create a template for the four letters. Then when the letters are articulated in a random fashion, the template of the incoming sound is compared to the templates in the system and identified properly in order to move the mouse.

The template was designed by taking the power spectrum of each of the signals and dividing it up into sixteen bins. A single number is produced for each of the sixteen bins by taking the average of the components in each bin. When the sound was articulated, it is processed and its template compared to those already stored. When a good match is found, that particular letter is identified and the appropriate movement of the cursor is initiated. A picture of a typical sound is shown in Figure 3 and its spectrum in Figure 4. For both the calculations of the templates, and the "unknown" test sounds, the average value of each bin is scaled to one hundred. The result of the template-matching procedure for one test sample is shown in Table 1. Several people trained the system and had their templates stored for use when they were active. The miss-identification rate was less than five percent in most cases.

There are certainly a number of issues associated with this particular technique. If a mistake is made, the user will hopefully, if not terribly visually impaired, see that an error has occurred and command the mouse to stop. In addition, the precise motion and control features can be configured on a user by user basis. This is similar to what we do with our other mouse controller modules [1].

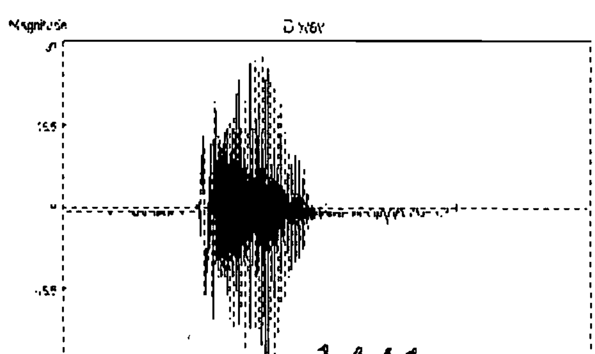

Figure 3: A typical "D" sound.

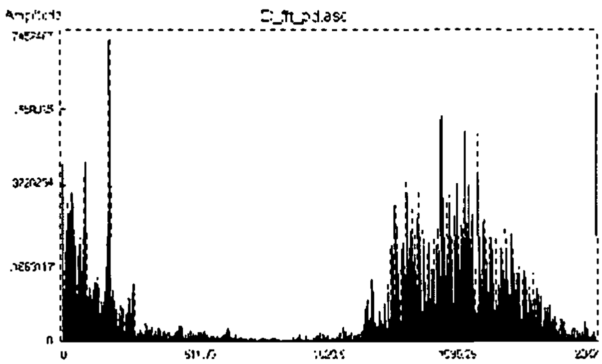

Figure 4: The frequency power spectrum of the "D" sound

Incoming Sound = D5_sound.asc	
	Template Matching Error
D	**0.29**
L	4.29
R	5.2
U	1.65
Sound identified as a "D"	

Table 1: Sample identification of female vocalization of "D".

Software

The question of software appropriate to such a project is always important, particularly in view of the fact that software is constantly changing and what might be appropriate today, might not be appropriate in another year. We have tried our best to avoid this problem by using software that has proven its worth over an extended period of time. Much of the software is available through Microsoft. The site itself makes extensive use of Microsoft's Active Server Page technologies. Many of the end user modules have been written in Visual Basic as ActiveX controls. In the future, we plan to move portions of code base over to Dynamic HTML (DHTML). This will provide improved platform independence as well as performance enhancements.

Conclusions

The exercise reported here has demonstrated clearly that the development of the web site for the disabled is both possible and necessary. While only the voice activated mouse is reported here, there are a number of other modules, which we have developed to handle other kinds of disabilities. These can be simply adapted to individual needs, but more to the point, a variety of these can be developed, a subset of which will be applicable to most individuals whose disabilities are severe. Each case is unique and will have to be examined individually. At this particular time, the web site provides access to all other webs in the system and also provides a very simple search engine. In addition, the web site also stores information for various users once they register and keep track of the modules, which they desire to use and save. This information can individualize the module when certain things must be learned for specific individuals. In the voice activated mouse system, templates would be customized for each individual user, so when they return at a later date, development will not have to be repeated. Readers are encouraged to look at the web site that has been created at http://www.nd.edu/-vx.

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A Multimedia Kiosk for Patient Education

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Abstract: The decentralization process of medical information is the major motivation for the construction and use of computer based systems for patient education. However, in order to reach their objectives it is necessary that these systems have a set of quality characteristics related to the information they provide and the way they are. This paper describes a public access system for patient education, on the field of Nuclear Medicine, specially about the Myocardial Scintigraphy. It also defines a set of quality requirements to be considered on their development and evaluation.

1. Introduction

It is well known nowadays that patients should know and understand the problems that are related to their health and to medical treatments. Also, they should share decisions about these treatments and possible surgery they should undergo. The lack of this knowledge brings about several consequences related to improper use of food and medicines, and also psychological disturbances started on not having the needed information [Kahn 93, Kim & Watson 95].

Patient education, from this point of view, is based upon not only the information collected orally among health professionals, but also in printed material, audio-visual and more recently on computers.

Several benefits are reached with this change. First of all we have the decentralization and democratization of access to information, since patients are able to have medical information without the physical presence of the health professionals. This information can be provided outside medical centers, sometimes even at home, and having the possibility of consulting the information how many times they want. Another benefit coming from this change is the possibility of cost reduction involved in treatments. Various studies pointed out that patients who use this kind of material supporting education are released from the hospital earlier. And, as a consequence, they show less problems at the phases before and after surgery. They also reduce the amount of medicines used against pain. Some studies have even shown a reduction of diseases and anxiety of the patients that used this material [Kahn 93, Abramson 95].

There are lots of ways of promoting the use of computers for patient education. Among them are the use of expert systems, interviews supported by the computer and hypermedia. Hypermedia use sound and special effects and should be used to inform patients with physical limitations, reducing and, sometimes, eliminating the need of reading text in the conventional media of spreading medical information. At the specific case of elderly patients, the user/patient repeat, explore or study a topic of interest, with the help of the computer, allowing freedom and comfort that some patients do not enjoy with physicians or nurses, mainly due to the lack of time of them. Computers can help on the process of democratization and dissemination of information about health topics and allow that through this individual educational proposal. Families and communities may hold a more active role concerning care of their own health, minimizing the psychological charge due to treatments, exams and surgeries and also reducing the use of costly and unnecessary services.

In order to reach the goal of having knowledge and patients participating actively in their treatments, through the use of computers as a tool, it is necessary to produce educational solutions adequate to individuals and to their social context as well as systems easy to use and based on user friendly interfaces.

2. Public Access Systems

Public Access Systems based on computers, or simply kiosk, are used to help the spread of information of the more diverse categories. Some examples of this use could be to find the spatial localization of some shop inside a shopping center, another example are banking information, timetable of public transportation inside railroad stations and listing of events inside cultural centers or information centers. This kind of system have as a main characteristic the fact that they are located in public areas, can be used by anybody, no training is required to its use, the access is unlimited and unsupervised, and usage is typically quite brief and irregular [Kearsley 95].

The development of these systems could resemble simple at a first analysis. But two fundamental aspects should be considered, the user interface and the time needed to use the system.

There is a great worry from the side of software engineering with the human-computer-interaction. In the public access systems this aspect becomes more evident, as it is not previewed any training to use the system. It is expected that these systems become self-explained and this aspect is only achieved in the way the interface is developed with this objective.

However, this worry should not have been excessively focused on graphical aspects of the media used. There should have be considered aspects as presentation and content correction, that should be clear and ease of understanding, not requiring a high cognitive charge and transmitting correct and adequate information.

Finally, the screen presentation as the content presentation should have been adequate to the user reality regarding his/her social-economical level, age, and system expectation of use. Even being the system projected to a certain user profile, we cannot forget that, by its own nature, anyone could in principle use the system.

Also the aspect time of use should be considered and planned according to the goal of the system. Some systems need quick use, like banking systems. Others need the attention of the user, for example, systems used for marketing and sales.

Specifically in the medical area the use of public access systems is still very little expressive. However, there are several possibilities of application in this area. The use of multimedia systems, in this case is adequate and could be of great value to the transmission of medical information. In the next section we report the experience of building the public access system in the area of cardiology.

3. Public Access system for the patient education about myocardial scintigraphy

Myocardial Scintigraphy is an exam that evaluates the circulation of blood inside the heart of patients. It is performed in two consecutive stages: the effort test, and the rest exam. At the first stage, the patient do some physical effort test. After this the patient receive the specific medicine for contrasting and goes to the gamma camera where are done images of the heart. In the rest stage there is a new inject of medicine and again the patient goes to the gamma camera to a new section of images.

The execution of this exam need some care with the patients. There are restrictions concerning prohibited or not indicated food in the days before the exam, clothes that are unsuitable and observation concerning medicines. No observation to food restriction, for example, do not allow the patient to perform the exam. Furthermore, the fact that this is a Nuclear Medicine exam causes a series of fear that need to be clarified and eliminated.

At the Cardiology and Cardiovascular Surgery Unit at Fundação Bahiana de Cardiologia - UCCV/FBC - Brasil, the usual way to provide information about the Myocardial Scintigraphy exam was a folder and oral explanation by a receptionist. When the exam was scheduled by phone, the information were given to the patient through the attendant of the nuclear medicine sector. After years using this procedures it was observed that still a lot of patients do not follow the procedures and keep doubts and fear about the exam. As a result of this, they come to the exam without the necessary conditions or even do not undergo the exam, bringing about the exam cancellation, financial loss, and leaving a blank in the schedule, having a lot of patients in the queue to perform the exam.

This situation causes the medical team of the nuclear medicine sector to search for an alternative solution. It was then that appeared the motivation to build up a public access system. The system concerning myocardial scintigraphy exam, aims helping patients on their preparation to the exam, reduce their psychological charge, normally associated with the realization associated with exams that involve nuclear medicine.

The first critical point at the development of medical application concerning patient education is to define the content to be transmitted and its presentation form. To solve the problem the content specification was done mainly through interviews with the responsible physician of the nuclear medicine sector.

The target user group to which the development of the system was directed is formed by the patients of the UCCV/FBC that were indicated to do the exam of myocardial scintigraphy. The taxonomy of patients scholar level is the following: illiterate 10%, primary school 40%, high-school 30%, university level 20%. This taxonomy was very important on the definition of the content used in the system.

As it is a system based on the use of computers to a group of people where the great majority do not know how to do it we had a lot of care with the vocabulary and the medical jargon used and a great importance was given to the aspects of the user interface. The latest version (3.0) was installed in February 1997. The system is working at a multimedia kiosk with touch screen at the reception of the nuclear medicine sector [Figure 1].

Figure 1: Multimedia kiosk about myocardial scintigraphy

The presentation screen of the system start the process of adaptation/learning to the use of the touch screen. The system supplies a pointing message, *Touch here to start*, on how to begin the navigation [Figure 2].

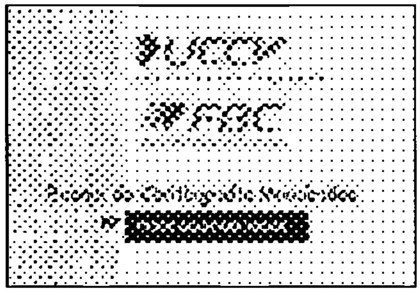

Figure 2: Presentation screen

On the second screen is presented a brief explanation about the indication of the exam and the user should then make a choice between the two main options offered: "What you should know to perform the exam" and "Additional Information" [Figure 3]. This division was suggested by the physicians of the Nuclear Medicine sector and aims to show up the main information needed to the exam and also some other additional information. We had then in the system the first part more emphasized on information and the other one with emphasis on education.

In the context of the option: "What you should know to perform the exam? ", the user find the following screens: *Alimentation restrictions, Medicine, Extension of the exam, What you should do on the day of the exam, Results,* and *If you could not come.* In all screens there is a bar on the lower part of the screen with the following message: *Touch on the desired option,* and with two buttons to navigate, the button of *Begin again* and the button of *Follow to the next.* Figure 4 shows, as an example, one of these screens.

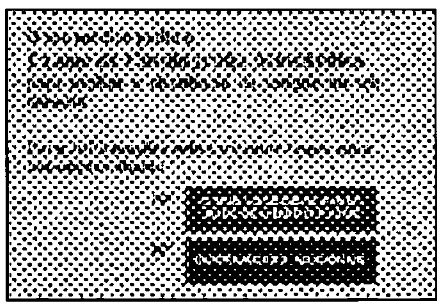

Figure 3: Introduction screen with two options

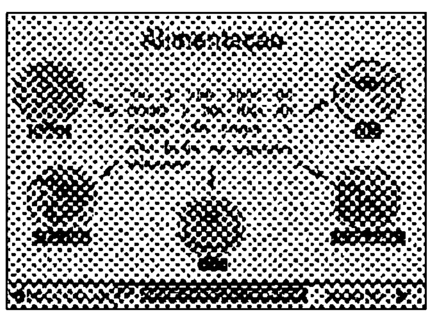

Figure 4: Alimentation restrictions

In the context of the option "Additional Information", the user finds the following screen of information *Why prohibited food?. Should I come alone?. Radioactivity is risky?, Accord Exam, Scintigraphy versus Cateterism, Alcohol and Smoking, How is the exam?.* Figures 5 exemplifies one screen of this option.

Figure 5: One screen of "*How is the exam?*" showing the gamma camera

4. Quality Evaluation of Public Access System

Public Access systems, or simply kiosk, are systems that should be used by people with any degree of computer literacy. This characteristic imposes that these systems should have a high level of quality. In the public access systems, the quality control should be done to evaluate different aspects of the system, for example readability, the existence of audible sounds, the interface used, the clearness of graphics and videos, the integration of software and hardware, among others. However, the proposals on how to evaluate these systems are rare and incomplete. In this work we departed from the model proposed in [Rocha, 83] and defined a set of quality attributes to be considered in the evaluation of public access systems for patient education. The defined set includes attributes that support the quality attributes, considering the point of view of the developers, of the physicians and the users of these systems.

The attributes defined should serve as a basis to the elaboration of the evaluation questionnaires of the kiosk.

From the point of view of the final user (patients) the quality attributes refers to the characteristic selected to the *easy of use* of the system and the *satisfaction of the user* with its use. Some examples of these attributes defined refer to *apprehension* (characteristics of the system that enable easy learning of its operation), *localization easiness of information* (characteristics that enable the localization of different subjects), *memorization easiness* (characteristics that facilitates the memorization of important information), *uniformity* (characteristics that make the system behaves always of the same form, keeping comprehensible and familiar to the users), *interactivity* (characteristics of the system have an interactive interface, where the control is, on the majority of the cases, with the user), *motivation* (characteristics of the system that enable his use motivating), *help in the case of errors* (characteristics of the system supports users in errors situations), *initialization evidence* (characteristics of the system that makes its initialization or re-initialization easy), *comfort of the workstation* (characteristics of the system regarding its installation in a comfortable equipment, that has adequate dimensions to different types of users), *privacy* (characteristic of the system be installed in a place that guarantees the privacy of the final users), *localization* (characteristic of the system be installed in a visible place and of easy access) among the whole set of attributes [Valle 97].

4.1 Evaluation of the Multimedia Kiosk about Myocardial Scintigraphy

The evaluation of the kiosk 3.0 version considered these attributes and three points of view: the physicians' of the sector, the patients' and attendants'. To perform the evaluation three questionnaires were build up where each question evaluates one of the identified attributes.

The result of the evaluation with the medical team showed up 100% of satisfaction with the system. The evaluation with the patients was done, initially, during a week with the patients from the UCCV/FBC, who used the system as they scheduled their exam. After the use they received a questionnaire. In a first evaluation were filled up 19 questionnaires by patients with ages ranging from 42 and 81 years old, with 8 females and 11 males. It was possible to observe, from the answers given by the patients, a very positive evaluation. The observation of the attendant, in most of the cases confirmed the opinion of the patients. However, sometimes, the patients were too optimistic in relation to their use of the system. For example, concerning the relative easiness of use, the attendant evaluated that 5 patients showed up some kind of problem. The same occurred related to the easiness to find information. On the evaluation of the attendants 6 patients showed difficulties in these items while on the evaluation of the patients, only 2 pointed some difficulty.

There were also some extra comments concerning the questionnaires. This is a resume of the opinions given to the open questions in the questionnaire.

- lack of perception concerning the touch screen
- lack of perception related to the use of navigating buttons (some patients found that the system would change the screens automatically without any help of the user)
- desire for more information or more detailed information
- satisfaction concerning the fact of finding information about radioactivity
- satisfaction of having information available in an objective format and of easy comprehension

5. Conclusion

This article presented an experience of construction and evaluation of a public access system for patients education. The use of the system by the patients that are going to do the exam is being continuous and the results from this first evaluation are being used to the new versions of the system. The results stimulated us to follow up the project and a new system concerning other exams is being developed.

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Designing Adaptable Educational Software : a Case-Study for Spatial Geometry

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Abstract: A Computer-Based Learning Environment (CBLE) needs to be adapted to several teaching styles, since this is a condition for acceptance and effective use in school. In this paper we propose to provide teachers with an opportunity for describing the learning sequences they plan to perform within the environment. Then, from these descriptions, a specific instance of the environment could be built and made available to the learners and teachers. To allow such learning sequences descriptions we need a common agreement on data, concepts and basic reasoning criteria that could be used. We describe such a process and the results we have obtained in the framework of a spatial geometry learning environment.

1. Introduction

Despite an increasing availability of technology, there are still many signs of dissatisfaction with existing educational software. It remains difficult to build complete and adequate requirements for a piece of educational software because many teachers are not yet aware of what is easily feasible and what is still difficult with the available technology. However, the participation of teachers in the design of these tools seems to be a key factor of acceptance and of effective use in schools. We have learned from many years of working with teachers involved in introducing technologies in their schools that they will not use a piece of software in which they cannot include their own know-how and that they cannot reshape according to their local needs.

Starting from those observations, we came to the conclusion that many pieces of educational software should include adaptation functionalities. Moreover, the adaptation process should remain as simple and as close to teachers' ways of working as possible. To fulfil such requirements we propose a framework for learning sequences descriptions ; from such descriptions we aim at deducing the accurate configuration of the educational software according to the learning sequence needs. To allow such descriptions we propose a model for knowledge classification and a set of "teaching" primitives".

The aim of this paper is twofold. First we describe an example of building such a set of definitions in a project for teaching spatial geometry. At the same time we focus on the methodology used in the project that could appear as another *suitably balanced marriage between the "technology push" and the "learning pull"* as suggested in [Conlon et al. 1996].

2. A Four-Level Knowledge Model

The collaborative work we have done with geometry teachers in order to design a learning environment underlined the difficulty for obtaining a consensus about the definition of the domain concepts and the functions that operate on them. These difficulties come mainly from the multiplicity of the teachers' points of view about the objectives of such an environment. We consider that these problems, that stretch from theory to implementation, can be easily overcome by using the 4-level knowledge model proposed in [Bernat et al. 1995].

By manipulating objets at the interface level of a CBLE, the user indirectly acts on an external representation of the objets of the learning domain, whereas the system reacts on an internal representation, which is not necessarily isomorphic. Then it is necessary to clearly separate domain specification mechanisms from interface specification mechanisms.

The *domain* level is a theoretical level that represents the domain knowledge to teach, independently from any symbolic-level representation. The *representation* level defines a unified *realisation* of domain concepts. This realisation is based on design choices concerning concept representation and underlines the relations between them. The represented knowledge is *reified* at the *presentation* level, which provides external points of view on domain concepts, as they are perceived by students and proposed by teachers. Finally, the *visual* level is the graphical interface level defined by the designer. It depends on the development environment for the implementation of direct manipulation.

2.1 The Domain : Teaching of Spatial Geometry

The taught geometry is a transposition of the geometrical theory, varying with respect to the progression needed for knowledge acquisition. A given concept may have different interpretations and its taught could be led according to different pedagogical activities. For example, the *cube* concept varies according to its use : it may be a *composite object* (i.e. composed of 8 points, 12 edges and 6 faces) or a *solid object* (i.e. taken as a whole object).

2.2 The Unified Representation

The *representation* level implements a unified representation of the different concepts to teach, i.e. the geometrical objects, the relations between them and the functions that apply to them. It underlines a unique conceptual facet that defines and represents the properties of an object. For example, the cube can be defined from 4 points and particular properties : the two first points define the initial edge of the cube; the third point belongs to a circle perpendicular to this edge and defines the first face of the cube; the last point is one of the two intersections between the circle and a perpendicular line to the first face, thus giving the cube volume.

2.3 The Presentation Points of View

The *presentation* level is an interface level that contains multiple views of the same concepts. This level allows the teachers to express most of their didactical choices : from the choice of one concept presentation depends the learning situation induced by the utilisation of the environment. In the context of a spatial geometry environment, the different presentation choices can be divided into three groups : the *visual units for comprehension*, the *geometrical objects* and the *interaction modes*.

2.3.1 The Visual Units for Comprehension

In spatial geometry, the interpretation of the plane projection of a spatial construction is a major difficulty. In order to make a scene easier to read, we introduce some *visual units for comprehension*. They are independent from domain concepts and thus could exist in fields other than geometry. For example, reference axes could be useful for understanding the position of an object in space [Fig. 1] but their precise kind may vary : traditional axes, grids, walls (i.e. a space delimitation by three perpendicular planes), ...

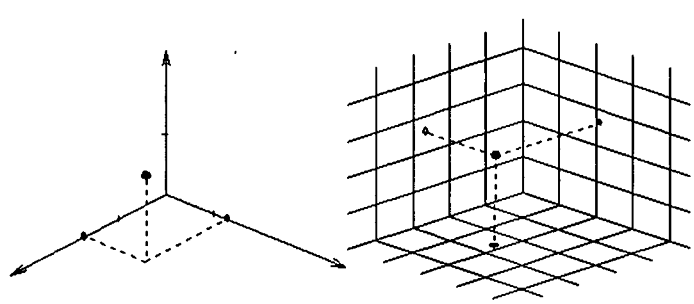


Figure 1: Perspective of the space and object position with reference axes (left) and with three perpendicular planes or 'walls' (right)

The choice of a particular *visual unit for comprehension* depends on the learning context and on the user's knowledge. For example, reference axes are useless in solid geometry learning (i.e. constructions based on a solid like a cube or a sphere) : the existence of strong cultural connotation objects could indeed be enough to provide good space reading. Some visual units like the *walls*, useful at the beginning of the spatial geometry learning for scaffolding, should be progressively removed.

2.3.2 The Presentation of Geometrical Objects

The choice of the presentation of geometrical objects also depends on the didactical situation that the teacher wants to realise. The cube, for example, may be presented as a *'wireframe'* cube (all the edges are visible) or a *'hidden faces removal'* cube (the edges behind the cube are hidden). The *'hidden faces removal'* cube is suitable for solid geometry (presented as a physical object, with a volume) although the *'wireframe'* cube would more underline its induced properties (e.g. opposite edges parallelism). The same problem happens for the choice of planes presentation [Fig. 2]. Shall we reify a plane by presenting it as a rectangle included in this plane (but which plane; what about the risk of misconception induced by limiting its visual dimension) ? Wouldn't it be better to adapt each presentation of the plane to the global presentation context (for example, presented by its intersection with the walls, if any) ? There is no unique solution to this question : the final presentation choice depends on the teacher, who is able to appreciate the relevance of a given solution.

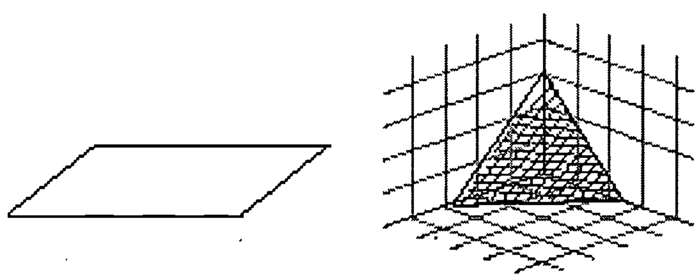


Figure 2: Presentation of a plane as a parallelogram (left) and by its intersection with the 'walls' (right)

2.3.3 The Interaction Modes

An interaction is a user's action, immediately followed by visual feedback and by a system's reaction. For example, direct manipulation of a point is one of the essential actions in a dynamic geometry environment. Moving a point according to the three dimensions of space cannot be performed by a simple mouse move. In order to restitute the third dimension, it is necessary to define a more complex task (e.g. combining mouse move with pressing a given key). Feedback has to clearly underline what kind of action is involved. Then the point could move according to user's expectations : a mouse move should involve a similar cursor move and the point move should follow the cursor's movement on the screen. In the CABRI 3D environment [Qasem 1997], the solution consists in decomposing the move of a point in a horizontal plane then along a vertical line (modification of the point elevation). Another method, based on the walls as a visual unit for comprehension, consists in directly dragging the projection of a point in the different walls. Whatever the chosen method is, it is necessary to decompose any movement in space in a set of movements in the plane, in order to avoid ergonomic ambiguities. Moreover, such a decomposition could offer a pedagogical interest.

2.4 The Objects Visualisation.

At the *Visual* level, the different objects presentation attributes are translated at the interface, according to the properties defined in these presentations : the points shape (round, square, ...) and size, the lines thickness, the object colour, ... This level also allows to define the communication vocabulary : geometrical notations, support messages, menus and items names, dialog boxes, ...

3. Learning Sequences Description

Specifying a CBLE necessarily requires a collaboration between people from different backgrounds (didacticians, psychologists, designers and, above all, teachers) [Guin 1994] and thus needs a common language, understandable by everyone. Consequently, this specification has to be based on the *Knowledge-level* perspective [Newell 1982], [Nicaud 1994], a level of knowledge description that is independent of any symbol-level representation. For the teachers, it has to ease the expression of their know-how and pedagogical purposes, i.e. their choices concerning the *knowledge presentation* and the *activities* they want to manage around this knowledge. In particular, this specification mechanism has to allow the *author-teachers* (the teachers who directly collaborate in the design process) to define the teaching *domain* and to propose both geometrical objects *presentations* and their *visual* properties, and the *user-teachers* (the teachers who need CBLE adaptation) to select, among the available choices, those which will create the didactical situation.

Our method was to provide author-teachers with a frame, called *utilisation context*, for learning sequences description based on the activities they want to set using the CBLE. In a mid-term perspective, we hope to be able to specify information stemming from these descriptions using *ontologies*.

3.1 Utilisation Context

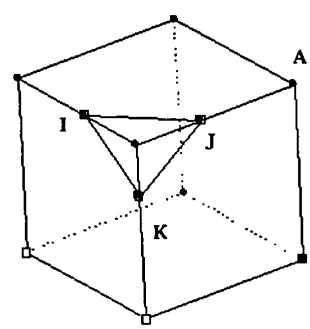
The presentations of a given object and the actions that could be applied to it are dependent on the context in which this object is used. Here we are closely akin to one of the principles of the KACTUS project [Laresgoiti et al. 1996] : "*the context can be seen as a "viewpoint" taken on the object. It is usually impossible to enumerate in advance all the possible useful viewpoints on (a class of) objects*".

We define a *utilisation context* as the information frame needed for performing activities that share the same pedagogical objectives. From these objectives and reference activities, it is possible to define the representative object classes of this context, their presentations and the user-available functions. In order to illustrate the *utilisation context*, let us consider the following example [Fig. 3].

Context : "*Cube section - Exercises*"
Objective : intersection of a cube by a plane.
Reference activities : exercises 1, 2, 3
Including contexts :
Cube section - Tutorial
Polyhedrons section - Exercises [...]
Characteristics :

Object class:	**Facets :**	
Cube	wireframe , hidden line	
Plane	*all*	[...]

Functions :
Construction of a parallel line
Construction of a midpoint
Construction of an intersection [...]
Environment parameters :
Perspective : cavalier [...]
Difficulties and supports :
{ specify the available supports, that are used by teachers }



Exercise 1 : constructs the intersection of the cube and a plane, parallel to the section (IJK) and going throw the point A.

Figure 3: Definition of the utilisation context "Cube section - Exercise".

The author-teachers wanted to manage a particular *activity* and thus decided to describe a *context* named *"Cube section - Exercises"*. They specified the *objective* of this context and defined its *characteristics* that in their view will allow the student to satisfy this objective.

In this context, some particular presentations of *plane* and *cube object classes* stand out : the cube could be presented either as *'wireframe'*, or as a *'hidden line'*. On the contrary, the *'hidden face removal'* presentation is not suitable in this context : it does not allow the user to visualise the required intersections. These various required presentations of an object class are defined as *facets*. The *functions*, that allow the student to perform construction tasks, are specified : the parallel line, midpoint and intersection between two lines construction tasks. From their experiences in providing such activities in the classroom, teachers have identified several types of *difficulties* and have built several *supports* to allow the learners to overcome them. In particular, they proposed some software-based supports, like the *visual units for comprehension* [see § 2.3.1] or the perspective type, that are specified in the *Environment parameters* field.

3.2 Toward Teaching Ontologies

According to [Gruber 1995], an ontology is an *explicit specification of a conceptualisation*, i.e. an explicit specification of a simplified representation of a world for a given purpose. An ontology is composed of different entities of the domain (e.g. object classes, relations, functions, ... depending on the domain to abstract), the definition of which associates a human-readable description with formal axioms that constrain their interpretation. The main purpose of an ontology is to allow people to *commit* to it, i.e. to come to an agreement to use the given shared vocabulary in a coherent and consistent manner. Ontologies are mainly used for expert knowledge sharing and reuse but, more recently, for also managing pedagogical knowledge [Murray 1996].

3.2.1 Construction of the Ontology

Only the *author-teachers* are able to improve the ontology. The ontology is incrementally built from each *utilisation context* by specifying every new entity, or by enriching existing ones, that appear in the context : functions, objects, facets, ... Each new entity is then added to the ontology. In the previous *utilisation context* for example, author-teachers used a *cube* and the *midpoint construction* function, that had to be defined respectively as *object class* and *function* entities and included in the ontology [Fig. 4].

Object Class "*Cube*"

Description :
A cube is a polyhedron made up of 8 vertices, 12 edges and 6 faces. Edges are [...]

Composed of :
{A,B,C,D,A',B',C',D'} set of Points
[...]

Constraints :
(perpendicular, (AB),(AC)) *{relation}*
[..]

Facets :
wireframe [...]
hidden line [...] *{points of view}*
Hidden faces removal [...]

Function "*Midpoint construction*"

Description :
Construct the equidistant point from 2 points.
[...]

Facets :
Midpoint of a segment :
function : Segment → Point
[..]

Midpoint of two points :
function : (Point, Point) → Point
[..]

Figure 4: Extracting the ontology entities

They described the *cube* object class by giving a short description and a formal definition (composition, geometrical constraints, ...). In particular, they specified the different cube *facets*. The definition of the *midpoint construction* function required arity and arguments kind specification . It also refers to the *'Point'* and

'Segment' entities that also need to be specified as object classes of the ontology.

3.2.2 Use Of Ontologies For Educational Software Adaptation

Until now, adaptation of an educational software to each user's specific expectation is only provided at the interface level. The CABRI environment [Laborde et al. 1994], for example, allows a user to configure all available functions by directly manipulating menu items. In CALQUES 2 [Bernat 1994], it is possible to select different interaction modes in a dialog box.

Such a parametrisation cannot be extended to too complex systems : the concepts points of view (and, consequently the parameters) are often too numerous and cross-dependent. Our *utilisation contexts* allow us to overcome this complexity. Indeed, they define a set of coherent parameters with respect to the context objective. Choosing a context can be done by a unique operation that automatically implies a parameters set.

Moreover, the context descriptions can be organised in a context library and made available to other teachers. Thus, the *user-teachers* could consult the library and choose a well-adapted context to the activity he would like to propose, avoiding to always begin from scratch.

4. Conclusion

In this paper, we have presented an attempt to provide teachers with a framework for describing their teaching needs with respect to educational software adaptation. The proposal includes a four level model for knowledge categorisation as well as utilisation contexts. The four level model has been successfully used to describe several teaching requirements at the appropriate level. The utilisation contexts have been used on the one hand to describe learning sequences and on the other hand to build step by step a type of teaching ontology for spatial geometry. Such an ontology will then be available for further context designs. Moreover, we expect that it will be part of larger pedagogical libraries available to teachers through networks in the schools of tomorrow.

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User Interface Design for WWW-Based Courses: Building upon Student Evaluations

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Abstract: The user interface of a WWW-based (World Wide Web) course environment influences the users' mental characterization of his/her goals with the system. Although research has accumulated with respect to the user interface of computer-related products, little direct focus has developed for the new type of product: a WWW-based course environment. At the University of Twente we have been designing and using WWW-based course environments since 1994 and we systematically collect student reactions to the interfaces of those environments. In this report we describe how the student reactions shape our design of a WWW-based environment through the example of a first-year course. Most of the user interface redesign choices to the 1997-98 course were well received by the students. The major problem of site structure and how this is presented to the students via the user interface remains.

1. The Importance of User Interface (Re)Design for WWW-Based Courses

The user interface, the point of interaction between a user and a tool [Cox & Walker 1993], of a computer system has long been studied. Long lists of guidelines for user interface design have appeared, particularly within HCI (Human-Computer Interaction) research [Shneiderman 1987]. The user interface for educational software, including multimedia products, has also received regular attention in literature [Boyle 1997].

The term 'user interface' does not seem to be much used with WWW environments yet, although many sets of guidelines have appeared for WWW systems that relate to the classic focuses in user interface design. The function of the user interface is helping the user to have an internal mental characterization of his or her goals with a system, helping the user select an action, helping the user execute the action, and helping the user evaluate the results of his or her interaction [Norman 1984].

WWW-based course environments have begun to receive attention in terms of design issues, but mostly in terms of 'presentation design' and 'navigation support' instead of user interface design. Eekma and Collis [Eekma & Collis 1996] have made a summary of 20 of those design guidelines for WWW-based course environments. Guidelines, when used, are often developed by theory and put into practice in a WWW-based course under development. Little evidence is found in literature about student evaluations regarding the interface design of WWW-based course environments. There are few evaluations present in which they are using the interface themselves and even less evidence of how such student evaluations have been systematically used as feedback for the redesign of WWW-based course environments over several cycles of a course. Undoubtedly this is mostly a result of the newness of the medium. At the Faculty of Educational Science and Technology at the University of Twente, WWW-based course environments have been in use since 1994

[Collis 1997]. Enough time has passed and experience has developed so that a number of cycles of student evaluations of WWW-based course environments have occurred, each resulting in a substantial redesign of the environments based on these student evaluations. In this paper we report on one such recent cycle.

In this report we describe how the student reactions shaped our design of a WWW-based environment through the example of a first-year course, and the redesign of its user interface between the 1996-97 and 1997-98 versions, as well as our first student reactions to the 1997-98 redesign.

2. Student Evaluations of the User Interface of WWW-Based Courses at the University of Twente

The Faculty of Educational Science and Technology has a pioneering history of WWW-based course environments. This has facilitated the steady collection of student-evaluation data about these courses. Also important is the nature of the courses themselves that are offered through WWW-based environments. Primarily these are courses in which students are studying instructional design, the design of educational media or user interface design as content areas, which means that the students are particularly sensitive to the direct impact of design and have specific criteria and vocabulary for articulating their evaluative comments. Even first-year students, in the ISM-1 (Instrumentation Technology 1) course, not only evaluate the user interface design of WWW environments made by others, but also learn to evaluate the user interfaces of sites they design and make themselves. It is natural that regular opportunities for the students to evaluate the user interface of their own course-site are built into the course activities as the course makes extensive use of a WWW-based environment [Collis, Verhagen & Gervedink Nijhuis 1997a, b].

2.1 Student Evaluations of the User Interface of the 1996-97 ISM-1 Course

An example of such evaluation by the first-year students occurred during the 1996-97 cycle of the ISM-1 course [Collis, Verhagen & Gervedink Nijhuis 1996a], a course that runs for an entire academic year. Approximately 85 students in the course were asked on four separate occasions to respond to a course-site evaluation form, offered via a CGI (Commón Gateway Interface) form. The 27 questions had to be answered on a scale of 1 to 5 (lowest to highest). After each of these cycles, the students' responses were summarized and graphically displayed within the site [Collis, Verhagen & Gervedink Nijhuis 1996b]. In the following paragraph some main results are mentioned from these on-going student evaluations of the 1996-97 cycle of the course. It is also indicated how the 1997-98 version of the course was redesigned, based on these main results.

With regard to the results, the students were consistently pleased with the possibilities of the WWW-based course environment. Students expressed they liked working on the course through the ISM-1 site very much. They also liked the specialist tasks assigned to each person in the group-project part of the course, and were able to work on their tasks without help. The way lecture notes were available on-line before and after the classes was considered a good idea compared to other courses, where the notes were not available or only after class.

Students also stated specific suggestions concerning future improvement of the course and the course site:

- It is difficult to read from the screen, especially after some time.
- Hyperlinked study texts take up too much time, especially when studied at home through a modem.
- It is very easy to get lost because the information wanted is stored very deeply in the site.
- The exercises are time-consuming, just doing projects is preferred.
- The communication between group members has to be improved.

While these points relate to the organization of the course and the course-site as a whole, points such as the following relate specifically to the user interface:

- The navigation could be clearer.
- The text is difficult to read.
- It is not immediately clear where new things in the site are put.

- Consistency on the pages is required for better clarity.
- It has to be immediately clear whether the current page is an internal or external page.
- Italics are very difficult to read from a screen.
- Tables sometimes do not fit on the screen.

Specific design-related conclusions are inferred from these suggestions and also by use of traces of student usage of the course-site and other student comments made during the course:

1. Students do not like to study by reading from the screen. They prefer printed, portable, linear study materials instead of hyperlinked interactive study materials so they can study them away from the computer.
2. Students do not want to go further than three clicks (or levels) to find what they need.
3. Students appreciate a navigation frame that is always present. They need a clear understanding of what is meant by each option in the frame.
4. Students are sensitive to the readability of text on the screen, to its layout, and to a consistent screen design, based on the way that text is formatted and spaced, with a restful contrast between background color and the colors chosen for text and links. Highlighting features such as italics are not appreciated because of their impact on readability. Consistent and restful are key attributes.
5. Students are not particularly interested in images and logos on the pages of the course-site, but they do appreciate being able to visually distinguish the course pages from external pages that are called up; thus all course pages have to possess a common look.
6. Students prefer to scroll through a page, rather than to use internal links to move around within the page, but they do appreciate a consistent link from the bottom of the page to the top of the page.
7. Students want a direct indication of what is new in a site, and where to find it, as soon as they enter the course environment.

3. Redesign of the User Interface for the 1997-98 Course Environment

The course was redesigned for the 1997-98 year based on these and other student reactions to the user interface. In the next paragraph the main way the evaluative comments of the students influenced the course redesign are described.

Navigation. In 1996-97 students said that the navigation frame appearing on the left of every screen had to be clearer. Thus the navigation frame has been changed from icon based to word based, because the students indicated that it was not quite clear what the icons represented. As it is difficult to find suitable icons for the different centres, the option of word-based navigation for the navigation frame has been chosen. Students also said that one of the results of using a frame was that it sometimes was not possible to go back or forward using the buttons in the browser. Therefore backward and forward arrows are now provided on the pages. A home button is also provided at the bottom of each page.

Layout. Consistency in the pages was required for better clarity. Thus all pages are now built using the same template. The template contains the background color, text color, title color, menu, ISM-1 logo, table format, bullets and horizontal bars. It was indicated that it has to be immediately clear whether the current page is an internal or an external page. Therefore different colors and the new (smaller) logo are used. The logo represents the KOPIE model [Collis & Verhagen 1997] which is the leading conceptual thread for the course-site. The Educational Science and Technology house-style colors inspired the choice of the colors blue, red and yellow.

Icons. In last year's course students said that the icons were not clear. Now the icons are renewed. As it was very difficult to find representative icons, headers are placed next to icons smaller than those of the previous year, to clarify their meaning; consequently an icon's function is reduced from a navigation item to a decorative recognition item.

Tables. The tables had to be clearer, thus a new template for the tables was designed, including no fixed table widths. Instead table width is indicated by a percentage of the screen, so that in this way the tables always adapt to the screen size.

Text clarity. Last year it was indicated that the black text on the white background was difficult to read, and not pleasing to the eyes when larger portions of text were read. The improvement made is that the text color has been changed to dark purple, and the background color to light yellow. The choice of these colors was directed by comments such as: the background was too light, and the text was too dark.

Text readability. In the 1996-97 course students said that the texts were presented in paragraphs that were too long. Paragraphs are now shorter, and subdivided by horizontal bars. The main items are stated at the top of each centre in a menu. By clicking on these items the text immediately scrolls down to the requested part of the text. At each break an arrow to the top is presented that allows the user to easily return to the menu.

As an example of those adaptations, the user interface from the 1996-97 course [Collis, Verhagen & Gervedink Nijhuis 1996a] is shown in Figure 1, while the revised user interface from the 1997-98 course [Collis, Verhagen & Gervedink Nijhuis 1997a] based on the student comments is shown in Figure 2.

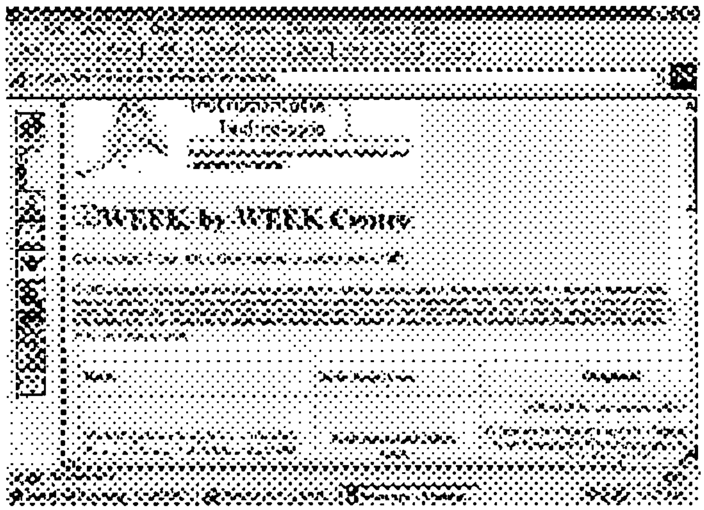

Figure 1: Example of the interface design of the ISM-1 course-site from the year 1996-97.

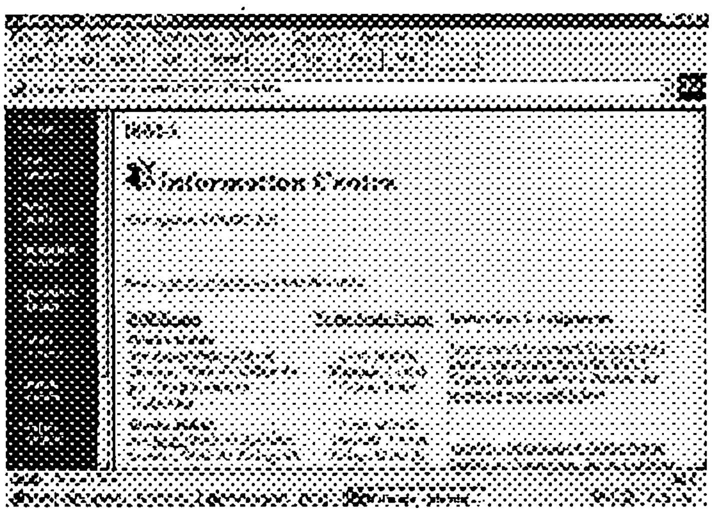

Figure 2: Example of the interface design of the ISM-1 course-site from the year 1997-98.

4. Student Evaluation of the Redesign

Continuing our process of on-going student evaluations of the user interface of the course-site, students in the 1997-98 cycle were surveyed during the fifth week of the course (October, 1997) with regard to the user interface of the course-site. This survey occurred with selected students via interviews and an evaluative CGI-form available within the course [Collis, Verhagen & Gervedink Nijhuis 1997b]. Students were not forced to respond, but 38 out of the 60 students did within a one-week period. The results were directly summarized after this one-week period and made available to the students via the course-site [Collis, Verhagen & Gervedink Nijhuis 1997c]. Table 1 gives some of the survey questions and a summary of the student responses.

Selected questions and answer options:		Percentage of students responding to each option (N=38)
What do you think about the color of the background?		
very bad		0
bad	(a bit pale, a bit bright)	2.8
no opinion		5.6
good	(nice to look at, better than a white background)	55.6
very good		36.1
What do you think about the color of the text?		
very bad		0
bad	(not enough contrast, a bit too bright)	2.8
no opinion		13.9
good	(good color, good contrast)	61.6
very good		22.2
What do you think about the size of the text?		
very bad		0
bad	(too small, too large, too thin)	5.4
no opinion		21.6
good	(good size, exactly right size)	43.2
very good		29.7
What do you think about the navigation frame?		
very bad	(I don't like to scroll)	11.4
bad	(not clear what information the words represent)	11.4
no opinion		11.4
good	(fast way of navigating)	40.0
very good	(very good, clear)	25.7

Table 1: Sample of items from student evaluation of the redesigned user interface of the 1997-98 ISM-1 course-site (Full results at [Collis, Verhagen & Gervedink Nijhuis 1997c])

5. Conclusion

From the survey results and student interviews, as well as other sources of data such as traces of student usage of the course-site, it is shown that most of the user interface redesign choices are well received by the students. The major problem of site structure and how this is presented to the students via the user interface remains. The conceptual decision to present the course-site based on the metaphor of 'centres' (Information Centre, Study Centre, Production Centre, Specialist Centre, Communication Centre and Search Centre) was taken as a basis for navigation, to organize the types of materials and interactions supported in each of these parts of the course-site. This decision is conceptually logical, and fits the instructors' mental models of the course-site. Students however, live and work in sequential time: finding what they need for a given week in as efficient a manner as possible may be a more appropriate approach for the organization of the site as expressed in its user interface. This is a serious point of consideration for further cycles of the course, and for the design of WWW-based course environments in general.

6. Discussion

Designing the user interface of a WWW-based course environment is a complex task, involving the combination of form, function, style and practicality. It is important that student evaluations of the user interface of these environments occur whenever they are used. Some of the design decisions that the course-site designers may feel are most appropriate may not be perceived by the students as most helpful. Examples of this are: organizing the course-site conceptually rather than by a week-to-week basis, offering the students hyperlinked study materials, and offering frequent internal navigation options within pages. Other aspects, such as the way text is laid out on the page and an overall peaceful feeling resulting from the colors and style of the site, may be more important than previously considered. Asking the students systematically and regularly about their opinions should become part of our standard practice when WWW-based course environments are used. This can be realized through a combination of CGI-form surveys, informal interviews, and examination of the logs of their movements within the site.

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Supporting Distance Learners For Collaborative Problem Solving

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Abstract. This paper describes a computer-supported environment to facilitate distance learning through collaborative problem-solving. Our goal is to encourage distance learning students to work together, in order to promote both learning of collaboration and learning through collaboration. Collaboration means working together on a common problem, communicating and coordinating activities towards a shared goal. We propose a system embedding three models: an activity model, a domain model and a conversational model. The system can support asynchronous collaboration in a number of dimensions: giving structure to activities and communication to articulate the problem solving-task, supplying a share space to build jointly common knowledge, providing relevant know-how by case and techniques libraries and facilitating further reflection on the whole learning process. Preliminary results have convinced us that this approach offers promises to establish collaborative distance frameworks to enhance students learning processes.

1. Introduction

Teaching and learning require a range of approaches to suit diverse domains and students. At the root of science courses, including computer science and engineering, is the acquisition of problem-solving skills, usually through practical activities performed individually or in group work. In the case of distance learning situations, communication technology opens for the first time, the possibility of deploying problem-driven and collaboration learning strategies, so that students could acquire and practice a variety of interpersonal and reasoning skills. Recently, several research teams work on developing tools to support the performance of (learning) tasks to be carried out together by students located at different places. As many authors point out, two key ideas are (1) learning activities should be structured to focus students on the issues to learn, and (2) educational software systems should exploit their interactive potential and the capacity to include and manipulate explicit models, in order to stimulate students' knowledge construction processes. Distance collaborative learning can be shaped in many ways [Collis 94], [CACM 96], [Verdejo 96], joint projects is appealing for a range of scientific and engineering subjects. To mention just a few of the current educational projects exploring this area, [Edelson et al. 94] offer a shared Notebook with a set of page types corresponding to a task model of scientific inquiry to be used for collaborative science learning. The page types include questions, conjectures, evidence for and against, information, commentary as wells as plans and their steps. Students can create instances of these pages and link them as their work progresses. A learner interface built upon their scientific inquiry model, suggest students next steps to pursue. [Wan & Johnson 94] report on CLARE, an environment supporting the task of learning to understand scientific literature. They define an explicit process model: summarization, evaluation, comparison, argumentation and integration and provide representations and structure for each of these individual and group activities. Learning as collaborative knowledge construction can be difficult to achieve, among other reasons because often students have to learn at the same time the abilities to collaborate. However, group competencies are basic skills to be acquired not only for the purpose of the learning process at hand, but for future professional proficiency. This paper describes our approach to build a computer-supported environment to facilitate distance learning through collaborative problem-solving. The paper is organized as follows: Section 2 sketches the distance learning scenario. Section 3 gives a description of our modeling approach. An application is presented in section 4, and finally some conclusions are given in section 5.

2. Scenario

A scenario, described as a summary of situations, including information about its setting, participants, their tasks, roles and interactions, is often used to develop a practical understanding of how an end-user will perceive and use a technology-supported environment. For designers, it is a means to perform a joint visualization of candidates ideas in order to explore, refine, and test them for further implementation. In our case, the scenes concern learners-related actions and interactions, embedded however in a broader context. Main features are the following:

• Institutional framework: The institution is a distance learning university, offering diplomas, in a regulated course time frame, with formal examinations. The prevalent model is independent self-study with appropriate learning materials. The use of a collaborative environment should be on a volunteer base (both from academic and student side). Groups using the environment should follow the same calendar (for deadlines, assignments,..) and academic requirements as the rest of students

• Kind of scenario: Collaborative learning, focusing on group project development. Groups of distance learning students, each group has to carry out a project using a system to support their personal and group work. This support should include, in an integrated way: (1) private and shared workspaces with notations for expressing alternative partial solutions at an adequate level of abstraction, (2) facilities to use domain-specific tools, (3) facilities to access information sources in a way relevant to the task at hand, (4) group communication facilities helping to manage the complexity of the interaction.

• Learners, organized in small groups, in each group there are a number of roles: moderator, contributor, and secretary. For the moderator role, two kind of functions are expected: organizational facilitation (such as conduct and end discussions), and social facilitation (motivate and promote cooperation). The role of secretary is to focus on intellectual facilitation, such as summarize contributions or highlight conflicting opinions.

• Settings, described by spatial and time dimensions: Students, Tutors, and Professors are in separate, distant and disperse locations, usually with different schedules, so that interaction and collaboration should be in deferred (no real) time.

• Facilities, comprising conventional and technological material and devices. We assume each participant has access to a standard multimedia computer connected to a central server, using low-cost communication technology (mainly asynchronous electronic mail, computer conferencing, or asynchronous access to file systems)

3. Modeling the system

Our system architecture to support learners for collaborative project development consists of three independent but interrelated components, which are based on the following models: (1) an explicit model of the problem-solving activities or activity model. This includes a description of each activity, to specify whether is a personal one or in group, main goal to attain, kind of information available and possible restrictions. Relationships between activities are also expressed. The group organization (participants and roles) is also provided; (2) a model of the participants interaction, both human-machine and human-human communication. Communication is performed through semi-structured messages using a conferencing system, each message belongs to a larger discourse unit, and depending on its type and purpose is related either to events of the activity model or to objects of the domain model; These two models are inspired on proposals from the CSCW stream, [De Cindio et. al. 88], [Malone & Fry 92] implemented for teamwork in professional environments; (3) a model of the domain comprising two sources of case-based structured knowledge, and a workspace offering a notation to express students ' constructions for a solution.

In our system these three components are integrated and related one to each other. For instance, the activity to be performed can constrain the type of dialogue that is used; an activity is developed linked to a type of problem-solving task in a particular knowledge domain. In this way actions and interactions in the learning process are properly recorded. Thus, not only the whole process is also an inspectable object to reflect upon, but its explicit representation allows, as well, to include supportive actions from the system. The activity model is generic, that is, its elements are valid for any type of activity not necessary educational. The proposed model of dialogue for a moderated debate (structured in terms of sessions, rounds, and messages) is valid for any discussion that has as an objective to build an agreed solution. In the same vein, the notation for expressing domain problem's description, is also generic (objects and relationships to which the user can associate the desired semantic behavior). To combine domain, activity and group modeling in a learning environment aims at least at two purposes, one to facilitate reflection so that students could have the opportunity to consider not only their outcomes but also the process they are following and, the other one, to provide students with support for building and exploiting cumulative understanding, giving them a further motivation: the opportunity to contribute to the extension of the domain memory for the use of future learners. Grounded on these models, different applications can be built following an user-centered design methodology as initially proposed by [Norman & Draper 86] and further developed by [Gould & Lewis 87]. An *iterative*, *formative*, and *situated* design process. Initial analysis leads to a preliminary specification to build a prototype, the evaluation of that release is used as a formative (information gathering) step, providing feed-back for further re-specification and re-implementation. Final testing should be situated with real users on a realistic task.

4. Developing an Application

We started focusing on the learning of a class of problem-solving methods, in particular related to software design. Taking into account our teaching experience on programming projects development for undergraduate students, a first set of scenes where defined, and experiments with small groups of students were conducted. Each scene characterized in terms of participants and task at hand, focused on a main issue to test a range of support tools. Taken all together, had lead to gain insights for an integrated environment. Through observation and discussion of students' performance and results, the notation used to describe domain objects, including the description of problems, requirements for a solution, and the expression of partial designs was revised. Some changes affected the groupwork process model, and so the definition of the private and shared workspaces and their support tools. After this phase, appropriate features for an integrated learner interface have been established, and a prototype built.

4.1. Activity Model

This section sketches the main objects provided by the activity model. An Activity has a name, a description, a mode (either individual or collaborative), participants, a characterization of the information required as data or generated in each activity, as well as a description of the tools needed to carry it out. A part of this information, but properly distinguished, is the result or product. A Complex_Activity is a set of activities with a partial order defined, it can be visualized as a labeled directed graph in which the nodes are activities. Attached to the nodes and/or edges, a control descriptor represents requests that the system will perform automatically during the development of an activity. For example, when the third step would be finished the teacher could establish that he wants to receive a report. Then the system will generate a message to the students requesting the report. A special case of complex_activity is when the set of activities is ordered i.e. a sequence of activities. For each activity there is a descriptor pointing to the set of electronic messages that students have interchanged while carrying on the activity. This descriptor establishes a link between the activity model and the dialogue model. For our scenario, we have written the description of a main activity related to computer programming design. Students have to learn to characterize a problem and then select an approach to solve it using a set of known techniques. As a final result of this activity students have to build a piece of software and a documentation. The design methodology they have to acquire includes the following sub-tasks: Specification, Instantiation, Structured Design, Implementation/ Test, and Generation of the Documentation. Each one is in turn, a complex activity with its own input and output, its time schedule and participants. An outline of the definition for the Specification is showed in table 1.

The individual phase for making a Specification consists on three activities, namely, problem description, selection of an algorithmic technique and making a justification. The description and the selection can be done at the same time; but the justification has to be done once the other two are finished (these restrictions are expressed in a graph, (see figure 1). A tool allows creating and editing an activity model. Along the learning process, the system works with the model, linking dynamically references to the event instances been created. A visualization of the current state of the activity model is available from the learner interface, so that always students can inspect the structure of the whole process, accessing to the information in a structured way, and being aware of the active sub-task in which they are involved.

Specification is a complex-activity consists of (CA1, CA2)			
ACTIVITY	TYPE	P ORDER	SUBACTIVIES

CA1 is a complex_activity	Individual	graph1	Build Problem description, Decide which algorithm techniques are candidates to solve the problem, Justification of the proposed techniques depending on the chosen description
CA2 is a complex_activity	Collaborative	moderated debate	Mutual understanding of the work, Collaborative construction

Table 1. Definition of Specification as a Complex Activity

4.2 Dialogue model

We had focused our study on the debate mode. Moderated debates are carried out through different stages related to a phase of the task model. There are two aspects, which become relevant: The structure and form of a debate and its relationship with the activity and domain model. For the specification task, the debate starts after a personal work phase, and consists of a set of sessions: the *initial* session is usually bounded to introduce personal solutions. This session just consists of one round. A round is accomplished when every member of the group has participated once at least. A session can be a set of rounds. A message from the moderator opens the discussion starting a new session, then students try to understand the others' solution proposals. A number of comments are made and new solutions are proposed out of the old ones. This is called a *diversification* session, because new themes can appear in the debate. The debate is eventually focused by a message from one of the participants, opening a *consolidation* session, and can be followed by a new diversification session, and so on, until an *agreement* session is caused by the moderator. As mentioned before, the debate is established by means of electronic messages produced by the students using a conferencing system. Messages related to a collaborative phase for constructing a solution can be roughly classified in two groups as follows:

1. Those referring to domain contents (IS, IRS, CS). Introduce solution (IS): this type of message is only sent at the beginning of the debate. Its goal is to share solutions with the other members of the group. Introduce reviewed solution (IRS): Normally, during a debate, one has to review its last introduced solution due to others students comments. The goal of this message is to propose a reviewed solution. Comments about solution (CS): comments can be of any type (suggestions, criticisms, questions, misunderstandings) and can refer to any of the solutions introduced by the members of the group.

2. Those concerned with the task and debate evolution (CTM, CC, R). Comments on task management (CTM) for instance to summarize the situation up to the moment. Comments on coordination (CC): They are mainly done by the moderator, they can refer to time scheduling, handling of participation. Reflection (R): a variety of written thoughts, expressing personal/ interpersonal dispositions.

Messages of the first group create new objects or links on the shared domain workspace, so that everyone can view for a proposal, new contributions as well as all the participants' comments on it. Providing a semi-structured way to perform interactions allows to create automatically links between the domain, activity and conversational models. This structured and interrelated information can be used in different ways, for instance by a teacher or the students to know the work progress, to focus on the current state of affairs, to analyze contributions to a particular proposal, or to further evaluate whether and how collaboration occurs. Furthermore, the system can have information, to some extent, about how the debate is going on. This, eventually, provides a potential source to be exploited for pedagogical support, as for example, to design and include a coaching facility to stimulate group interaction.

4.3 Domain Model

To support problem-solving in a domain, a variety of knowledge sources and tools can be foreseen. Sources may include declarative knowledge, for example the criteria to use a particular technique, and procedural knowledge i.e. how to proceed to solve a type of problem, with available examples from a case-based library. Tools like compilers and debuggers provide dynamic models to be used in some stages of the learning process.

Central to our application is a shared tool: a common workspace where students can write their solutions for a given problem using a graphic editor. Based on the entity-relationship model, the notation is precise enough as to be interpreted unambiguously, and powerful enough to describe the solution at different levels of abstraction. A semi-graphical representation has the advantage of being easy to use so that students can concentrate in the problem itself and not to bother about the features of a new formal language. An advantage of this type of representation is, that to some extent, an object can be automatically analyzed, and then the system can help in the comparison of the variety of solutions worked out, providing operations to answer questions such as the number of different techniques proposed by the group to solve a problem or check whether the restrictions for the input in a set of proposal are the same. The workspace model includes a set of predefined objects, built up from primitive elements, so that students can either built their objects from scratch (using the primitive operations) or by means of selecting and filling operations. The level of abstraction and grain size of the objects and the operations provided to manipulate them, is a tool design issue of great importance. Combining a graphical and textual representation for operations such as to visualize, edit, search and compare seems intuitively a sensible approach.

4.4 The learner interface

The learner interface aims to make easy creating and discussing a solution for a given problem. Figure 1 shows a screen shot from a *mutual understanding* activity.

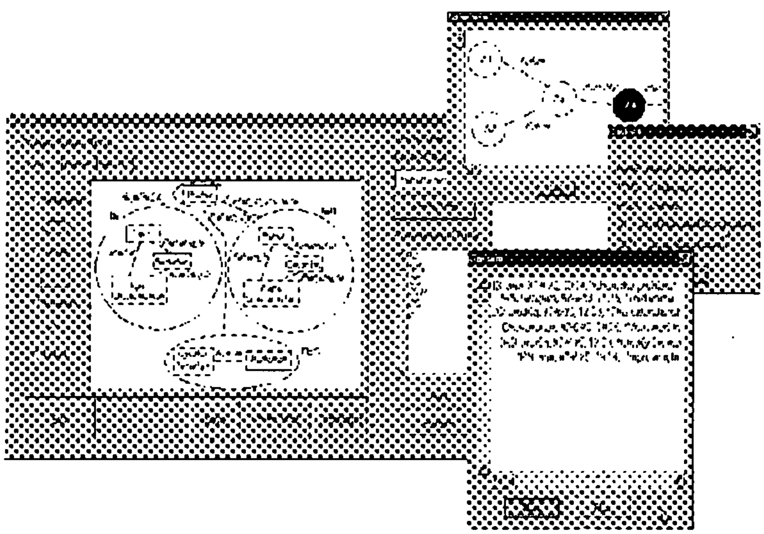

Figure 1. Learner Interface

The main window is divided in three areas: problem solving on the left, activity and conversational spaces on the right. The problem solving area includes a shared workspace were contributions can be written, either by selecting and/or editing a previous proposal, or by importing a new one. A set of buttons gives access to the case-based and technique libraries, where navigation is facilitated to find easily the information required. The discussion tool offers a set of typed messages. Students can discuss by posing comments to proposals, questions,... and responding to them. All the messages for the session can be visualized on the session window and the filter option provide a variety of views to see only kinds of interconnected messages. This semi-structured support facilitate learners to focus on the content of their discussion The activity button give access to the activity plan, to visualize the requirements of the current step, or to know about the next/past activities. This tool facilitates to students involved in the task, and also to teachers, to monitor their progress.

5. Conclusions

A number of experiences, involving students, have been undertaken with a previous version of the system prototype. The application described above, include all the changes derived from observation, analysis and discussion of the students activities. For the case study, we have used as domain subject a course on Algorithmics, run on the second year of a Technical University. Students following this course were involved in the design and implementation of an information system for the management of a library. They have previously done some groupwork and have positive feelings towards the use of electronic communication. The specification step was defined as the main focus of attention for analysis and assessing purposes. Scenes have been selected to study particular modeling aspects. The experiment was conducted with different groups, each one involving three students. The activity included an individual work phase followed by a collective debate to produce the collaborative solution. The concatenation of several phases covering the whole process has not been tested yet. Every group has been provided with the same problem. As these experiments went on, guidelines to incorporate pedagogical support on the models were established. As well, the mapping of learners activities on interface actions was clarified. Roles, particularly the moderator, were clearly seen as useful.

Our goal is to encourage distance learning students to work together, in order to promote both learning of collaboration and learning through collaboration. Collaboration means working together on a common problem, communicating and coordinating activities towards a shared goal. We propose a system embedding three models: an activity model, a domain model and a conversational model. Based on these models, a computer system can support asynchronous collaboration in a number of dimensions: giving structure to activities and communication to articulate the problem solving-task, supplying a share space to build jointly common knowledge, providing relevant know-how by case and techniques libraries and facilitating further reflection on the whole learning process. Experiences and preliminary results have convinced us that this approach offers promises to establish collaborative distance frameworks to enhance students learning processes.

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Education and Spatial Hypermedia: The HyperMap Browser

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Abstract: To illustrate the potential of spatial hypermedia for education, we present HyperMap. HyperMap is a concept implementation of a spatial hypermedia browser. Information is presented in a scrollable 2D space, based on a map metaphor. Where the unrestricted navigation style of WWW hypermedia is undesirable, HyperMap provides extra navigation and guidance. Educational hypermedia content displayed on a map allows various limitations of WWW information display and linking to be lifted. The 2D view of information in HyperMap provides ubiquitous navigation and allows communication of implicit structure through the positioning of information. With the conditional hypermedia links in HyperMap, a student can be given knowledge-based guidance support. Other innovations in HyperMap are persistent objects that can be annotated, interactive multimedia content, and straightforward hypermedia authoring.

1 WWW hypermedia for tertiary education

platform for hypermedia development. WWW hypermedia, originally designed for straightforward textual information retrieval, is more and more applied in educational se tings, either in the classroom or outside for distance learning over the Internet, as described in [Marshall and
students, the role of distance education and hy
future.

Currently, most educational hypermedia applications are based on WWW browsers and HTML v3.2. Because of

users and authors. Although HTML and WWW browsers have undergone numerous extensions over the years, there is as yet no fundamental a proach towards guidance and navigational support. This is a definite problem when using WWW hypermedia for tertiary education. Students often become disoriented when browsing a large i formation space. When there is insufficient information to select a particular link out of many alte natives, users tend to feel lost and browse at random ypermedia links are still direct links, and thus prevent

unrestricted navigation where users know where to go and how to get there. In contrast, in educational applications of hype media, .

From our previous research into tertiary hypermedia based computer science laboratory support [Verhoeven and Warendorf 1997], we consider navigational support to be essential for the success of educational h permedia applications. Other researchers into hypermedia in education agree; [Jones and Berger 1995] suggest that hypermedia gnitive style influence a

compatible with that particular design. These find
content is desirable. The potential of educa
been explored before [Trentin and lthough no user interface design specifications were included.

for an innovative hypermedia browser. We illustrate our design with a concept implementation named *HyperMap*.

metaphor.

2 Shortcoming of the WWW for education

Hypermedia developers have in various ways addressed guidance and navigation. One is to generate on-line adaptive HTML documents. Individualized hypermedia content allows links to be omitted, ordered, and colored in order to guide a user [Schwarz et al. 1996]. Schwartz and Brusilovsky preferred icons and text-based adaptive annotation to only coloring, but were restricted by the current HTML standard.

In the area of user interface improvement for browsers, some HTML limitations have been addressed with Java *applets*. Applets run as small programs inside HTML documents and provide interaction in their separate graphical user interface. With applets, HTML can include highly graphical user environments. Recent HTML hypermedia applications increasingly include both applets and scripts integrated in HTML for adaptive user interaction. Applets and browser scripts are able to achieve localized user interaction in a graphical user interface, but do not scale up well for integrated navigation support, as reported in [Verhoeven and Warendorf 1998]. Size and communication limitations of applets, caused by restrictive WWW browsers, make them unsuitable as integrated guidance and navigation tools. In addition, the 'next generation' WWW research such as the Hyper-G project [Mauer 1996], have made few improvements of the standard hypermedia user interface and its maximum guidance level

We propose an alternative educational hypermedia design based on Spatial Hypermedia. A concept implementation named HyperMap has been implemented in Java. A major feature of HyperMap is that it is not restricted by HTML for its hypermedia document size and format.

3 Spatial Hypermedia and education

Spatial hypermedia [Marshall and Shipman III 1995] is based on a user interface with a central canvas where media objects (text pages, notepads, pictures, interactive visualizations, and questionnaires) are displayed and manipulated. Implicit relationships between media objects are visually present in the size and proximity of objects. The spatial layout helps authors to express relationships between objects and helps readers to interpret the information. The notion of a central canvas has been applied in development of collaborative hypermedia applications [Marshall and Shipman III 1995], geographic information systems [Lokuge and Ishizaki 1995], and applications for the communication of *concept maps* [Gaines and Shaw 1995].

Spatial hypermedia applications have been largely regarded as a tool for computer supported co-operative work. The usefulness of spatial hypermedia for education has not been fully explored yet. To investigate the potential of spatial hypermedia for education, HyperMap has been designed as a domain independent hypermedia browser for educational content. HyperMap allows knowledge-based connection between media objects, and thus the creation of adaptive hypermedia links. Its graphical user interface is based on a scrollable central canvas. A navigation tool, consisting of a scaled map of the canvas, is always visible. Interactive multimedia objects on the canvas form a media rich environment with a high level of interaction through guidance in link selection, questionnaires, visualization, animation, and audio support. This promotes a motivating multimedia experience that goes beyond passive reading of textual content. Where in HTML text is the central medium that links content together, in HyperMap the visualization and layout of objects is central. For educators, it aims to provide a tool in which a curriculum can be expressed visually.

4 HyperMap as an educational tool

HyperMap is intended for educational assignments in which information retrieval is a part of students' activities. Both courseware and traditional intelligent tutoring approaches would be overly restrictive. In the spectrum of guidance in educational systems (figure 1), HyperMap aims at the middle area, with unguided WWW hypermedia on the extreme left and classical intelligent tutoring systems on the right. Here, *guidance* is interpreted as more than merely reducing the set of links from which to select. When restricting the available link set to one, navigation problems disappear, but also the opportunity to select the information that answers a student's specific information needs. Thus, guidance should also explain and point out alternative links. For some educational domains, tutoring in HyperMap will be similar to *guided discovery tutoring style* [Elsom-Cook 1988]. Guidance is offered in a mixed-initiative dialogue, where the student usually will decide where to go in the information space. For some educational assignments, unrestricted browsing of information may be sufficient. Even then, HyperMap browsing will still differ from WWW browsing in that it takes full advantage of students' map reading skills for orientation and navigation.

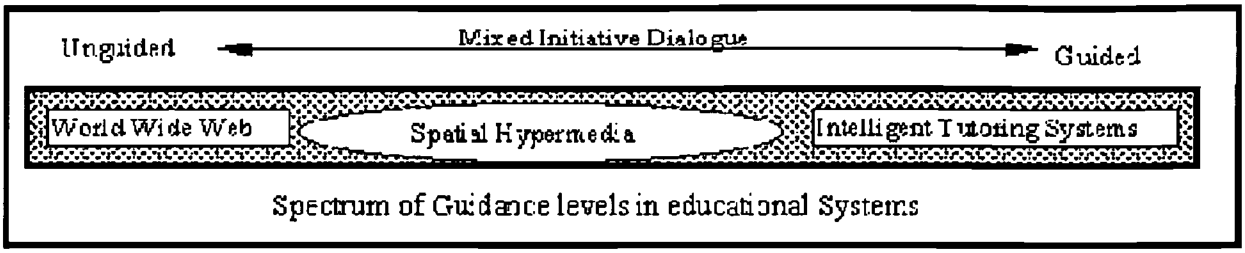

Figure 1: When an assignment involves information retrieval tasks, guidance is essential. Spatial hypermedia can provide the direct navigation support lacking in most WWW hypermedia. Unlike tutoring systems, it leaves the student the ability to browse.

In HyperMap, all hypermedia links are indirect to allow intervention in the browsing process by a knowledge base (figure 2). For basic applications, simple *conditional* links may be sufficient. They restrict a user's path through an information space by becoming active only after a set of links has been first visited. The user is thus forced to follow a path defined by the hypermedia author. This potential resembles 'hypermedia sequences' in Hyper-G [Mauer 1996], except that HyperMap gives more flexibility. Not the number of links is restricted, but their state will change between either enabled or disabled.

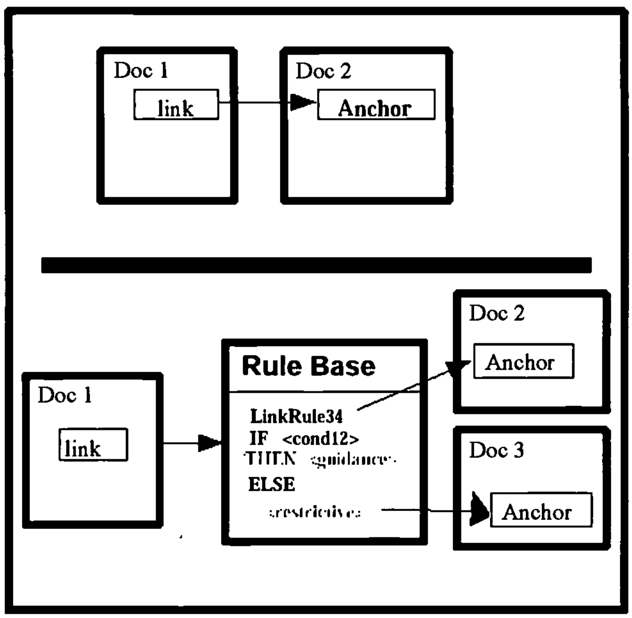

Figure 2: The direct links in most WWW hypermedia restrict direct rule based intervention. With indirect links, a knowledge base can select the optimal destination, based on the student's knowledge levels and browsing history.

Spatial Hypermedia, as implemented in HyperMap gives the user access to a large scrollable canvas, which may be up to several square meters in size. Free navigation takes place with the aid of a scaleable map, displayed next to it (Figure 3). When navigation is unrestricted, one mouse click on the map causes the large canvas to scroll to the requested position. When a valid link is selected, the view scrolls to the canvas position where the information is displayed. Guidance takes place when the application initiates scrolling to give the user a 'tour' around the canvas.

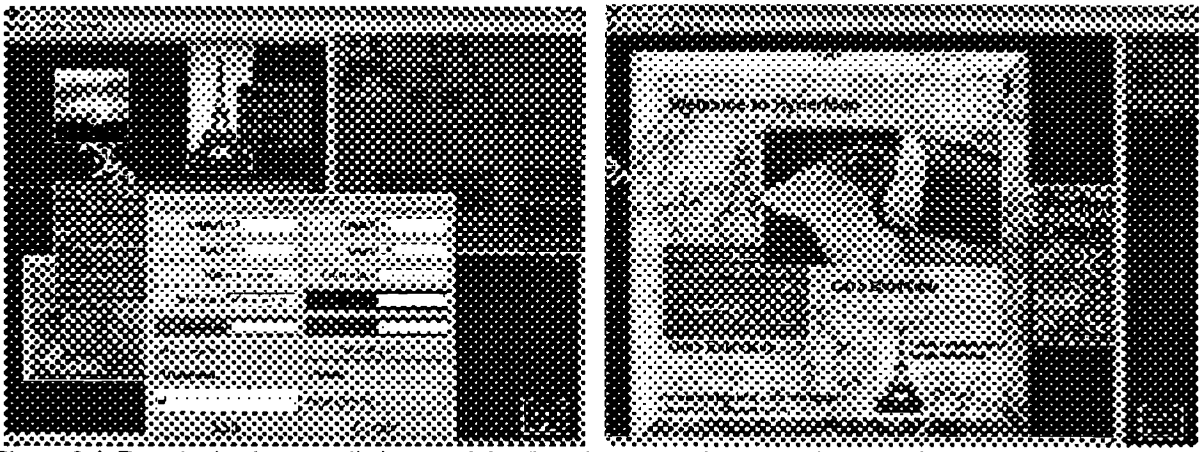

Figure 3.A-B Authoring hypermedia in HyperMap (left picture) consists of moving and reissuing the media objects on the canvas. The right picture displays HyperMap from a user's perspective. For reasons of clarity the total canvas size has been kept relatively small.

5 Accessing a 2D information space

Due to the virtually unrestricted size of the central canvas, even large information bases can be organized and placed on a single view area. This single-window approach avoids space contention, which occurs frequently in applications based on multiple windows, investigated in [Henderson and Card 1986]. Space contention can be regarded as user disorientation in window space. A navigational support facility, which relies on large numbers of simultaneously accessible windows, is likely to create more disorientation than it resolves. Therefore, HyperMap uses scrolling in a single window to access parts of the canvas currently not visible. Fast scrolling is initiated by a mouse click or mouse drag on the map in the right upper corner (figure 4). The map, which can be enlarged when necessary, displays the object on the canvas and the currently visible canvas area properly to scale. A map grid helps to visualize the current canvas - according to the map size ratio. Even when the map scrolling is disabled, the map still provides information to the student about the current position in the full curriculum, as all objects are displayed on the map.

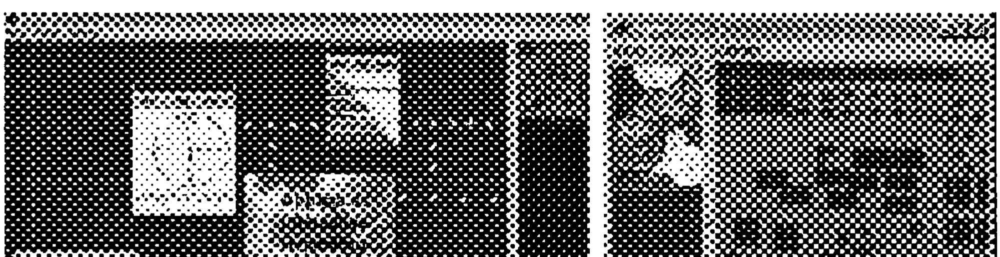

Figure 4 A-B The mapped canvas is always visible in the right corner (left picture), and can be enlarged for detailed map based navigation. Its size is independent from the browser's window size (right picture).

One advantage of a large information canvas is that information objects can be displayed completely, as opposed to only displaying symbolic icons as in [Marshall and Shipman III 1995]. Further, HyperMap provides unlimited space for help texts and graphical guidance near hypermedia links. Thus, the user will generally have valid expectations when selecting a link. A third advantage is the space provided for users to leave annotations in empty slots scattered on the canvas. Whenever the need arises to add an observation, reminder, or memo, the user can do so and thus personalize the information space. The annotations are stored after the session has ended, and the personal information remains intact for future sessions. No separate and potentially distracting paper-based note taking activity is required.

Results in the literature on empirical experiments with hypermedia maps as navigational tools have shown mixed results. A negative effect from spatial navigation maps on information searching has been reported in [Sousa and Dias

1996] where it is argued that the presence of a spatial map of the content interferes with the development of a cognitive map. Although not empirically tested yet, a similar negative effect of the navigation map in HyperMap is not expected for two reasons. First, the map in HyperMap is not a separate node that has to be revisited repeatedly; instead, it is integrated in the browsing process and continuously visible. Second, the layout of the hypermedia objects visualizes their semantic relations, and is identical to the map layout. Thus, there is continuous and consistent semantic information available to help students in the development of a cognitive map.

6 Hypermedia link differentiation

In spatial hypermedia, the role of links is different then in conventional hypermedia. Information about the relevancy of a link is implied in the geometric organization. For educational purposes however, explicit links are also necessary. In HyperMap, explicit links provide guidance and restrict navigation, both by providing textual information and by scrolling the central canvas to the position where the link is anchored. Below five types of links are listed which are applicable in HyperMap. They can be combined on a single canvas to create a curriculum with an appropriate level of navigational freedom (figure 5):

- *Sequenced links:* In a sequence of single links, the student is forced to take one path. This may be desirable from didactic considerations, although it restricts free information search.
- *Multi-links:* When a link has multiple valid destinations, a multi-link offers a choice to the student which path to follow. Textual descriptive link information may be offered to guide the selection.
- *Conditional Links:* A basic condition for a conditional link to be a valid choice is whether a pre-read set of links has been visited before. This was proposed in [Lai et al. 1996] as a restrictive navigation control method. A knowledge base in conjunction with conditional links can provide a level of adaptation into hypermedia links, as in [Trentin and Midoro 1996].
- *Proximity links:* This type is specific for spatial hypermedia. When a proximity link is reached, it restricts navigation by disabling scrolling beyond a radial distance from the link location. This combats random browsing, while local information retrieval remains unrestricted.
- *Implicit links:* When laying out hypermedia content on the canvas, information is implicitly stored in the proximity of objects. For purely information retrieval, implicit links allow free but unguided browsing.

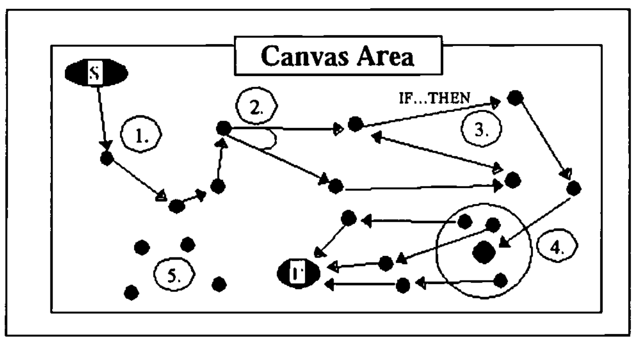

Figure 5 Five types of hypermedia links are displayed. Sequenced links (1), multiple destination links (2), conditional links (3), proximity links (4), and implicit links. A curriculum can be laid out on the canvas from start S to the end E, with an educational optimal degree of browsing freedom.

7 Interaction and Multimedia

Multimedia in educational hypermedia provides extra motivation for students. However, when non-interactive media are applied, the benefits are small. HyperMap is intended to provide both passive and interactive multimedia. Currently a component library, consisting of multimedia HyperMap objects, is under development. As an alternative, the inclusion of existing Java applets, with only minor modifications, is possible as shown in figure 4, allowing the inclusion of existing HTML applets in HyperMap. Future HyperMap components will be based on a more robust and versatile component model.

8 Support for object-oriented hypermedia development and authoring

The hypermedia authoring process is often a bottleneck in the realization of a real world hypermedia application [Nanard and Nanard 1995]. Various map-based authoring tools, such as [Zizi 1995], aim to support authoring with graphical entity-relationship diagrams and other mapping techniques. In contrast, when authoring hypermedia content for HyperMap, the browser *itself* is the central authoring tool to display the information relationships.

Another supportive factor is that implementation in Java, an object oriented language, complements high-level hypermedia design. Object-oriented programming encourages the definition of classes of persistent multimedia objects, in accordance with existing object-oriented hypermedia development methodologies such as *the Object-oriented Hypermedia Development Method* [Rossi et al. 1995] and the *Extended Object-Relations Model* [Lange 1994]. We mention these advantages in [Verhoeven and Warendorf 1998]. An advantage for distance education applications is that Java applications easily support deployment over the Internet, while retaining platform independence. This makes Java an ideal foundation for educational applications. HyperMap has been designed with Internet features, either executed from the desktop or from inside a WWW browser.

9 Conclusion

The spatial hypermedia paradigm holds promises for tertiary educational hypermedia applications. The HyperMap browser under development is intended to provide a fundamentally education-oriented environment for hypermedia applications in which a student curriculum is integrated. The combination of a map-based user interface with knowledge-based hypermedia links offers guidance and navigation beyond WWW standards. Hypermedia authors benefit from the overall object-oriented design of HyperMap.

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RESCUER: Intelligent Help for Plausible User Errors

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Abstract: This paper deals with the problems that arise when a human user interacts with a computer via a command language (such as the UNIX shell) and makes mistakes. It investigates how to add reasoning to the computer so that it behaves like a helpful expert who watches over the user's shoulder and offers spontaneous help on problematic situations involving user's errors. A prototype, called RESCUER implements such additional reasoning by tracing the user's thinking that may have led him/her to issue a command that s/he did not really mean. The main focus has been on the adaptation and incorporation in RESCUER of a cognitive theory called Human Plausible Reasoning Theory which is used for the generation and evaluation of hypotheses about possible user's beliefs underlying the observed user's actions. The success of RESCUER has been evaluated on sample scripts of real UNIX user interactions showing that RESCUER does follow the user's correct and/or incorrect reasoning to a satisfactory extent.

Key words: user modelling, intelligent help systems, human plausible reasoning, error diagnosis.

Overview

It is often the case that users make mistakes because they type other than what they mean. For example, they may accidentally delete files that they did not mean to lose. This may happen if they have issued the wrong command with respect to their intentions. Situations like this may occur even in user-friendlier interfaces than command language interfaces. For example, in a Graphical User Interface of an operating system, like Windows 95, there are still some actions that the user has to do in order to carry out a plan which s/he thinks serves her/his intentions well. In this case, the actions may be different from actions in a command-language interface, such as selecting some files and then clicking on a certain icon for them to be deleted or placed in the clipboard. However, a novice user still needs to conform with the user interface's formalities and may end up initiating the wrong actions with respect to her/his intentions.

We strongly believe that an important cause for the problems that people face when interacting with a computer, is the reasoning that they use as people. This reasoning often proves inadequate or even misleading when applied to solving problems which are based on formal methods, such as giving a command in a command language. This belief has been formulated by analysing the results of an extensive empirical study in the domain of UNIX [Virvou 1992] and has been reinforced by other empirical studies such as that described in [Fung et al. 1993] where the authors report that students talked of an introduction to formal reasoning methods as a "culture shock" or "surprise". People use approximate reasoning based on analogies, generalisations and specialisations which is very good as a heuristic method for understanding, discovering, making guesses and learning, but is error prone. In addition, as Lopez points out in [Lopez 1997], analogy-making is a natural human process which often shows that not everyone thinks about a situation in the same way.

Returning to the problem of the interaction of a human user with a computer, it seems that the computer lacks a *human reasoning interface* that could reason about the user's beliefs and the user's possibly incorrect thinking that may have led the user to a *plausible error*. What accounts for the incorrect thinking could be the same generative procedure that in some occasions may lead to correct guesses. Self in [Self 1989; 1991], also points out the same issue when he considers it strange that researchers have emphasised the use of generative procedures to generate faults without emphasising that these procedures may generate correct beliefs as well.

This view reveals a role for a cognitive theory, such as the Human Plausible Reasoning theory [Collins & Michalski 1989] that provides a formal model of the approximate reasoning that people use to reach some conclusions about questions for which they do not have an immediate answer. The Human Plausible Reasoning theory (from now on referred to as *HPR*) tries to model the reasoning, that a person uses, to find an answer to a question asked, given the facts s/he knows and considers relevant, provided they do not give an immediate answer to the particular question. The reasoning that this theory has formalised concerns the inferences made, based on similarities, dissimilarities, generalisations and specialisations that people often use to make plausible guesses. These guesses may be correct as well as incorrect. The theory is not concerned directly about the correctness of the guesses as long as these are plausible.

Here we exploit the fact that plausible guesses can be incorrect and thus turned into *plausible errors*. In this sense the theory is used in the reverse order. Starting from a user's possibly incorrect action (rather than the question) an intelligent help system tries to find out what reasoning s/he used to reach that action. The more human-like interface takes the form of an active help system, called RESCUER, which stands for *REasoning System about Commands of UNIX using Evidence Reasonably.* The reasoning underlying RESCUER could be extended to be used in domains other than command languages as well.

The UNIX shell, with particular focus on the filestore commands, has been used as an example domain for the construction of RESCUER. The UNIX user interface has often been criticised for not being particularly user-friendly for reasons such as its terseness or the names of commands not conveying the meaning of these commands [Norman 1988]. Therefore there have been in the past quite a lot of research projects which aimed at constructing Intelligent Help Systems, such as UC [Wilensky et al. 1988]. There have been various approaches in the aims of these help systems and the kind of response they generate. One of them is the trouble-shooting approach [Jones & Virvou 1991] which aims at providing help on user's errors and misconceptions which have occurred in UNIX-user interactions. This is exactly the kind of response that RESCUER aims at providing.

Design of RESCUER

A help system has to solve three main problems in order to achieve the behaviour of a helpful advisor in a situation involving user's errors.

1. Recognition of a problematic situation.
   The main difficulty is to find out when a situation may be problematic especially when the user appears to be giving commands that UNIX does not complain about. It may be the case that a user has typed a perfectly acceptable UNIX command that s/he did not quite mean. For example, a user has been observed removing a directory which she probably thought she had already copied elsewhere although she had not.
2. Diagnosis of the cause of the problem, if there has been one.
   Even if a problem has been recognised by the help system with a high degree of certainty, this does not mean that the cause of the problem has also been known. As Hollnagel [Hollnagel 1991; 1993] points out, it may be wrong to mix the classification of observable *phenotypes* of errors with the interpretation of the underlying causes of these errors. What has been identified as a problem, or the UNIX error message may just be scratching the surface of a user's problem. There may exist deeper misconceptions which are to blame for what appears to be a peculiar behaviour of a user, in terms of the commands s/he issues.
3. Decision upon the kind of advice and generation of response.
   In view of the hypotheses the system entertains, it has to decide whether to intervene or not, and if so what to say to the user in order to help resolve a problematic situation. The answers that we have given to these problems are summarised in the remainder of this section which describes RESCUER's design.

RESCUER's *architecture* follows the main line of Intelligent Tutoring Systems (ITS) architectures. Researchers in the area of ITSs [Hartley & Sleeman 1973; Burton & Brown 1976; Wenger 1987] largely agree on the major functional components constituting an ITS architecture, namely a Domain Representation, a User Modeler and an Advice Generator. The three components will be briefly discussed separately in later sections in this paper.

The *overall performance* of RESCUER is outlined as follows:

Its input is the command typed by the user. Then RESCUER uses its *domain knowledge* to record what change has been made to the filestore by the command typed and thereby generate the UNIX's interpretation of the command typed. The UNIX shell is an interface between a user and the operating system. The actual compilation and execution of a user's command can be viewed as UNIX's "interpretation" of this command. This interpretation does not necessarily account for what the user believes about the command s/he typed and does not necessarily account for what RESCUER believes about the user's beliefs.

Control is then passed to the *Advice Generator* which evaluates this interpretation using several criteria of belief or disbelief. These criteria include the questions whether the command was acceptable to UNIX or not, whether it was expected by RESCUER, in terms of the hypothesised users' intentions, whether it was a command frequently used by most users, whether it was typical of its class and so on and are only used as unconfirmed symptoms of a possible problem.

According to these criteria, each command is assigned one of four different labels: *expected, neutral, suspect, or erroneous*. Each of these labels represents a degree of belief or disbelief as to whether the command typed was intended. The label *«expected»* means that RESCUER expected the command typed with respect to the hypothesised user's intentions, therefore it has a high degree of certainty that the command typed was well intended by the user. The label *«neutral»* means that RESCUER has not found any reason for believing or disbelieving the UNIX interpretation, therefore in this case it adopts the default hypothesis that the command typed was intended by the user. The labels *"suspect"* and *"erroneous"* mean that RESCUER's criteria for belief have not been satisfied, therefore the *User Modeller* is asked to generate a "better" interpretation of the user's beliefs. For example, if the command typed has failed to do anything at all except producing an error message ("erroneous" command) or if it has partly succeeded but has also produced an error message ("suspect" command), or if it contradicts the expectations of RESCUER in terms of the plan recognition scheme ("suspect" command), then the User Model Generator will generate hypotheses about possible interpretations of what may have happened. The hypotheses will be generated using HPR transforms.

First RESCUER tries to generate an alternative command which is similar to the one typed and which would fit better in the context. RESCUER starts generating hypotheses about possible user's misconceptions. The order in which hypotheses are generated is by the degree of depth of the misconception. The deeper the misconception, the later it is generated. The depth of the misconception is measured by the place where the HPR transform has occurred as will be explained in a later section.

Each hypothesis generated is evaluated by the User Model Evaluator which takes into account information about the filestore and the hypothesised user's intentions. If a hypothesis about an error is considered viable by the User Model Evaluator then the Advice Generator will respond with a suggestion of an alternative command that would have worked in accordance with what RESCUER believes the user wanted to do.

However, RESCUER's response to the user depends on the significance of the error. This is a similar approach to other systems offering explanations such as Trauma-TIQ [Abigail 1997] that classifies errors into 3 categories, namely tolerable, non-critical but potentially harmful and critical (potentially fatal).

The response of RESCUER consists of a suggestion of an alternative command which would fit better in the context and an explanation of what happened. The explanation consists of a description of the problem observed in terms of what alerted RESCUER in the first place (criteria of belief or disbelief) and the cause of the problem (which misconception at which conceptual level was to blame.)

The Human Plausible Reasoning Theory in RESCUER

The Human Plausible Reasoning Theory

HPR is a descriptive theory of human plausible inference which categorises plausible inferences in terms of a set of frequently recurring *inference patterns* and a set of transformations on those patterns which is mainly described in [Collins & Michalski 1989] and also in [Burstein & Collins 1988] and [Burstein et al. 1991].

The theory consists of *a set of primitives* and a *set of inference rules*. The primitives specify the way knowledge is represented so that the inference rules can be applied to this knowledge in order to draw plausible inferences. A collection of a person's beliefs are called *statements*. An example of a statement is:

precipitation(Egypt) = very-light, which means that the precipitation of Egypt is very light. Precipitation is called a *descriptor*, Egypt is called an *argument* and very-light is called a *referent*. A *descriptor* is said to *apply to an argument* and together they form a *term*. For example, precipitation applies to Egypt and they form the term *precipitation(Egypt)*. A term constitutes the left hand side of a statement and a referent the right hand side of a statement. A term is related to a referent by an operator which is usually the equality sign although this is not necessary.

The simplest class of inference are called *statement transforms*. If a person believes some statement such as that the flowers growing in England include daffodils and roses which translates to flower-type(England)= daffodils, roses, ... there are eight statement transforms which allow plausible conclusions to be drawn. These statement transforms consist of four *argument* transforms and four *referent transforms*. *Argument transforms* move up, down, or sideways in an argument hierarchy using generalisation (GEN), specialisation (SPEC), similarity (SIM) or dissimilarity (DIS) transforms respectively. *Referent transforms* do the same in a referent hierarchy.

For example, the person knowing the above statement can draw conclusions such as that the flowers growing in Surrey include daffodils and roses because Surrey is a part of England where these flowers are known to grow.

Argument transforms

1. GEN flower-type(Europe)=daffodils, roses,...
2. SPEC flower-type(Surrey)=daffodils, roses,...
3. SIM flower-type(Holland)=daffodils, roses,...
4. DIS flower-type(Brazil) ≠ daffodils, roses,...

Referent transforms

1. GEN flower-type(England)=temperate flowers,...
2. SPEC flower-type(England)=yellow roses,...
3. SIM flower-type(England)=peonies,...
4. DIS flower-type(England) ≠ bougainvillea,...

There are certain assumptions about the knowledge representation underlying the theory. It is assumed that all descriptors, arguments and referents belong to some kind of *type* (isa) or *part hierarchy*. It is also assumed that the potential referent of a term consists of the descendants of the descriptor of the term in some kind of hierarchy. There are four kinds of *relations* among objects in hierarchies. These relations are *generalisations*, *specialisations*, *similarities* and *dissimilarities*. Generalisations (GEN) and specialisations (SPEC) relate any two nodes belonging to two different levels of some hierarchy.

HPR in Generating Hypotheses about Users' Misconceptions

The problems of applying HPR to an active help system arise immediately from the fact that there is no explicit question asked to the user about the UNIX domain. Therefore the application of the theory is made on the assumption that users ask themselves certain questions about UNIX in their effort to form a command that would be accepted by UNIX and meet their goals. The chain of such questions constitutes a *path of reasoning* that is assumed to have led the user into concluding what command to type.

For example, the user is assumed to have assessed the command typed before typing it in terms of whether UNIX would accept it and must have come to the conclusion that the command was acceptable. This assessment is expressed in HPR statements and is called the *basic principle*. There are two HPR statements taking part in the formation of the basic principle and each of them represents a question that the user is assumed to have asked her/himself in her/his effort to check that the command s/he has selected to type, is correct:

1. What is the semantic and syntactic structure of the command?
2. Is this semantic and syntactic structure acceptable to UNIX?

The user is assumed to have given the answer "yes" to the second question if s/he has typed the command. Using HPR's representation language we have expressed the two statements as a multiple descriptor statement, as follows:

UNIX-acceptable (internal-pattern(action))=yes

In the above multiple descriptor statement, we have two descriptors, namely "UNIX-acceptable" and "internal-pattern". Each descriptor has an argument. The argument of "UNIX-acceptable" is "internal-pattern (action)" and the argument of "internal-pattern" is "action". The term "action" means the command line typed by the user. The term "internal-pattern" is used to mean a simplified form of the preconditions of a command. For example, if a user has issued the command: rm fred then "rm fred" is the action and the internal pattern of it is "rm file" which means that "rm" takes a file for an argument.

Hence, we should have:

internal-pattern(rm fred)=rm file

"rm file" in the above statement plays the role of a referent.

The second statement is formed by replacing the "internal-pattern (rm fred)" with the referent "rm file".

UNIX-acceptable (internal-pattern(rm fred))=
UNIX-acceptable (rm file).

The statement UNIX-acceptable(rm file) refers to the second question that the user is assumed to have asked himself or herself:

Is this semantic and syntactic structure acceptable to UNIX?

The answer that the user is assumed to have given to this question is "yes" unless s/he is not sure about the correctness of the command that s/he issues.

The set of HPR transformations are applied to statements constituting the basic principle and generate different possible interpretations of how a user may have come to the conclusion that the command s/he typed was acceptable to UNIX. These interpretations reveal the possible misconceptions involved. Depending on where the transformation takes place, we have the conceptual level of the error and depending on the kind of the transform we have the cause of the misconception.

For the purposes of the illustration of some examples of hypotheses generation we will assume that a user has typed the incorrect command: % rm tf, where tf is an empty directory. This means that the *typed internal pattern* is rm empty-dir. We will also assume that the user has a file called tff in her filestore.

Examples of interpretations of the user's error are the following:

1. *Another action was intended.*

   This case is characterised by an *argument transform in the first statement.* For example, the user who typed % rm tf may have meant to type % rm tff which is a different action.
2. A *unix-acceptable internal pattern was intended.*

   This case is characterised by a *referent transform in the first statement.* It is assumed that the user intended a similar pattern to the one typed. In this case, the action intended was the action issued but the user thought that a different internal pattern corresponded to this action. However, the pattern that the user had in mind was unix-acceptable. The misconception involved here would have to do with the types of the arguments[1] of the action typed. The user must have believed that the arguments had different types from what they actually had. For example, the user may have typed % rm tf only because she thought tf was a file.
3. *The typed action and its internal pattern were intended.*

   This case is characterised by an *argument transform in the second statement.* This would mean that the action intended was the action issued and the internal pattern intended was the typed pattern which the user falsely concluded to have been unix-acceptable. In terms of the misconception involved, this case reveals a problem with the semantics of the command. The misconception is deeper in this case than in the previous ones.

[1] "Arguments" here, mean the Unix arguments and not the "arguments" used in the HPR terminology.

For example, the user may have typed % rm tf because she thought that rm could be used for removing directories as well as files.

From the above examples of he use of statement transforms in generating hypotheses about possible misconceptions, it is clear that transforms taking place in the second statement imply deeper misconceptions of the user than those generated through transforms in the first statement.

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EXPERIMENTS IN VIRTUAL SUPERVISION

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Abstract

Computer-mediated communication offers the opportunity to teach outside the conventional settings of the classroom, the tutorial or the faculty office. But we know little about the social, linguistic, educational or emotional forms of relationship that are a consequence of virtual teaching. In this paper I will look at the use of First Class conferencing used to create a virtual culture among research students and as a vehicle for supervision/advising.

CMC and research

When personal computers first became available most of us tended to use them as them as superior typewriters. The printer in the room across the corridor never stopped, but now it remains quiet for long periods while we conjure up all kinds of things on our screens; catalogue searches, the directories of distant universities, on-line journals, specialist discussion groups, conferences and discussions, databases, transcripts and multiple conversations.

Perhaps paradoxically, as the marketing arms of universities put their efforts into making each university appear distinctive, for most academic staff the invisible college is becoming increasingly the day-to-day working environment. Much funded research is now inter-institutional and many of us find that we spend more and more of our working lives talking with our research colleagues (wherever they happen to be), and less and less time talking with people down the corridor. The nature of research work, and of the research community, has changed.

As the locus of research and the nature of research work has changed, so too have our working relationships with others. The cell-like nature of research groups, with often intense inside-relationships but only loose connections to wider networks, which characterised the social organisation of research until ten years ago, is increasingly being replaced by virtual communities. The table tennis table, once the centrepiece of most working research units, has almost disappeared. One of our conference areas now has a folder called 'The Gym'.

Entry to cyberculture

It is generally assumed that the training of research students is not just a technical matter but a form of induction, even initiation, into research communities. As the nature of these communities changes, it is obvious that the nature of the training that we provide must change too. Of course these changes are not just driven by the technology but by the need to manage research degree programs in conditions of change. Everywhere numbers are up, students are older, increasingly part-time and are often working in areas with little in the way of an established higher degree tradition (nursing, education, law, studio art, dance, business), not least in the 'new' universities.

Elliott Eisner [Eisner 1979] has talked about a 'null curriculum' (as an addition to the more familiar notions of the 'explicit' and 'hidden' curriculum). He explains the null curriculum as that which is not taught, for in any curriculum selections must be made, and once made this leaves gaps and silences that are usually left invisible to the student. I always found this a difficult concept to grasp, but perhaps the conventional supervisory relationship is an example, for in supervision the curriculum is not obvious. The student is required to make sense of the research field by paying attention to some of what is said formally and some of what is said informally, but not all of either. This can be very confusing but progress is only possible when the student is able to see the research field as a gestalt. In practical terms the project may be concerned with investigating a small fragment of the field, but the meaning of the project must be located in a wider understanding of the field as a whole. The significance of much of what is said lies between the lines.

Supervision and the internet

Despite the abstracted nature of research at the level of meaning, for many students and supervisors, supervisory practice is essentially defined by face-to-face contact. (I am using the terms 'supervisor' and 'supervision' as they are the terms most often used in Australia and in Europe, but they carry overtones of authority that are inappropriate. The American term 'adviser' is perhaps better, or the term 'consultant' used in some programs.) Whatever term we choose, 'supervision' is a conversational form, or at least a form of teaching, conceived as dialogue. Putting computers between people seems, at first sight to destroy the very thing that is valued in supervision, the direct contact between people who interact as whole individuals dealing in multiple levels of meaning.

Our experience has been that computer conferencing has some clear advantages:

- at least for the moment it requires us to shift from talk to writing as the main medium of communication. This means that, from the start, students are working in the medium in which they are ultimately tested.
- The written word slows down interaction. Writing is more time consuming than talk, but it can be studied more closely. There is a record of what is said that can be re-read, questioned, referenced, quoted and developed.
- Though time-consuming, the medium frees us from schedules. We do not need to arrange times and places for meeting, worry about being late, disrupt other activities, travel to other sites.
- It is easy to move in and out of conversation - to include references to sources, to point to web pages, to attach documents and tables, even to discuss experiments.
- There is both an intimacy and a distance inherent in the medium. Some of the ambiguities of face to face conversation are ruled out (what to wear, where to sit, when to smile, when to interrupt) and this frees us from those constraints (and opportunities) inherent in social proximity.
- At the same time we need to be aware that it removes some of the checks in conversation that protect areas of intimacy.

Currently we seem to be at an interesting point of conjunction, where the nature of research is changing and where we need to adapt supervision as universal mass education reaches undergraduate education and begins to touch postgraduate programs. The use of computer-based communications appears to offer a rational solution, for it makes expertise more widely available in a situation where the one-to-one, craft-based, apprenticeship notion of supervision has become difficult to sustain. But at the same time, the new communications media are still poorly understood and whether they can sustain the demands of the supervisory relationship is open to question. They may be less an answer to a problem and more in the nature of a new set of problems. My view is that we need to treat them, not as solutions to the problem of how to teach people how to become researchers, but see them as providing a new set of opportunities for research. Applied to supervision they have the effect of making supervision itself problematic, a suitable topic for research, rather than a merely instrumental means to other ends.

The emergence of professional doctorates

In the early nineties a number of Australian universities began professional doctoral programs in response to a view expressed by the Commonwealth government that the PhD was perhaps not the appropriate qualification for the growing numbers of people enrolling in it. For some universities and for some faculties, especially those lacking a strong research tradition but with strong links into the professions, this was seen as an opportunity to extend the coursework masters degrees that they had recently developed. For others it was a way of building up numbers in the higher degree area by offering extended opportunities for study for the growing numbers who had completed masters degrees but who either did not want to, or were deemed unlikely to succeed in the PhD. [Trigwell, Shannon & Maurizi 1997] For a minority of universities (in Education; Deakin, UTS and Central Queensland University; in Business, the Swinburne Organisational

Dynamics program; in Technology, the Deakin DTech) the development of the professional doctorate was seized, not as a way of extending masters programs, but as an opportunity to reconstrue the nature of the research degree [Brennan & Walker 1994], [Brennan 1997].

In the past ten years the strains within the Education PhD have become increasingly acute for those working in areas like action research, evaluation and curriculum, to the point where many research projects have been distorted to fit the instrumental needs and requirements of the degree. While many people (students, supervisors and examiners) have becoming adept at threading their way through the complexities, the emergence of the professional doctorate provides a new starting point; a means of setting an agenda that puts the needs of new forms of research to the fore rather than finding loopholes through which it could be threaded.

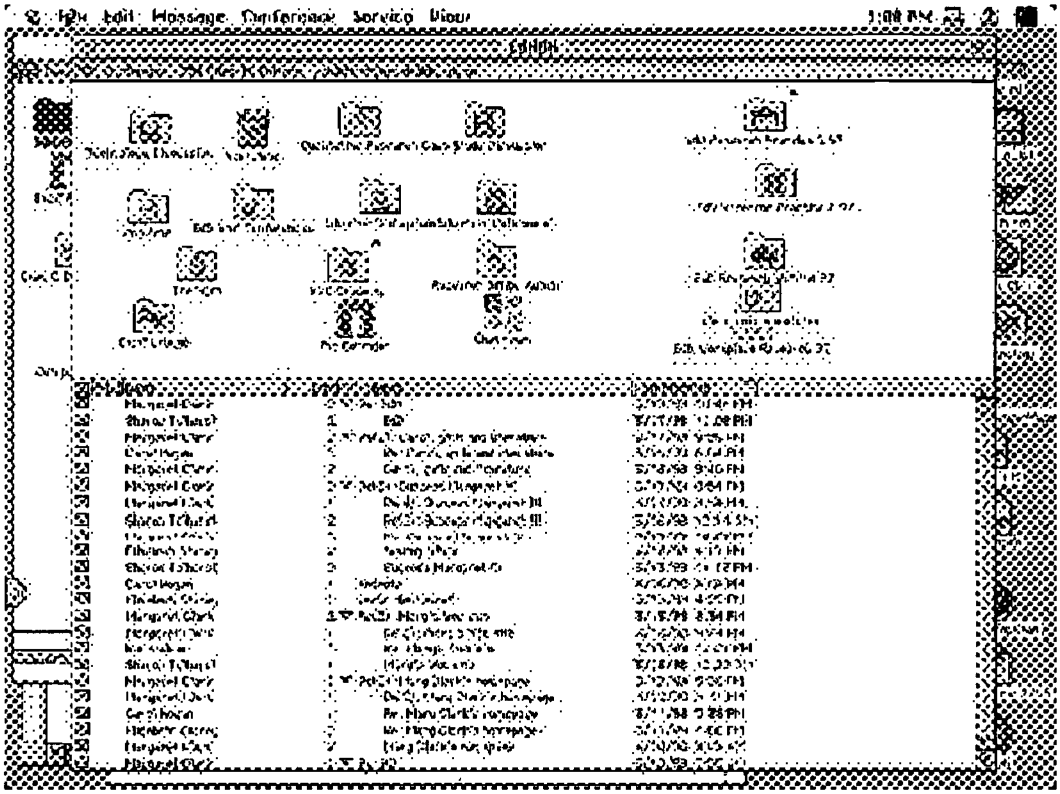
In our creating our EdD program we saw an opportunity to establish the following priorities:

- research projects in and for education (rather than projects that are studies of or about education),
- opportunities for collaborative research work,
- recognition of writing as a central research process (not just the medium of reporting research),
- recognition of audiences for research beyond the academy (the professions, client groups, the press and other media),
- recognition of the problematic role of the researcher within the research project (the demise of conventional notions of objectivity),
- responding to the changing nature of communications and its impact on the nature and practice of research.

None of these shifts are novel and all to some degree touch the work of all research students and their supervisors, but it seemed to us that the cumulative effects of these different shifts was enough to precipitate a structural change. We have responded in a number of ways -- constantly re-writing our courses and revising our procedures and practices, experimenting with new forms of supervision, progress review and assessment and examination. Central to these changes, however, has been our attempts to seize the opportunity created by Deakin's establishment of computer-based communications as a key resource for distance students.

Computer-based supervision

Since 1995 we have been using First Class conferencing as the basis for establishing a 'virtual campus' within which students and advisers can interact. The First Class conference provides access to a series of discussion areas.



We have tried setting up these folders in different ways. Some contain the discussions for particular tasks and assignments within the EdD program (for instance the folders called, 'Research Practice 1 & 2' and 'Workplace Research'). Other folders allow for discussions around phases of the program (the folders called 'Pre- and Post Colloquium'). Some are topic based and follow topics and ideas that have arisen within other discussions ('Case Study' and 'Hathaway'). Some are intended to be informal ('The corridor') and others formal, ('Staff'). Some are interest based (the folder 'KKU' has been established by a group of EdD students who are based at Khon Khaen University in Thailand).

These conference areas are intended to be 'classroom spaces', at least while we orient ourselves to this space and begin to stretch its pedagogical characteristics, but being a research oriented program we soon found it was important to have a 'corridor'. This was intended not so much as a social space - we wanted to use our entrance 'foyer' for this - but to provide a space where conversation could free-wheel around work topics. Most of what happens in the corridor is serious and productive!

Some might find this all too task focussed and leaving little room for more immediate and social conversation. Perhaps so, but there is an on-line chat function within First Class which some users find meets this need. Though it is sometimes said that e-communications are good for people who already know one another, they can also be a way of getting to know others, and for some are less intimidating than a research seminar or even the cafe.

Conferencing as supervision

My intention here is not to provide a comprehensive description of this software and its functions and capabilities but to indicate the kinds of shifts this implies for supervision. From the start we have tried to make this conference the centre of our program, not simply an adjunct to it. This is the marketplace, the common room, the seminar and the lab. We expect students and supervisors to use it on a regular basis and to treat it as equivalent to walking into the building, indeed we sometimes call the folders 'rooms' (it would be nice if we could do this graphically too instead of being trapped in the iconography of commerce and administration!). So to go into a discussion like the ones on Research Practice we think of as 'going to class'. Here one staff member and a group of students discuss research issues, share papers, submit work for assessment and relate their experiences in attempting to do research in the workplace. There are other resources available, students are sent a collection of papers for each 'course', we make extensive use of audio tape and each discussion also has a web page which defines the topic and sets expectations and deadlines.

The differences are that we rarely meet face to face, that discussion is asynchronous, that it is written and semi-public. This may sound straightforward - but it isn't! Just as the word 'classroom' seems at first sight simply to denote a space where teachers talk to students, but where we know that the practice that develops has its own complex dynamic of text and sub-text, explicit curriculum and hidden curriculum, so too there is more happening here than is immediately obvious. First, for all users, finding a voice is problematic. Making an entry is daunting for some people (students and supervisors) since they feel exposed and under scrutiny. Having found a voice, losing it can be difficult. At some time or other most of us have found ourselves becoming 'typecast'; shut in a role that is limiting and finding it difficult to move out of it,

As with email, discussion here is written (and so has a degree of permanency) but is also responsive, so having some of the character of oral interaction. We are all of us still finding our way with this. Some are cautious and considered, others spontaneous and immediate. Every so often it 'works' and we get extended discussions, directly to the point that move our ideas and our thinking along. At other times we circle around one another, missing connections, talking over the ideas of others and missing opportunities. Just like any other classroom.

But, unlike a conventional classroom, what is said here is open to scrutiny and to challenge. Anyone in the program can 'walk-in' to a discussion at any time, they can monitor performance, even see who has been working late at night or early in the morning! Those of us who like working in this space have learnt to be thick skinned about some of these things, we have learnt too to be forgiving of others, especially those just finding their way. 'Flaming', often identified as a feature of listservs, has not been a feature of our discussions to date. Friendships have formed and we have felt our way to a new set of intimacies inherent in the medium (just as we did earlier with the telephone, and before that with letters).

This is hard for those of us with a degree of fluency in writing in our first language. In a second language it is harder, especially given the somewhat telegraphic tendencies inherent in these media, the temptation to in-group joking and plain showing-off. Managing this demands a level of communicative and cultural competence that causes even some native speakers/writers to struggle. For others it may be doubly confusing, and having only the written text to read/write exacerbates the demands for there can be no sudden recourse to laughter to resolve a communicative impasse or a smile toencourage, gender can be invisible or even ambiguous, it may be hard to tell who is a supervisor and who is a student. As with all new media there are potentials here for liberation and for tyranny, for isolation and despair, and particularly confusing is the dissolving of the conventional distinctions between speech and writing.

But, we argue, research itself is primarily an oral culture and, despite many texts assuming that research exists only in the literature, anyone who has participated in a research conference, worked in an active research centre or simply sat around among researchers knows that the process and the products are different. In relation to methods and process most of what the literature has to say is in the nature of fiction, intended to position the researcher as hero, to reconstruct the irrational and implausible in terms of convention. In order to learn to be a researcher one must become a competent member of this virtual village, yet in most research training programs this is left to chance, mediated only through supervisors or a part of the hidden curriculum. What e-conferencing of the kind we have described does is make some of this explicit. So while this may seem daunting to the student (and supervisor), it is in fact making a significant aspect of research culture more accessible than it would be otherwise.

The virtual research community

The problem remains of how to create bridges between the kind of local culture we are attempting to create and the wider research community. One obvious way is through the other resources available to students; the library and the internet, but we have also introduced guest seminars into the conference desktop. During last year we had three outside visitors contribute to discussions on narrative inquiry, on technology issues and on qualitative research. Out of the last of these has developed an experiment in conducting a collaborative memory work project on-line, which we think has not been attempted before.

From the start we have made extensive use of audio taped conversations with researchers, and these have been very successful, being especially popular with students and supervisors who spend a large part of their working day in the car. These do, however, create some problems for those without fluent English for colloquial spoken English can be hard to follow on tape. The ideal solution is to transcribe the tapes and put them on CDROM, so that students can see what is said as well as hearing it and so we can build in links and additional material and provide word search capabilities that make the taped discussion much more useful as a resource. But transcripts are expensive to produce, the CD format a little less accessible and the time that would be needed to produce such resources difficult to justify for small numbers of students. 'Guest appearances' on the conference may be a possible solution.

These ideas for development also point to other possibilities for collaboration. Producing a set of CDROM based discussions would be expensive for us to do for no more than a hundred students. But if we shared the task around other institutions and we each produced a CD for perhaps 500 students, then the economics of development might begin to add up. The current climate of competition between universities (or at least between their vice-chancellors and presidents) puts some barriers in the way, but not ones that are impossible to squeeze past.

New headings

We are all well aware that universities are headed in new directions and that the nature of academic work is changing in ways over which we appear to have little control. For some time we have tried to manage increasing demands within conventional frames, but it is clear now that these frames can no longer contain the demands that we make on them. As academics we are daily forced to rethink the nature and purpose of the research that we do, the forms in which we publish and the ways in which we construct our careers in terms of the changing functions and purposes of the university.

The supervisory relationship is perhaps the last structure to break, for it has been hedged around with myth and privilege and kept largely hidden from the change process. We now see this changing as the pressures for change become too hard to resist and as the new communications opportunities appear to be offering alternatives to the one-to-one, face-to-face armchair/laboratory bench notion of supervision.

We have sketched out some of the ways we have been trying to make these changes in the context of a professional degree. We are still at the beginning in doing this, but we see potentials in it. Being involved in it gives us some grip on the process, rather than just responding to economic and other pressures we are able to see that some things work better than others and work to steer the process in those directions.

Students who are not native speakers of English may encounter special problems, problems we have scarcely addressed because at the moment everything is new to us, but centrally these are problems of language, culture and communication. We have argued that the world of research is changing, and changing not just in what it does, but how. Computer mediated communication, not long ago an obscure enthusiasm among a group of nuclear physicists, is transforming research in the humanities, social sciences and professions. In supervising research students we have to take them into this world because this is where the action will be in the future. This shift is not just a technical shift but requires people to relate and communicate in new ways. Language issues lie at the centre of this change.

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Telepoly - A Teleteaching Scenario Supported by High-Speed Networks

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Abstract: We report about technical and didactical experiences obtained in the teleteaching experiment *Telepoly*, which has been set up between the two Swiss Federal Institutes of Technology in Zürich and Lausanne, and the Swiss Centre for Scientific Computation near Lugano. Using a high-speed network with Asynchronous Transfer Mode (ATM), Telepoly offers high quality audio and video transmission with full interaction possibilities to all participants at all sites, which is very similar to a real presence teaching situation. The Telepoly scenario is being extended beyond the classroom to any desktop computer connected to a high-speed network which can provide a guaranteed quality-of-service. This scenario, if successful, will offer a new perspective to distance education, bringing fully interactive synchronous teleteaching right to the place where people use to work and live.

1 Introduction

The advanced developments in digital and multimedia-oriented information and communication systems are increasingly influencing the education sector. They enable not only a multimedia support and extension of the traditional teaching and learning, but offer new and attractive methods especially for Distance Education (DE), which may be defined as a teaching and learning environment where lecturers and students are separated in space or in time. Space and/or time independent teaching and learning becomes increasingly important due to the fact, that the lifetime of specific knowledge in many fields becomes shorter and shorter. Thus, the need for Life-long Learning, Just-in-time learning and learning "any time, anywhere and any subject" is rapidly growing.

With respect to the time dimension, DE methods can be categorised as asynchronous and synchronous; see [Günther 96] for a general overview of projects and systems. In the first category, lecturer and students are separated in space *and* time, whereas in the second a separation exists only in space. A number of projects have been launched which support either of these two DE environments or a mixture of it. To mention only a few, [Schneider & Block 95, Apostolopoulos et al. 96, McLoughlin 96, Barnett & Burton 96] describe approaches in *asynchronous* distance education which use *networked* workstations with tutorial programs where students access lecture material over a network, e.g. through the world-wide web. Interactions with the lecturers occur only indirectly by e-mail or bulletin boards. Some of these systems support a direct interaction e.g. via telephone or ISDN-based videoconferencing, and thus get a synchronous component.

Since the potential of human communication with all its features is unreached by purely computerised learning environments, face-to-face teaching will always remain an essential component of the teaching and learning process, in particular in the sector of advanced, non-standard knowledge. To enable a more adequate *synchronous* teaching and learning environment, the networked systems mentioned above have been refined to solutions where lecturers and students can communicate and fully interact via real-time audio and video [Effelsberg 95, Hogrefe 95, Bodendorf et al. 96, Znaty et al. 96, Pedersen 96, Neuman 97]. We call such an environment *teleteaching*.

We present a solution for synchronous, fully interactive face-to-face teleteaching using high quality audio and video transmission based on Asynchronous Transfer Mode (ATM) networks, and supported by networked desktop computers with application sharing capabilities. *Telepoly* is a teleteaching project between the Swiss Federal Institutes of Technology in Zürich (ETHZ) and Lausanne (EPFL), and the Swiss Centre for Scientific Computing (CSCS), in order to obtain experiences in application-oriented multimedia communication as well as in didactic research [Stiller et al. 96].

2 Telepoly Scenario

At all sites involved in a Telepoly session, a classroom is equipped with audio and video recording and display devices [cf. Fig. 1]. For digitising analog audio and video streams, coder/decoder devices (CODECs) are used which are connected to a high-speed network and which prepare the digital data for transmission using the ATM protocol [cf. Technical Approach]. In addition, networked workstations are employed for the exchange of electronic teaching aids, such as slides, graphics, or tables which are locally and remotely displayed by a beamer.

Let us assume that only two sites, ETH Zürich and EPF Lausanne are involved, and that the lecturer is located at ETHZ (local site). Then the following audio and video streams of the classroom at Zürich are transmitted to the remote site at Lausanne: Firstly, a mixed audio of the lecturer's voice and the sound from the local audience; secondly, separate videos of the lecturer, the local classroom, and occasionally also of a visualizer used by the lecturer. From the remote classroom at EPFL, an audio and a video stream are received at Zürich, where the remote audio is directed to loudspeakers and the remote classroom view is displayed on two different TV screens: One TV screen is turned towards the lecturer to allow her or him to always be aware of the situation at the remote site (in particular, if a remote student wants to ask a question or make a comment), and the second monitor is directed towards the local audience to create the feeling of one single learning community.

The one-to-one teleteaching scenario described above can be extended in principle to a many-to-many scenario. As in the one-to-one case, from the local site a mixed audio and two separate videos (lecturer and local classroom) are sent to all connected sites, using the multicast features of the ATM. In order to present the audio and video streams from all remote sites involved, the local classroom is equipped with as many sets of loudspeakers and TV screens as correspond to the number of remote sites. Each remote site in turn receives a mixed audio of the lecturer and the local classroom's audience as well as an audio from each of the remaining remote sites. Furthermore it gets two separate videos from the local site (lecturer and local audience), and a video from each of the other remote classrooms.

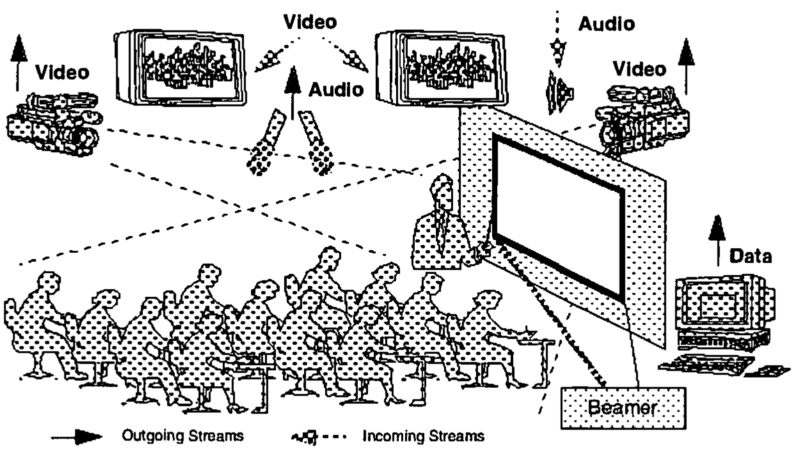

Figure 1: Telepoly Scenario

3 Technical approach

Apart from the didactical and pedagogical requirements, various technical criteria need to be fulfilled for a successful teleteaching. Among these are the following: video of sufficient quality; very good audio quality (close to CD quality); perfect synchronisation of audio and video; well integrated facilities for electronic presentation of teaching aids; support for ad-hoc annotations; interactivity for audio, video and annotations; and last but not least sufficient reliability and stability throughout a session which may last up to several hours.

In order to fulfil these criteria, ATM [de Pryker 95] is chosen as network infrastructure for Telepoly, together with advanced video and audio coder-decoder devices (CODECs). The ATM network provides Telepoly with the required data rates at high bandwidth and low delays with guaranteed quality-of-service, in order to carry the video and audio streams and perform a perfect synchronisation between audio and video at each remote site.

Electronic teaching aids are distributed between sites using an application sharing tool which runs on workstations on top of a TCP/IP protocol.

3.1 ATM Network

Considering the ATM network configuration in use [cf. Fig. 2], the ATM switch at Zürich receives cells from the local end-system, which in the Telepoly setting comprises the CODEC. The switch is connected by a bi-directional 155 MBit/s STM-1 link (Synchronous Transfer Module Level 1) to the ATM network KOMBV 3 of the Swiss Federal Administration. At any participating remote site an ATM switch is connected by a 155 MBit/s STM-1 link to the ATM network as well. It receives the transmitted ATM cells and forwards them to the remote end-system which is again a CODEC.

As ATM inherently supports the multicast functionality during the connection set-up time, a many-to-many communication between *n* different sites is available. And this without any major adaptations of the one-to-one Telepoly scenario and the cabling of the utilised devices, except for adding a supplementary set of loudspeakers and TV screens per additional remote site. In this case, the generated audio and video streams respectively are multiplied *n* times transparently for the sender and all receivers inside the ATM switch or the ATM network. Every participating site receives multicast data streams likewise as unicast data streams.

3.2 Technical Set-up

For simplicity reasons we only consider the one-to-one scenario [cf. Fig. 1]. Analog audio and video signals are fed into the CODEC [cf. Fig. 2], transforming analog signals to digital ones and vice versa. The CODEC consists of three units, called CellStacks™: one master and two slave units. A single CellStack hosts an analog to digital converter and is capable of processing incoming and outgoing streams, one audio and one video stream each. It performs full Motion JPEG (Joint Pictures Expert Group) [ISO 92a] compression on video. Each CellStack assembles this compressed video into ATM Adaptation Layer (AAL) 5 frames and segments them into ATM cells. Since only the master unit is connected to the ATM switch, all ATM cells from slave and the master units are transferred via the interconnected STM-1 link to the ATM switch. Simultaneously to sending the MJPEG compressed video, audio is transmitted in CD-quality: The remote CellStacks do the reverse transformation from ATM cells into AAL 5 frames, from compressed data into the uncompressed form, and from digital to analog audio and video.

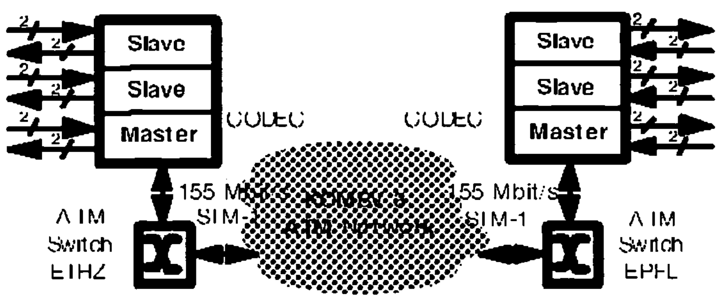

Figure 2: ATM Network Configuration

3.3 Experiences with Telepoly

Telepoly has become operational in January 1996. For almost two years it has been used on a regular basis for transmissions of courses, conferences, seminars, and for examinations. The experiences are promising, although some improvements have been already identified.

Concerning the data rates required for the transmitted audio and video streams, the measured audio data transmission rates have reached an average value of 1.75 MBit/s (about 5% variance) due to packing audio samples into AAL 5 frames and ATM cells in turn. For MJPEG compressed video transmission an average rate of 8.5 MBit/s per video stream was measured, while variances (in average about 10%) are dependent on the transmitted video.

Within Telepoly the didactic quality of teleteaching and the quality of the technology used have been evaluated together by means of several questionnaires distributed to participants. The results obtained showed that in general the quality of the audio and video transmission has been judged positively as well as the main quality of the computerised teaching aids. Apart from the telecommunication aspects, important experiences have also been collected concerning ergonomic, didactic and pedagogical aspects of teleteaching:

1. Concerning the manner of preparing and organising teaching aids, the use of a professional presentation package has been beneficial, since it supports a clear structuring of teaching aids and provides a basic standardisation of the layout. On the other, it introduces the risk of choosing inappropriately small fonts, thin lines, and tiny graphic elements in order to concentrate as much information as possible onto one slide.
2. Most of the projection devices, such as beamers and TV monitors, are still immature in resolution to display small text and picture elements in a clearly recognisable manner. This problem can be reduced slightly by distributing paper copies of teaching aids to all students prior to every lecture.
3. The style of presenting teaching documents to students, given the restriction that, in order to enable electronic transmission, the used material either had to be stored electronically or to be presented appropriately (on a visualizer) in order to be visible and audible on the remote site.
4. The frequently observed weaknesses of conventional teaching became even more severe in the case of teleteaching: too little interaction, too brief animation, and inappropriate time management. Certain investigations revealed that during teleteaching sessions, students in general have to concentrate extensively compared to traditional teachings to follow the lecturer and her or his explanations. Therefore, frequent interactions are a necessity and a sufficient number of breaks has to be incorporated.

Referring to the requirements stated at the beginning of this section, Telepoly provides high quality audio and video transmission which is possible due to the guaranteed quality-of-service of the ATM connections. Drawbacks of Telepoly are the rather high investment costs due to the need of specialised equipment, and limited support for multi-point scenarios. Therefore, we are presently looking into an alternative to the current Telepoly scenario which combines the advantages of the Telepoly setting and resolves some of the drawbacks. In particular, our emphasis is on a better integration of components for audio, video and data communication and on extending the scope of possible participants in a Telepoly session.

4 Telepoly++ - Fully Distributed Teleteaching Scenario

Telepoly++ is aiming at providing teleteaching capabilities right to the desktop. As shown in [Fig. 3], the anticipated teleteaching scenario is similar to the Telepoly scenario except that remote sites are not necessarily classrooms but can be multimedia PCs or workstations on the desk even at home.

Following the approach taken in Telepoly, a mixed audio and two separate videos (lecturer and local audience) are sent from the local classroom to the remote sites. For pragmatic reasons only audio and video of a single remote site, i.e., the active site asking a question, is transmitted and received at the local site and all other remote sites. The local site sees the active remote site only, so that even in this restricted scenario, direct interaction between lecturer and student is possible.

4.1 Telepoly++ Research Issues

The challenges with the proposed teleteaching scenario are the following: Firstly, local and remote sites have to be connected by a network that provides the required quality-of-service guarantees and high data rates and which, at the same time, is cost effective and widely accessible. Secondly, transmission of audio and video has to follow agreed standards so that cost-saving off-the-shelf CODECs can be used. A solution to the latter problem is using MPEG 1 (Moving Picture Expert Group) [ISO 92b] and MPEG 2 [ISO 94] CODECs (hardware or software). In general, these CODECs support user-selectable bandwidth utilisation from some KBit/s up to several MBit/s. Since MPEG compression performs better than MJPEG, we get an audio and video quality similar to the one observed in Telepoly already at data rates of 2 MBit/s.

Our experiences up to now have shown that ATM is the technology that provides all the necessary features for supporting teleteaching sessions even if a large number of remote sites is involved (due to its quality-of-service guarantees and its multicast capabilities). However, providing ATM services - or broadband services in general - to those users we are aiming for requires either considerable investments into the communication infrastructure too expensive to be affordable by a non-commercial user, or a re-engineering of the existing infrastructure, so that excisting cabling can be used to carry ATM traffic. During the past years such alternatives have been explored. One such an alternative is the ATHOC (ATM Applications over Hybrid Optical Fibre Coax) [Krijntjes et al. 96] project.

Its objective is the provision of broadband communication services with flexible bandwidth over existing cable infrastructure. PCs and workstations are connected to already existing coaxial cable TV networks (CATV network) which, in turn, are connected to the public ATM network. For the downstream direction, i.e., from the network to PCs or workstations, the provided bandwidth is about 34 MBit/s, while for the upstream direction, i.e., PCs or workstations to the network, a bandwidth in the range of 10 to 34 MBit/s is provided, starting initially with 2 MBit/s. In the overall network, ATM is applied as transfer mode and, thus, end-to-end ATM connectivity is provided with all the characteristics of ATM, such as multicast and guaranteed end-to-end delay.

4.2 Telepoly++ Prototype Implementation

For the prototype implementation of Telepoly++ three phases are planned. In phase 1, we install the infrastructure in the local classroom and at remote sites and set up the communication network. We use MPEG 1 CODECs for PCs and workstations in this phase. Because MPEG 1 can handle one audio and video stream only, this implies that we have to look for alternatives to transmit two videos from the local site, e.g., mixing two videos picture-in-picture. An audio and a video as well as computerised teaching aids are transmitted to all remote sites using the multicast features of ATM (over the ATHOC network). Video and audio of a *single* remote site is received at the local site *only*. To this end a connection from the remote site to the local site is established on demand. The local site relays all questions to all other remote sites. In phase 1 we start looking into the organisational and didactical details of having a large number of sites. On the technical side we have to deal with details of the ATHOC network, particularly a resource reservation protocol for bandwidth reservation in down- und upstream directions which are shared among *all* users.

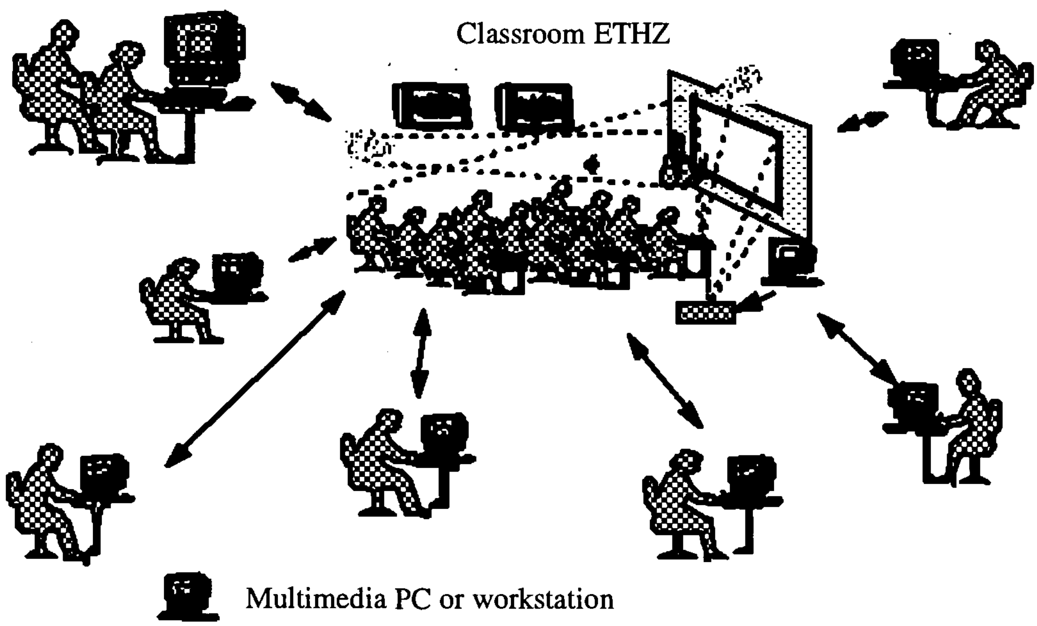

Figure 3: Telepoly++ Teleteaching Scenario

For phase 2 a transition is planned using MPEG 2 instead of MPEG 1 CODECs. The advantage of MPEG 2 over MPEG 1 is that several multiplexed audio and video streams can be simultaneously transmitted. The receiving site can select which audio and video is being displayed. In this scenario, an audio and two or more videos are sent from the local site to all remote sites (the same mixed audio is sent with all videos). From a remote site to the local site an audio and a video are transmitted. As in phase 1, the local site relays audio and video to all other remote sites. In phase 2 we investigate how well the communication network scales with the additional bandwidth required by the transmission of several videos from the local site to all remote sites.

Finally, phase 3 transforms the scenario into a fully distributed teleteaching environment. The relaying of remote audio and video at the local is done by the network itself. This requires additional functions to be implemented in the CATV network due to its tree structure which is from the CATV provider towards the subscribers. Relaying audio and video of remote sites can only be done in the head-ends of the CATV network which requires additional investments into the CATV network. Additionally, signalling has to be implemented so that all remote sites are informed which audio and video to be received.

At ETH Zürich, the Computer Engineering and Networks Laboratory (TIK) and the Communication Technology Laboratory (NARI) have started the implementation of phase 1. A number of PCs have been equipped with MPEG 1 CODECs which are used in the local classroom and at remote sites. For the transmission of lecturers we initially use the in-house ATM and CATV networks.

5 Conclusions

Telepoly has been established as an experimental platform for synchronous, fully interactive exchange of courses between remote sites, as well as for application-oriented networking and didactic research. Although initially considered as a one-to-one vehicle for the transmission of courses between ETHZ and EPFL, Telepoly is used successfully for the transmission of workshops, presentations, and conferences even in a many-to-many scenario. In particular, the Telepoly set-up allows lecturing on every kind of topics.

Three of the main technologic prerequisites for Telepoly have to be considered explicitly. This includes the availability of electronic teaching aids paired with an application sharing tool, then a public ATM network, and finally CODEC devices for handling audio and video.

Since Telepoly only is a first step into a fully distributed teleteaching environment, we have started to explore alternatives to increase the number of participating remote sites and to reduce the initial costs of the equipment. With Telepoly++ we will provide a teleteaching infrastructure which will cover a large number of possible participants from academia (particularly students) and industry. Apart from the work done in networking, multicast, and audio and video communication, we have to further elaborate on a sophisticated integration of all components, CODECs and PC with application sharing software, in a single teleteaching platform.

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Telling Stories - the Role of Narrative in Intelligent Tutoring Systems.

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Abstract: This paper considers the use of narrative within intelligent tutoring systems (ITS) and in particular the need for a narrative structure and the effects it can have on the learner. The use of narrative in ITS is reviewed and the application of narrative to a computer-based adventure game to teach computer architecture is considered.

1 Introduction

The design of hypermedia based tutoring systems often assume that the mere use of such systems by themselves will increase students motivation and desire to learn. This may be so for those learners who have not been exposed to such systems before but with increasing exposure, (and use of such systems), it is highly unlikely that the elements themselves (sound, graphics, video etc.) will be the prime motivators. The components of hypermedia systems themselves are not intrinsically motivating.

It is suggested that good teachers are able to adopt appropriate teaching strategies based on an assessment of the motivational state of learners and their understanding of the students' misconceptions or lack of understanding. Additionally the use of an appropriate narrative is both a useful method of communication as well as a way of connecting the complex social and cultural constructs that are part of any learning situation.

The use of a distinct narrative in educational hypermedia systems is useful for a number of reasons:

- narrative structure can affect a learners comprehension
- the use of narrative is a familiar and established method of structuring texts
- the structure of a narrative can be used by learners to assist in navigating a hypermedia environment
- the narrative itself can act as a motivating factor

(Plowman, 1996)

This paper reviews the use of narrative and other motivational strategies in intelligent tutoring systems and then describes the architecture of a game based simulation to teach tertiary level students about the domain of computer architecture.

Characteristics of good teachers often include the ability to tell good stories and to increase their students' desire to learn along with the domain knowledge they are trying to impart (Edelson 1993 and del Soldato 1992).

2 The use of narrative in Intelligent Tutoring Systems

Edelson (1993) has suggested that good teachers possess two qualities that make them "exceptional". They are the ability to "ask good questions" and "tell good stories". The development of the YELLO (Burke, 1993) and the CreANIMate (Edelson, 1993) systems are both based on a case-based teaching architecture. This technique uses storytelling and the context of a task as the basis of the teaching strategy. Both systems also make use of video as the major method of conveying information to the learner, simple indexing schemes have been developed for the retrieval of the appropriate video.

YELLO is a system designed to teach the selling of Yellow Pages advertising. The underlying theme of the system is that the stories of experts capture the realities of a realm of knowledge from an experienced perspective, this type of knowledge can be very important to novices' learning. YELLO uses video based stories and indexed interpretations of them, to present situations to the student and provide instruction.

Traditionally Intelligent Tutoring Systems (ITSs) use modelling techniques to determine when to intervene in the learning process and what to say. The practical implication of this is that this type of system must deal with narrow domains where the knowledge is well-defined. One of the advantages of the YELLO system is that students can access a large body of expert knowledge that has been preserved as the stories of experienced practitioners. The system observes the students' responses and recalls those stories that are of interest using a failure based learning model (Burke, 1993).

CreANIMate is another case-based learning environment that teaches animal adaptation to (American) 4th-7th graders. The system is designed to teach the relationships among physical features of animals, the actions they can perform and their high-level survival strategies, by allowing students to design new animals. The system combines storytelling and the asking of relevant questions to teach students.

In common with YELLO this system uses experiences within a task environment and responses from stories in particular situations to teach the relevant concepts. The system uses a Socratic style of questioning as the main method of interaction in a free text environment. The architecture of this system has been developed to take advantage of the high information content of video based stories. Edelson (1993) identifies the key problem here as being knowledge representation as it is this that "enables a teaching system to identify appropriate questions to ask and present stories that follow through on the learning context established by the questions".

The CreANIMate system presents information in video form related to the context of the learning experience as opposed to the linear predetermined structure often seen in many systems. Edelson points out that students' motivation for learning appears to be enhanced with a wide range of emotions recorded.

3 Motivation and Learning

The relationship between the motivational state of students and their ability to learn has been investigated by a number of workers.

Lepper et al (1992) report the results of studies on educational activities with identical instructional content but differing motivational appeal. Computer-based learning activities with third to fifth grade school children where used as the basis of the investigation. These studies have shown that gains in learning occur when the learning activities occur in a motivationally embellished setting. The embellishments used were the provision of a number of fantasy contexts for the games - providing a simple narrative.

It is reported that students exposed to the motivationally enhanced programs showed significantly increased motivation for learning the domain knowledge, even when the motivational factors where removed. Lepper et al also distinguish between intrinsic and extrinsic rewards for learning. Intrinsic rewards are based on a high congruence between the material being taught and the motivational techniques used. Lepper notes that extrinsic rewards can have a detrimental effect on learning (Lepper et al 1992 and Lepper 1985).

Lepper and Malone (1987) have suggested that increasing the learners' sense of cognitive surprise and curiosity is important in motivation. They make a distinction here between perceptual surprise (that which relates to changes in colour or sound for example) from the sense of puzzlement that could arise from an ambiguous statement or a result that is unexpected (cognitive surprise).

They suggest a number of tactics that could be used in a tutoring system to ensure that a learners cognitive curiosity is stimulated. These are summarised below:

- cognitive curiosity is stimulated when unexpected facts arise from the subject domain. This encourages the student to explore the domain and determine an appropriate explanation of the facts.
- A similar effect is caused if the tutor asks questions of the student which are in related but "unknown" domains, or if incomplete information is presented. These tactics are designed to encourage exploration, generalisation and simplification.

Lepper and Malone (1987) point out that challenging situations can provide a high degree of motivation. They identify three factors that cause this:

1. A task that is too easy or too hard is not as attractive as a task that is of "moderate" difficulty whose successful completion is not easily predicted. Creating a sense of suspense regarding the outcome of any particular task is a useful motivational tactic.
2. The user must know what they have to achieve to complete the task. A clear goal for success of the task should be defined.
3. Informative feedback on the progress of the task is required to allow the student to assess and refine or restructure their approach to the task. When a task has been successfully completed some form of feedback should provide suitable acknowledgement and reward.

Lepper and Malone suggest that learners feelings' of control and competence are directly related to the level of control they have. Although acknowledging the need for feelings of control in the learner they consider that this control need only apply to those features which are not directly relevant to the teaching process (such as the colours of the interface).

Elsom-Cook (1990) considers the problems of providing the learner with hints and suggestions when they are required and trying to maintain the learners sense of control.

Feelings of control are obviously also related to the learners feelings of confidence. Those learners who do not feel confident require a more closely controlled teaching experience. Keller (1983) suggests that such students should be given some experience of success to build their confidence. For instance they could be presented with a series of similar problems which they are able to solve - these problems may or may not enhance their domain knowledge.

4 Making Learning Fun

It is well known that computer based games are able to hold the attention of the player - that is motivate them to continue to play. Malone (1981) has identified several reasons why this is so.

These are discussed as four factors which should be incorporated into a successful game:

- Goal. The activity should have a clearly articulated goal.
- Uncertain outcome. The system should have a variable difficulty level. Multiple goal levels and incorporate some randomness. Some information should be hidden and selectively revealed.
- Fantasy. The program should contain an emotionally appealing fantasy, and skills learned within the environment should be related to the program.
- Curiosity. Audio and visual effects should be used to decorate the system, enhance the fantasy and as a reward.

Malone also describes "cognitive curiosity", the system should provide some surprises and constructive feedback.

Provenzo (1991) points out the "universe" of commercial video games is strictly limited - often there are only a handful of possibilities available to the player but these are enough to allow them to immerse themselves completely in the illusion of an artificial world. The important point here is that the illusion does not have to be sophisticated to be entertaining as long as the user has rules to grasp about the environment and these rules are applied consistently. The opportunities available to act at any single point in a game is often very limited but the fact that users feel they have some control over the environment is enough to hold their attention.

The principles applied to the commercial games analysed by Provenzo also apply to educational computer-based games.

The adventure game genre is one that has been used in an educational context for some time (Sherwood, 1991).

Quinn (1996) has described the development of an educational adventure game designed to teach low-literacy youth about independent living skills. The system Quest for Independence, has been designed to run on low specification computers and to use a game format to motivate the intended user group to use the software. The game itself consists of a simulation of the tasks the learners would have to complete in the real world if they were to survive by themselves on a day to day basis. Such as getting a job and opening a bank account. The game does not attempt to simulate all the possibilities - just those that are considered most important by the games developers.

As the target audience have low literacy levels the use of a mainly graphical environment was considered an important design parameter. The entertainment value of the system was also emphasised as the users had "little tolerance for any material of a low entertainment value". The game provides guidance for learning within the simplified environment, not all the actions available in the real world are available to users of the system - those discarded were the ones that either did not contribute to relevant knowledge acquisition or to game play.

The Quest for Independence does not however provide intelligent adjustment of the scenario based on the users interactions, this decision was made for because limited funds, time and hardware were available for such a system.

Quinn reports that pragmatic evaluation of the game by centres that are using it indicates that it has been favourably received.

5 The CAT System

Computer architecture courses involve a domain which contains abstract concepts and procedural knowledge. The problem faced by the tutor is devising suitable practical activities (Lees, 1987).

The author is involved in the teaching of such a course to students who may have little previous experience of the architecture of a personal computer or the components that comprise one. It is noted that such students often have a great deal of difficulty in visualising the inter-relationship between components and their inter-connections and functions. The use of real machines to allow the students to change, upgrade or repair components has been used but has two disadvantages. With repeated use machines used for this purpose frequently malfunction, also maintaining suitable machines and related equipment has a significant cost.

A simulation of a personal computer clearly has numerous advantages. The procedural skills the students must acquire as well as the conceptual ones can be taught at much reduced expense.

A game based simulation designed to teach the domain of computer architecture is currently under development as the Computer Architecture Tutor (CAT). The design incorporates a strong sense of narrative using a fantasy environment that allows direct manipulation of animated graphical objects.

6 Narrative Structure and Motivation

The narrative structure used has been based on the work of the Russian Structuralists, particularly the work of Propp (1968).

Narratives and the use of language are shared by all societies and the use of storytelling by effective teachers has already been discussed. A narrative allows us to make sense of the world by using common social and cultural experiences. The interaction between a teacher and her student occurs in this wider social context and therefore some analysis of the structure of narrative is important if it is to be usefully incorporated into a tutoring system.

The work of the Russian Stucturalists on the structure of narrative has been particularly influential and is briefly considered here. The Structuralists argue that language and narrative share many properties and that, "they are structured along the twin axes of the paradigmatic and syntagmatic, that there may be a universal narrative structure" (Fiske, 1987).

The work of Vladimir Propp (1968) on one hundred Russian folk tales has been widely applied to film and television. Propp found a common narrative structure through all the folk tales he analysed. This structure was described through a series of thirty-two narrative functions which were subdivided into six sections.

The use of a strong narrative structure within an ITS is an area that has not been closely investigated. Several workers have commented on the relationship between good storytelling and good teaching. The aim of this project is to investigate the role of narrative in a game based ITS.

The advantage of the use of Propp's "universal narrative structure" in an ITS is that is can be related to the motivational tactics described by Lepper and Malone (1987). For example a clear goal (or set of goals) can be created by a narrative. Achieving the goal provides satisfaction to the user and instant feedback. Tasks can include interaction with characters – the ease of the task can be varied easily in a narrative. Thus the use of a Proppian narrative structures provides a useful tool for implementation of the tactics.

The use of an adventure game based environment allows a number of interesting possibilities. The learner can be placed inside a personal computer as the microworld, where they must carry out a series of tasks and solve puzzles to build a working machine.

Firstly, the goals of the learner can be clearly articulated as a series of tasks, adventure games frequently incorporate puzzles, problems or tasks. In a fantasy environment these tasks must be related to the domain knowledge, however this can be further related to interactions with a series of characters that inhabit the fantasy world. A narrative can be used to help navigate the learner through the system and to motivate them to explore.

For example within the computer "world" the learner will encounter various tools, pieces of hardware and characters that may or may not assist them with the overall goal of building a working computer. The characters must have their own motivations and actions if the narrative is to work. If the learner is aimlessly wandering around exploring the environment, the system should present them with tasks to complete to increase their confidence level - this could involve an interaction with a character or the "discovery" of useful equipment or direct help.

Conversely, if they are presented with a task where they must carefully inspect and choose an object and they randomly pick one, the system should "ensure" the object chosen is not the correct one. The learner must then repeat the task using the correct procedure - after receiving appropriate feedback. The feedback itself can be provided by other characters rather than through direct instruction. Aimeur et al (1997) have described an analogous strategy of "learning by disturbing".

From these simple examples it is clear that the use of a strong narrative has many potential advantages for an intelligent tutoring system and that this area has received limited attention as yet.

7 Conclusion

This paper considers the role of narrative in ITS related research and relates this to the issue of motivating students to learn. The importance of narrative structure is considered and work on a computer-based adventure game in the domain of computer architecture is considered. The use of a strong narrative structure is important because all human interactions take place within a wider social context and this applies to learning as much as any other field. The use of narrative and an analysis of its importance within ITSs is an area that needs greater investigation.

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ARMVLS - Atomic Reaction Model Visual Language System

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Abstract: Visual language (VL) is a programming language without textual codes and algorithm animation (AA) is about visualizing a computer algorithm. Visual programming (VP) and AA are traditionally separate factions in software visualization (SV). With the Atomic Reaction Model (ARM), we have bridged these two major branches in SV. ARM Visual Language System (ARMVLS) is a visual language algorithm animator, modeling the fundamental cause-and-effect of a simple atomic reaction. ARMVLS is a system that allows the end-user to animate algorithms - to visually demonstrate or to assist in the description of how a computer algorithm works by means of drawing and moving images on screen.

1 Introduction

Since the early 1980's when researchers began building systems to visualize computer programs and algorithms, there have been many terms defined and used in the literature, such as VP and AA that we used in the previous section, and other phrases like *program visualization*. Yet after more than a decade of advances in interface technology, researchers have not fully agreed on these definitions.

The Oxford English Dictionary suggests *visualization* as "the power or process of forming a mental picture or vision of something not actually present to the sight", so a visualization can result from input of any combination of the human senses. The general consensus of *program visualization* is the use of various techniques to enhance the human understanding of computer programs, while *visual programming* is the use of visual techniques to specify a program in the first place. *Algorithm visualization* or *animation* is understood to be the visualization of a high-level description of a piece of software which is in contrast to *code* or *data* visualization (which are collectively a kind of program visualization) where actual implemented code is visualized. Price et al [1993] used the term *software visualization* (SV) to include all these definitions.

Although there were various attempts to bridge these two visualization branches from 1994 to 1996, we consider only Opsis [Michail 1996] to have achieved this task to a certain degree, based on our definition of a VL. Since there are no other currently existing systems[1] that can integrate AA and VP, we put ARMVLS among the ranks of pioneer VL algorithm animators.

The objective of ARMVLS is the following:

a. *Portability and extensibility.* Portability concerns the amount of effort needed to deliver the new system across platforms; extensibility determines the extent of restructuring required when building new features on old ones.

b. *Object orientation* deals with assigning properties to graphical objects created using the graphical editor. Graphical objects are the basis for Object-Oriented Visual Programming (OOVP) [Kimura 1995].

c. *Resource sharing, group-working and networking.* Resource sharing pools graphical objects to share among users of the new system; group-working and networking distributes the responsibility of system development and maintenance between all participating members or users.

d. *Incorporation of multimedia.* This addresses the issue of integrating multimedia into animation. We defined visualization to be the result of combined input from all the human senses. Incorporation of multimedia pertains to the ease of specifying images, as well as sound for visualization.

e. *Code-free programming.* This is visual programming.

[1] We based our claims from the papers submitted to the annual International Symposium on VLs organized by the Computer Society of the Institute of Electrical and Electronics Engineers (IEEE), up to the year 1996.

2 The Traditional BALSA Approach

BALSA stands for Brown University Algorithm Simulator and Animator [Brown 1991]. It is one of the earliest AA systems to make use of the graphics and windowing capabilities of personal workstations in the 1980's. It was designed for two purposes: as a teaching tool for undergraduates and as an aid to algorithm design and analysis. As a teaching tool, it allows the teacher to give a running commentary on the prepared graphical animation running on each student's machine. This is the automated process of the traditional classroom teaching example that we gave in the previous chapter. Figure 1 shows BALSA with several *view* windows. A view is an animated picture portraying the events generated by an algorithm. Each view can exist as a separate window to show the various aspects of the algorithm being animated.

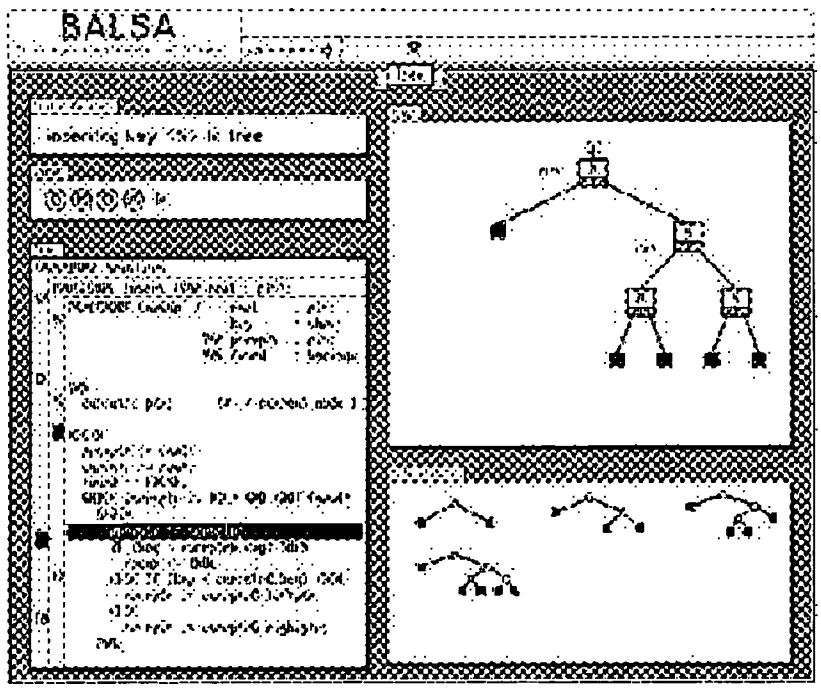


Figure 1: BALSA showing the code view, input, status message, current view of the tree data structure, and a view of the tree history.

We see from the still in Figure 1 that BALSA supports multiple simultaneous views of the running algorithm. The contents of each view window depend on what the teacher has provided and cannot be changed by the student. A code view (the window at the lower left quarter of the BALSA screen) is usually provided to show the listing of the current procedure in Pascal with the current line highlighted. Views of data structures can range from dots or sticks to complex graphs, trees or computational geometry abstractions. BALSA is able to display multiple views of the same data structure, and is also the first system that can show algorithms racing with each other on the same display (e.g. to compare the speeds of various sorting algorithms). This pioneering work made it the benchmark against which all subsequent AA systems have been measured.

To animate a computer algorithm in BALSA, the teacher starts with the standard Pascal implementation of the algorithm and annotates it with markers at points where the code changes interesting data structures or enters/exits a subroutine. These markers are called *interesting events* and they make calls to BALSA's Interesting Event manager with parameters that typically identify program data [Brown 1991]. After annotating the source code, the teacher builds views. Each view controls some screen real estate and is notified by the Interesting Event manager when an interesting event is encountered in the algorithm. The notified view is then responsible for updating its graphical display appropriately based on the event. This is done by either modifying the existing view from the BALSA library or by building a completely new view using the built-in graphics primitives. With these overheads, the code can bloat to a considerate length. Animation code can even be longer than algorithm code, resulting in a situation where the student spends more effort on constructing the animation than on experimenting with the algorithm. Therefore, we re-state that BALSA systems are not particularly effective as tools for active learning, i.e. to let students animate algorithm themselves.

3 ARMVLS: Design Issues

3.1 Features of ARMVLS

The features are manifold and only a few can be described it this paper. ARMVLS ...

a. belongs to the ranks of pioneer VL algorithm animators,
b. is the first VL algorithm animator to perform sorting, searching, tree and possibly graph algorithms using the same engine,
c. enables very fast prototyping for both the novice and the expert animation programmer,
d. allows VP in the most natural manner so that algorithms can be programmed exactly as how we would visualize them to be,
e. is Internet ready and capable of cross-platform interface since it is a Java applet[2], and
f. employs dynamic state transitions to reduce programming efforts and to increase the detail level and realism in animation.

ARM has an impact on the current SV technology as it injects fresh ideas into AA and VP. For AA, it is a break from the traditional textual coding of algorithms; for VP, it gives a new lease of life to GRSs to handle complex problems, and hence the ability to wrestle with the ever dominating dataflow VLs.

3.2 How to animate in ARMVLS

The snapshot in Figure 2 shows the Atomic Reaction Model Visual Language System (ARMVLS) after the completion of a three-level binary search tree (BST) construction. The BST was programmed from scratch and made ready to run in less than five minutes, demonstrating the rapid prototyping capability of our Atomic Reaction Model (ARM). There are no functions or modes which specially cater for tree construction. All features and constructs of ARM are generic and can apply to all algorithms that it can animate, where deemed fit. Creating animation in ARMVLS also does not require an expert user. In fact, the BST was animated by a programming illiterate who was only briefed on the aspects of ARM pertaining to BST, and taught the BST insertion algorithm itself just minutes before she created the animation.

ARM is designed as a general programming heterogeneous visual language (GPHVL) with the ultimate aim of animating all algorithms achievable by textual coding. This is not to be confused with BALSA systems [Price et al 1993]. Algorithm animation (AA) using BALSA's approach are basically coded in text and therefore restricted only by the machine power, compiler capability and human creativity. ARMVLS is a visual programming (VP) system to animate algorithms that are themselves programmed in ARM.

Of course, our goal is extremely ambitious and will take many more years of research to achieve, considering the level of VL technology today. Nevertheless, we felt that our contribution to the VL research community is our approach adopted in ARM.

ARM introduces many new terms that may be unfamiliar in Computer Science. These terms are either Physics or Chemistry jargon since ARM, as the name implies, is modeled after a simple atomic reaction.

[2] Architecture-Neutral is one of the greatest attributes of the Java language. A Java applet is designed to run on a variety of hardware architectures and operating systems without the need for recompilation. Applets are truly portable and inherently network ready.

3.3 The Atomic Reaction

In our simple atomic reaction, we assume only two types of atoms: the active and the inactive. Active atoms have kinetic energy. They are unstable particles and they move around. They are called *reactors*. Inactive atoms, or *reactants*, are stable and do not move. Because reactors move, they initiate *interactions* with reactants. In an interaction, there can be two possible outcomes: either nothing happens, or there can be excitation. We say the interaction is *sparked* when there is excitation. If the excitation involves only one reactor and one reactant, it is a *reaction*; if many reactants are involved, it is a *compound reaction*. ARM does not define the many-reactor-to-one-reactant and the many-reactor-to-many-reactant cases. In subsequent discussions, we use the term 'reaction' to include compound reaction as well, unless we explicitly specify that compound reaction is excluded.

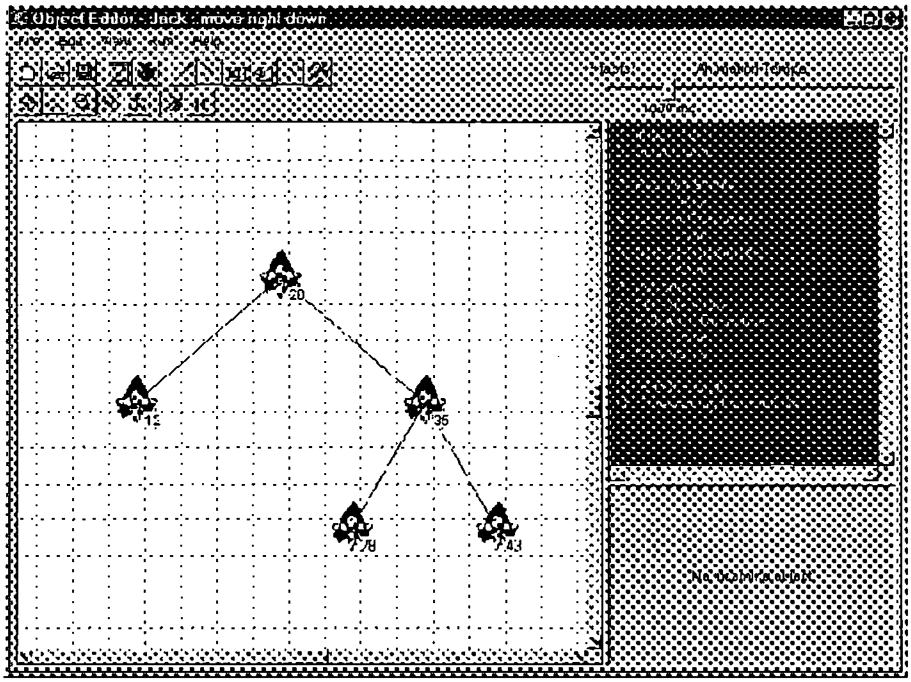


Figure 2 ARMVLS constructing a binary search tree

In a reaction, there can be three resulting scenarios:

a. the reactor remains excited and the reactant remains stable,
b. the reactor remains excited and the reactant becomes excited, or
c. the reactor stabilizes and the reactant becomes excited.

When the reactor *stabilizes*, it becomes a reactant; the opposite is also true — when the reactant is excited, it becomes a reactor and fires an *excitation response* (potential energy to kinetic energy) that throws it into motion. The reactor also fires an excitation response in order to keep itself in motion if it is to remain excited. We use *active responses* to refer to the set of excitation responses that an atom fires as a reactor; and for those excitation responses that the atom fires as a reactant, we call them *passive responses*. *Dual responses* is the intersection set of these two response types, i.e. a dual response is both an active and a passive response. We say that an atom is *triggered* when it either becomes or remains active after a reaction.

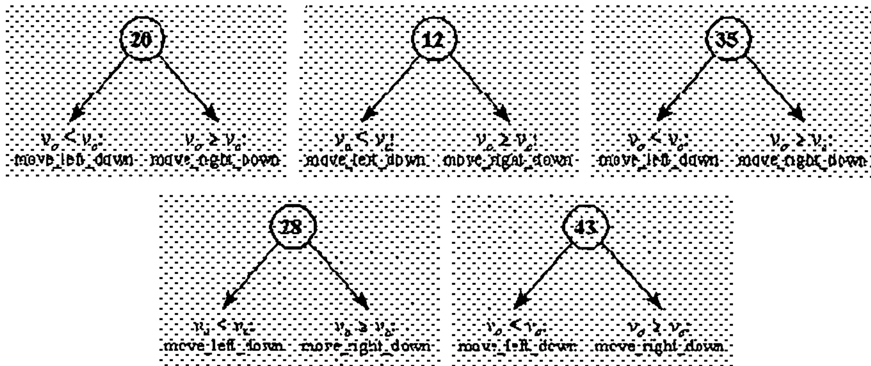
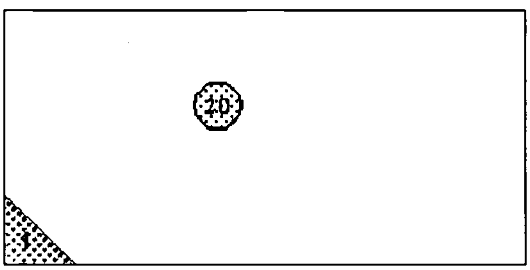


Figure 3 Atomic objects defined with two responses for building binary search trees in ARM

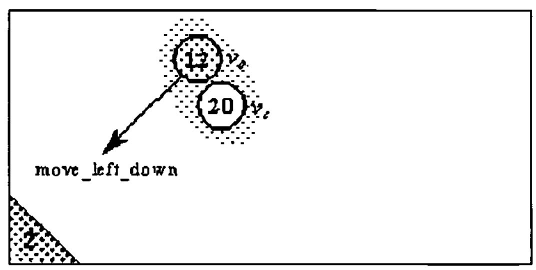
To make clear the concept presented so far, we apply it to build a Binary Search Tree. Suppose we have the numbers 20, 12, 35, 28 and 43. We let these numbers be represented by an atom each. Each atom is specified with two active responses: 'move left down' and 'move right down'. The *trigger conditions* for these two responses are $v_o < v_c$ and $v_o \geq v_c$ respectively, where v_o is the value of the atom, and v_c is the value of the *complement*.

The complement refers to the other atom in an interaction, e.g. reactor A and reactant B interact, A is the complement of B and B is the complement of A. v_o and v_c are known as *weights*. Weights are like variables in textual languages; we do not call them variables because they are not memory cells that store only values — they are active structures. Yhe meaning of the trigger conditions is that active response 'move left down' will only be fired if the atom's value is less than its complement's ($v_o < v_c$); otherwise 'move right down' will be fired ($v_o \geq v_c$) instead as illustrated in Figure 3.

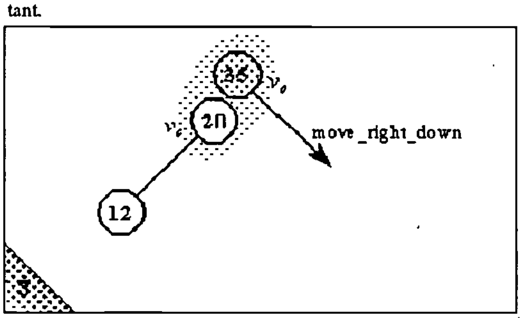
In figure 3, circles represent atoms, and the arrows are the active responses. Observe that all the atoms are identical except for their values. This means that we only create one atom, then we duplicate them to the required number (in this case, five) and assign them their individual values.



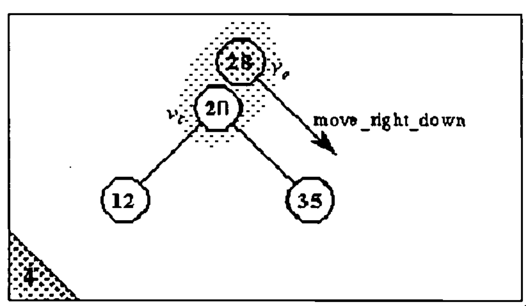
Atom 20, i.e. atom with value = 20, enters the *interaction arena* (represented by the enclosing box) as a *reactor*. There are no *reactants* that it can *interact* with, so it *stabilizes* to become a reactant.



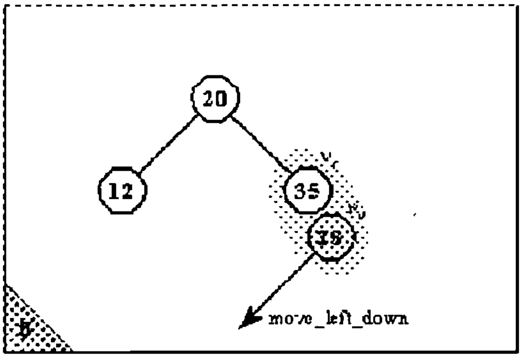
Atom 12 (v_o = 12) enters as a reactor and interacts with atom 20 (v = 20). As it is atom 12 that initiates the reaction, and. Since $v_o < v_c$ the *active response* 'move left down' is triggered.



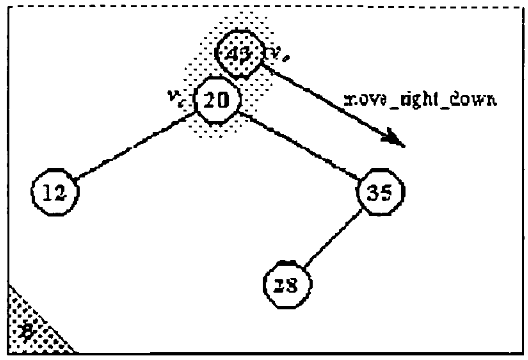
After the *reaction*, atom 12 stabilizes at its final position. Atom 35 now enters and interacts with atom 20. The *trigger condition* for active response 'move right down' is met as $v_o \geq v_c$.



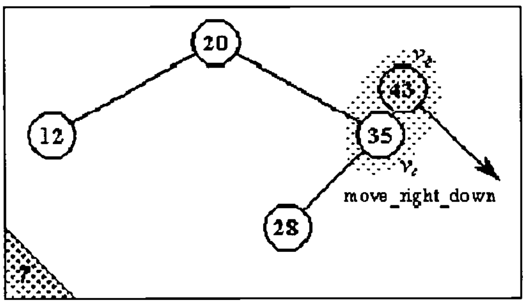
Similarly, atom 35 then stabilizes. Atom 28 joins the interaction arena, reacts with atom 20 and fires 'move right down'.



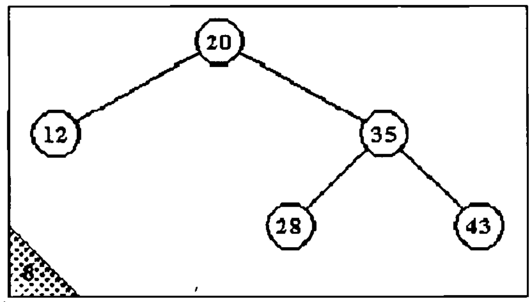
Unlike previously for atoms 12 and 35, atom 28 does not settle this time; instead it starts another interaction with atom 35. $v_o < v_c$, so atom 28 remains excited and consequently executes the action for active response 'move left down'.



Atom 28 finally stabilizes after two consecutive reactions. It then allows atom 43 to enter. This frame now repeats the occurrences of frame 4.



Reaching atom 35, atom 43 fires active response 'move right down', since $v_o \geq v_c$.



Atom 43 settles and the *chain reaction* initiated by atom 20 stops.

Figure 4 Chain reaction sequence for binary search tree construction example

Before we animate, we have to introduce another term — *interaction arena*. This is the place where atoms interact. In implementation, we call this place the animation window or the animator board, which is actually the window that displays the atoms. Figure 2 shows an animator board with grid lines. Initially, this interaction arena is empty. Each atom will join the arena one after another and cause a series of reactions. This series of reactions is called a *chain reaction* as illustrated in Figure 4.

4 Conclusion

We have tried to achieve the following objectives with this new approach of Algorithm Animation:

a. *Portability and extensibility*. As ARMVLS is entirely written in Java the system can either be accessed via the Internet or as a standalone application on all platforms supporting JDK 1.1.

b. *Object orientation*. All animations are programmed using objects and interact by Atomic Reactions.

c. *Incorporation of multimedia*. This was not further explored in detail but all objects can be associated with images, and each reaction with sound.

d. *Code-free programming*. The BST was programmed without any line of code in comparison to the BALSA approach where the original PASCAL program hat to be modified with animation sequences.

ARMVLS can be used as a supplement for Data Structure teaching since it allows students to understand the principles of an algorithm while using it. We think, that programming of algorithms is much easier when we can build a mental image of the algorithm execution sequence in our mind. Complicated procedures and recursive algorithms are more easily understood and therefore aid in the process of programming it in "real" programming code.

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Actor Interdependence in Collaborative Telelearning

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Abstract: In our research we are developing an interdependence model for collaborative telelearning. We envisage that such a model will inform the instructional design of learning scenarios, the technological design of the telelearning environment and the design of intelligent agents to mediate, or to support the mediation of collaborative telelearning. In this paper we present a model of a collaborative telelearning scenario and describe how coordination theory has provided a framework for the analysis of actor (inter)dependencies in this scenario.

1. Introduction

Collaborative telelearning emphasises the collaborative interaction between students in a telelearning environment. The fluid mediation of collaborative learning activity is a major challenge for telelearning. Mechanisms to support synchronisation, exchange and sharing of information or documents need to be as transparent as possible to avoid hindering learning. An environment capable of supporting collaborative telelearning needs to be knowledgeable about organising and supporting the collaboration.

The design of collaborative telelearning requires the instructional design of collaborative learning scenarios and the specification of the technological design comprising the learning environment configuration as well as the tools and services available. Furthermore, the specification of software agents to mediate the time, space and collaborative learning activity distance between students, is a means to including some needed knowledge about organising and supporting collaboration.

In our research [Bourdeau et al, 1997; Bourdeau & Wasson, 1997; Wasson 1997] within the Canadian Telelearning Programme (http://www.telelearn.ca), we are developing an interdependence model for collaborative telelearning. We envisage that such a model will inform the instructional design of learning scenarios, the technological design of the telelearning environment and the design of intelligent agents to mediate, or to support the mediation of collaborative telelearning. In this paper, our approach to building this model is described and an analysis of actor (inter)dependencies in a collaborative telelearning scenario is presented.

2. CSCL and Coordination theory

Computer supported collaborative learning (CSCL) gives an insight into what collaborative telelearning can be. Salomon's work on CSCL [Salomon, 1992; 1993] provides the most complete approach to the study of CSCL in that it is built upon learning theories, relies on observations, raises strong design issues and gives methodological tools for educational research. Salomon's focus is on the mediation in CSCL, which is a key issue in collaborative telelearning. In his view, collaboration means interdependencies, sharing, responsibility, and involvement. Instructional design issues become, for example, to orchestrate these interdependencies and the shared activities, while maintaining personal responsibility and mutual involvement [Bourdeau 1996].

Genuine interdependence is characterised by [Salomon 1992] as: the necessity to share information, meanings, conceptions and conclusions; a division of labour where roles of team members complement one another in a joint endeavour and the end product requires this pooling of different roles; and, the need for joint thinking in explicit terms that can be examined, changed, and elaborated upon by peers. Salomon's emphasis on genuine interdependence between team members raises our first challenge: How can such interdependencies be specified and supported in a collaborative telelearning situation?

[Malone & Crowston, 1994] describe coordination theory as an emerging research area focused on the interdisciplinary study of how coordination can occur in diverse kinds of systems. Coordination theory provides a means for specifying (inter)dependencies between, and among, actors, tasks, and resources by identifying a *dependency type* (e.g., shared resource) and a *coordination process* (e.g., group decision-making) for managing the dependency. In their work, coordination is defined *as managing dependencies between activities* [Malone & Crowston, 1994], hence they have focused on dependence between activities. Drawing on ideas about activity coordination in complex systems from disciplines as varied as computer science, linguistics, psychology, economics, operations research and organisation theory, they present a first version of an analysis that characterises the basic processes involved in coordination. [Tab. 1] gives examples of dependencies between activities and possible coordination processes for managing them.

Using ideas from coordination theory, an (inter)dependence model for collaborative telelearning is being built [Wasson 1997].

Dependency	Examples of coordination processes for managing dependency
Shared resources	"First come/first serve", priority order, budgets, managerial decision, market-like bidding
Task assignments	(same as for "shared resources")
Producer/Consumer relationships	
Prerequisite constraints	Notification, sequencing, tracing
Transfer	Inventory management (e.g., "Just In Time", "Economic Order Quality")
Usability	Standardisation, ask users, participatory design
Design for manufacturability	Concurrent engineering
Simultaneity constraints	Scheduling, synchronisation
Task / Subtask	Goal selection, task decomposition

Table 1: Dependencies between Activities [from Malone & Crowston, 1994]

3. Modelling a Collaborative Learning Scenario

Adoption of Salomon's definition of genuine interdependence has lead us to focus on the ponderation of interdependencies between actors such as individual students, teams/groups of students, instructors, tutorial assistants, or experts. Empirical studies have been carried out in order to document collaborative learning scenarios for various versions of a strategic management course given at HEC, École des Hautes Études

Commerciales in Montréal [Wasson 1997]. The part of the courses that the learning scenarios document are exercises utilizing Netstrat [Fig.1] an Internet-based (http://cetai.hec.ca/netstrat/), strategic management simulation used to provide students with an opportunity to experience a realistic market. Participants form teams and compete for Market Shares. These documented learning scenarios have been modeled using a knowledge modelling tool, MOT, developed at the LICEF Research Centre at Télé-université. These MOT models form the basis of our analysis of inter-actor (inter)dependence.

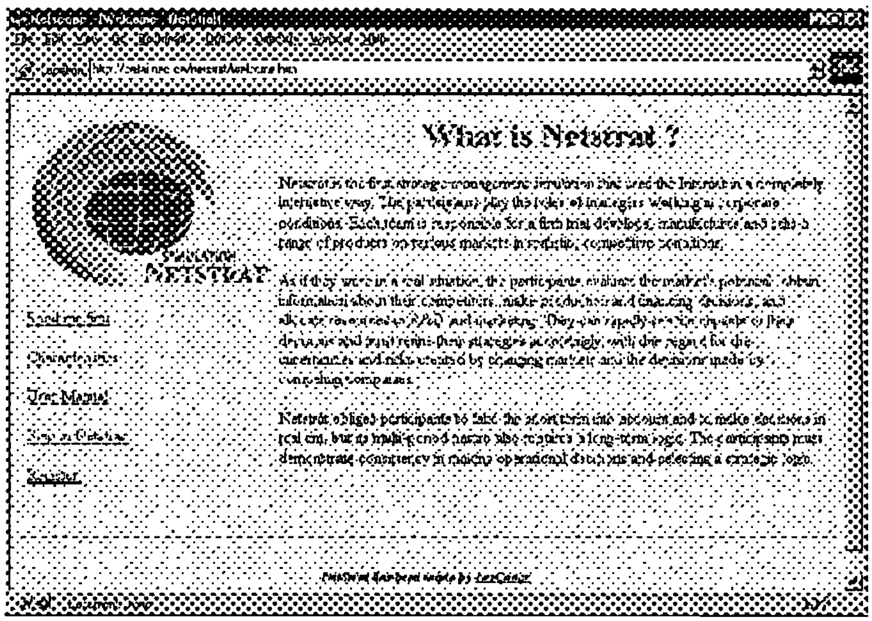

Figure 1: Netstrat Simulation Game on the Web

The Netstrat simulation game is used in 4 different variations of the strategic management course at HEC. There is a 3rd year undergraduate BAA course, an MBA graduate course, a 3-day Executive course for managers, and a 1-week tailored course for a particular industry. In each variation, the Netstrat simulation game is central, but its role and implementation varies. For example in the 3rd year BAA course [Fig. 2], a month long Netstrat competition [Fig. 3] is held half way through the course and serves to give the students a chance to practice the strategic management skills they have been learning about over the past three years. The MBA students, on the other hand, are welcomed to their program with an intensive week long Netstrat session that serves as an orientation exercise to highlight just how much they have to learn.

Strategic Management Course (BBA)

Course Objectives: to integrate concepts & develop skills in strategic management, including strategic thinking and collaborative decision-making *(team based collaborative learning is central)*

Role of Netstrat simulation game: to develop skills in applying strategic management concepts learned through readings, case studies, and group discussions

Evaluation: Netstrat is worth 30% of course grade (undergrad)

Netstrat Grading: 10 % strategic plan
5 % stock value
15 % written report & presentation

Netstrat Simulation Game

- strategic management simulation on the Internet
- participants play the roles of managers working in corporate conditions
- each team (5-6 students) is responsible for a firm that develops, manufactures and sells a range of products on various markets in realistic, competitive conditions.
- 5 - 6 teams compete against one another in a simulation game
- an Animator runs the game

Figure 2: Strategic Management Course at HEC **Figure 3:** Netstrat Simulation Game

The learning scenario for the 3rd year BAA documents student, instructor and a simulation animator's participation in the Netstrat competition. The major activities in which the actors are involved (although with varying roles) include: Briefing; Decision-making (7 rounds of team decision-making); Debriefing; Report writing; Team presentations; and Evaluation.

[Fig. 4] gives an overview of the model of the 3rd year BAA scenario emphasising the student view where collaborative team work plays a significant role (the complete model can be found in [Wasson 1997]). In this overview model, only the first three activities, briefing, decision making and debriefing are included. In the model actors are indicated as: an instructor (I); 200-250 students (S); an animator (A); teams of 5-6 students (Tx); and simulation groups (SG-x, i.e., a set of 5-6 teams). Goals are indicated by non-shadowed ovals, and activities by shadowed ovals. Concepts and resources are enclosed in rectangles and governing/regulating entities in diamonds. The shadowed elements indicate either a collaborative goal or activity, or a concept/resource that has been produced collaboratively. Links include: C - component; G-A - goal-activity; simultaneous, I/P - input/output; R - regulates; and P - precedence.

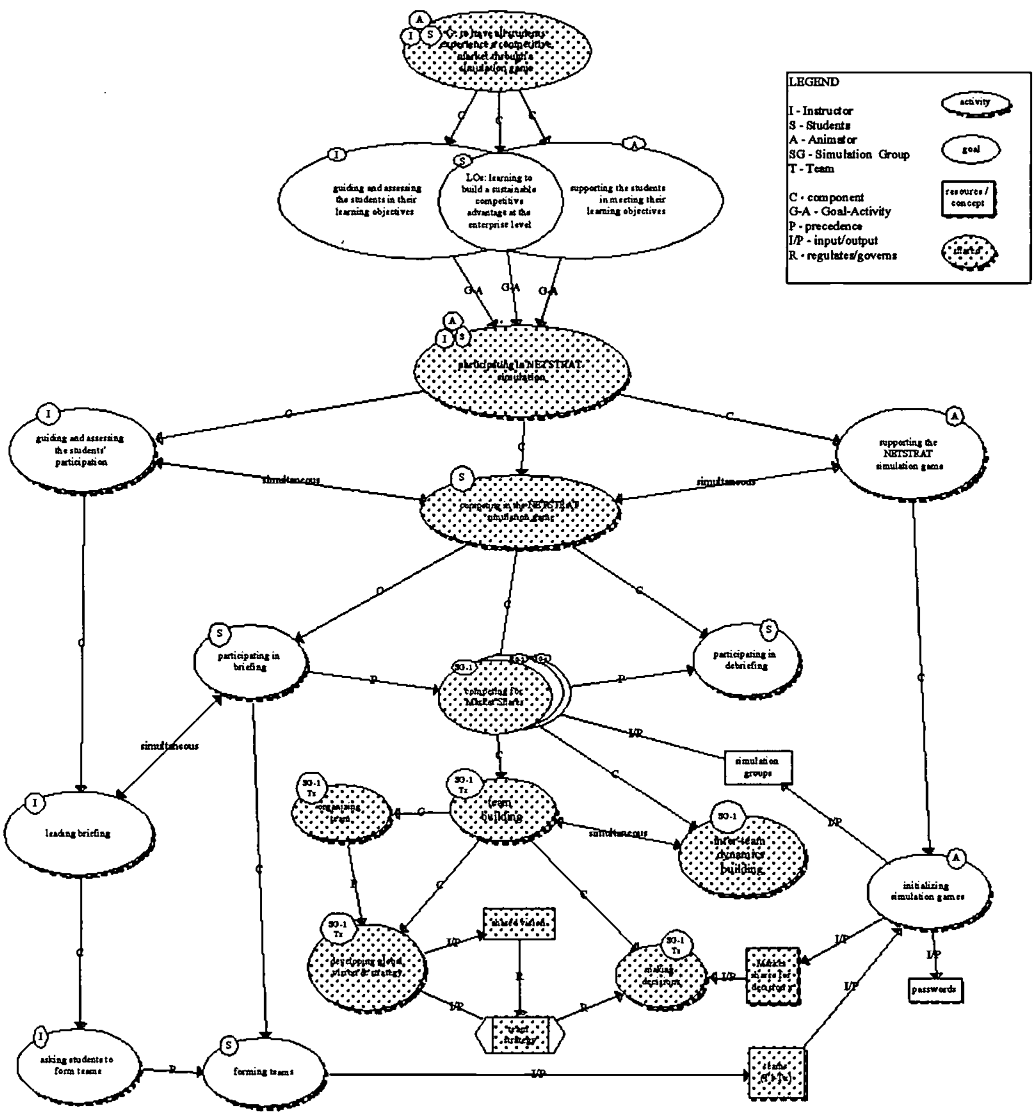

Figure 4: An overview of the 3rd year BAA learning scenario model

4. Reading the Model

The top node of the model indicates that the instructor (I), the students (S) and the animator (A) share an overall goal "A,I,S: to have all students experience a competitive market through a simulation game". This goal is decomposed into three subgoals one for each of the actor roles. The instructor will meet the overall goal by "I: guiding and assessing the students in their learning objectives"; the students will meet the overall goal by meeting their learning objectives of which the overall objective is "S: learning to build a sustainable competitive advantage at the enterprise level" (three are 3 sub-learning objectives not shown here); and the animator will meet the overall goal by "A: supporting the students in meeting their learning objectives. Each of these subgoals is linked to a shared activity "A,I,S: participating in the Netstrat simulation" by a goal-activity link (G-A). Three simultaneous activities "I: guiding and assessing the students' participation", "S: competing in the Netstrat game", and "A: supporting the Netstrat simulation game" illustrate both the task/subtask and simultaneity constraint interdependencies identified by [Malone & Crowston, 1994] and listed in [Tab. 1].

Following the students activity three sub-activities nodes, "S: participating in the briefing", "SG-x: competing for Market Shares" and "S: participating in the debriefing" are met. There is a prerequisite constraint dependence [Tab. 1] between these activities indicated by the precedence (P) link. In the complete models [Wasson 1997] each of these nodes has a sub-model but for brevity only the highlights are shown. Notice here that in the second activity the students (S) have been divided into simulation groups (SG-x) and it is a SG-x that competes in one simulation game.

The simulation group activity "SG-x: competing for Market Shares" has two sub-activities "SG-x,Tx: team building" and "SG-x: inter-team dynamics building". More will be said about these two activities in the next section, but note that the simulation group has been split into teams (Tx) for the team building activity. Under "SG-x,Tx: team building" there are three sub-activities "organising team", "SG-x,Tx: developing global vision & strategy" and "SG-x,Tx: making decisions". These activities (of which there is a precedence order) are the heart of the collaborative team activity. Output (indicated by the I/P link) from the "SG-x,Tx: developing global vision & strategy" activity is a "shared vision" and a "team strategy". The shared vision is input into the team strategy which in turn governs (or regulates (R)) the "SG-x, Tx: making decisions" activity. This means that the team strategy has an influence over how team decisions are made. The final item to be highlighted is the "Market shares for decision x" concept. This concept represents the value of the Market Shares for which the teams within a simulation game are competing. The Market changes after each decision thus feeding new values into the next decision making round. The Market updates are released by the animator (not shown in [Fig. 4]) after a set criteria is met (e.g., all decisions have been entered by time x and no team will be out of the competition).

5. Discussion: Actor Interdependence

In analysing the dependencies between actors in the learning scenarios, the following observation has emerged. Actors in a collaborative telelearning situation have the obligation or necessity to:

- share Goals *to complete* Activities
- share Activities *to achieve* Goals
- share Resources to *complete* Activities
- share Activities to *produce* Resources

The first two are illustrated in [Fig. 4] by the interconnection of the overall shared goal's subgoals to the shared activity "A, I, S: participating in Netstrat simulation". This illustrates a *collaborative interdependence through a shared activity.* The shared activity is sub-divided into three activities which have a simultaneous constraint dependency as identified by Malone and Crowston [1994]. By carrying out these three activities simultaneously, each actor carries out their part of the collaborative activity which in turn satisfies the shared goal. The third obligation arises in this learning scenario by the sharing of the actual Netstrat software to compete for the Market Shares. This *sharing of a resource to complete an activity* is not illustrated in [Fig. 4]. The last obligation is illustrated in [Fig. 4] by *the shared team activity* "SG-x,Tx: develop global vision & strategy" *production of the concepts/resources* "shared vision" and "team strategy".

Another aspect of this learning scenario that is worth noting is that there are both collaborative and competitive interdependencies and they are interlaced within each other. The *collaborative shared goal* "A,I,S: to have all students experience a competitive market though a simulation game" is achieved by a *collaborative shared activity* "A,I,S: participating in Netstrat simulation" which includes a *competitive shared goal* "SG-x: competing for Market Shares" which comprises *collaborative shared activities* "SG-xTx: team building" and "SG-x: inter-team dynamics building".

6. Conclusions

Beyond the issues of reliability of computer communications and services, it critical for collaborative telelearning that environments possess the knowledge as well as the ability to orchestrate and support collaboration. The analysis of actor interdependence in collaborative telelearning scenarios has been the first step in the process of defining this knowledge. In the Norwegian project OCTA, we are proceeding to identify coordination processes to manage the interdependencies between actors and to determine how to mediate these within a collaborative telelearning environment. Fjuk's analytic framework [Fjuk 1995] that has a foundation in activity theory [Leontiev 1975] and integrates elements from CSCW/CSCL, situated learning and problem-oriented project pedagogy, provides a basis for the design of our investigations and evaluations in OCTA. In an activity theory approach to human interaction the unit of analysis is extended to include a social dimension where individual interactions are analysed as part of a collective activity. Furthermore, activity theory is especially strong in emphasising the role a mediating tool (e.g. a computer system) plays in this web of human activities and stresses that it must be seen in the context of the entire learning environment within which it will be used [Wasson 1996].

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Teaching and Learning with Flexible Hypermedia Learning Environments

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Abstract: Hypermedia systems may be used for different purposes. However, in order to be used for teaching and learning purposes they have to be designed in a comprehensive manner taking into consideration features considered as crucial for flexible HMLE. In outlining these features we will follow a conceptual model for describing computer-based systems. We then present our approach to apply this theoretical framework and to create a layered model of an hypermedia system, called HyperDisc, which served as a guideline for further conception and development activities.

1. Introduction

In information society lifelong learning is essential. People of all ages have to cope with an ever increasing complexity of subject matters as well as multiple formats of subject-matter representations. There is a need for just-in-time self-regulated, open and flexible access to world-wide distributed information as well as the need for flexible use of this information according to the individual´s own study interests. Thus open and flexible teaching/learning environments as well as subject-matter representations which may support individual study interests effectively are becoming more and more important. Hypermedia Learning Environments (HMLE) are attributed to have a great potential in fullfilling the above mentioned requirements.

A review of empirical studies shows, that initial optimistic views on the efficacy of HMLE have to give way to a more realistic view [Rouet 1992]. Several other reviews revealed that existing hypermedia systems as well as empirical research often suffer from theoretical, conceptual and methodological shortcomings [Tergan 1997 a,b,c]. It is claimed that in many cases hypermedia environments have not been designed and used appropriately to foster learning. This is why Jacobsen [Jacobsen 1994] and Tergan [Tergan 1998] strongly argue for a closer link of theory to design, research and application in real instructional settings.

In the present paper some of the problems mentioned are addressed. In the first part the empirical background is discussed. Deficiencies of existing systems are outlined briefly. The second part deals with requirements for the design of HMLE. In the third part of the paper we present our program HyperDisc as an example of a HMLE which has been developed at the German Institute for Research on Distance Education as a prototype to cope with design requirements outlined for fostering open and flexible learning.

2. Empirical background

The first ten years of hypermedia use and research have been inspired by some basic expectations and theoretical assumptions concerning the global efficacy of these systems in promoting knowledge acquisition and information retrieval. For example, some researchers have argued that basic structural and functional features of hypertext/hypermedia-technology match very well with cognitive network theories of the human mind, constructivist principles of learning and multiple mental modes for representation of knowledge. The assumptions draw back on the potential of hypertext/hypermedia to represent subject-matter content in a non-linear fashion, to enable flexible information access and self-regulated learning, and to represent a subject matter from different views and in different symbol systems.

The suggested match has nourished expectations that hypertext-based technologies may overcome deficiencies inherent in the traditional reading comprehension and information processing approach of teaching and learning and may even revolutionize learning [Jonassen 1986, Landow 1990]. It has been claimed that hypermedia technology may overcome some of the limitations of the traditional database approach for information retrieval [Marchionini 1995].

Meanwhile the initial enthusiasm concerning the potential of hypermedia for promoting learning has given way to a more realistic view. Reviews concerning the empirical evidence of the suggested potential of hypermedia for fostering learning and information retrieval have revealed both disappointing and encouraging results [e.g. Rouet 1992]. The results indicate that learning based on hypertext and hypermedia on the one hand may lead to navigational and conceptual disorientation and is often less effective then learning with traditional media, as is shown in comparative studies [e.g. Gordon et al. 1988]. On the other hand the results indicate that learning with hypermedia may contribute to enhance learning and contribute to cognitive flexibility when the learning environment is designed taskappropriately and when it is used by learners with appropriate learning competencies in a flexible manner [Spiro et al. 1991, Rouet 1992].

Tergan [1997 a,b,c] has analysed the theoretical, instructional and methodological conditions which may be of relevance for explaining failures and successes in using (capitalizing on) the potentials of hypermedia for enhancing learning. His review on the validity of theoretical assumptions concerning the global efficiency of hypertext/hypermedia supports the suggestion that the theoretical rationale of most of the approaches has been primarily led by technology-based enthusiasm on the potential of hypertext/hypermedia to enable and support learning [see also Spiro et al. 1991]. From an instructional design point of view it is criticized that the rationales for hypertext/hypermedia design have not always been tailored taskadequately and have disregarded conditions of effective learning in instructional contexts [Tergan 1997 b]. It is claimed that because of the inadequate tailoring of hypertext/hypermedia design and an inappropriate match between the inherent potential of a system to support certain learning functions and the criteria used for assessing learning effectiveness, the potential of certain types of systems for supporting particular aspects of learning may have been underestimated.

Tergan [1997c] draws attention to empirical results and the central claim of cognitive psychology that effectivity of learning with the help of a technology is the result of a complex interaction of constraining conditions on the side of the learner (e.g. level of learning, study interests, motivation), instructional methods to support learners in task appropriate processing (e.g. modeling, coaching, scaffolding), attributes of the learning material (structure, complexity, formats of representation) and the media used (e.g. interactivity, accessability of information elements, potential for multiple coding formats). It also depends on situational constraints like authenticity of the learning situation, embeddedness in an overall instructional approach, etc.

3. Design features

Hypermedia systems may be used for different purposes. However, in order to be used for teaching and learning purposes they have to be designed in a comprehensive manner taking into consideration features considered as crucial for flexible HMLE. In outlining these features we will follow a conceptual model for describing computer-based systems [Tergan, Mandl and Hron 1992]. Basic components of this model are the learner component, the subject matter component, the pedagogic-didactic component, and the information technology component.

3.1 Learner component

All learners do have their individual characteristics concerning motivation, cognitive abilities, and preknowledge, which have to be taken into consideration. Such an important factor is the learning strategy. Three main types of learning strategies in hypermedia-systems are postulated for improving learning [Astleitner and Leutner 1995], based on results in an exploratory study in which three component processes were identified (attaining a temporarily activated goal, ensuring spatial orientation, aquiring knowledge). The authors differentiate these further into eleven substrategies (i.e. use filtering, neighborhood exploration, and zooming as general methods for successful goal attainment; use nodes with landmark-quality for better orientation).

In spite of the lack of empirical data on the effect of these strategies on "learning" with hypermedia, it seems most important to offer a wide range of orientation and navigation features, in order to support most of the conceivable strategies and to give the learners a real choice. Within the learning process the learners thus can be encouraged to change their strategies, according to task and training.

3.2 Subject matter component

Subject matters are not only increasingly complex but also change rapidly in many fields. HMLE, dealing with such complex subject matter and providing for flexibility in learning topics and extensive contents, have to be open for continuing completion and updating. This presupposes an open structure, allowing successive addition of new nodes and links. By now, this may be accomplished - at least to some extent - by directly accessing the WorldWideWeb, which has hypertextual elements itself. In the same manner application programs can be linked to the HMLE, thus enabling the learners to apply newly aquired (procedural) knowledge in real tasks with common tools.

Nonlinear use of the material should be stimulated by optional visits of nodes with additional information. They can be made available to the learners by filters or tours, thus highlighting different aspects and enabling different approaches. The relevance of the nodes within special filters or tours should be elucidated with annotations.

3.3 Pedagogic-didactic component

There are roughly three modes in which information technology resources can be used in teaching and learning:

Expository learning activities involve the learners in working through information presented at an appropriate level by a teacher.
Exploratory learning activities involve the learners in exploring ideas about a topic presented by someone else (teacher or expert), where the ideas may often be quite different from the learner´s ideas.
Expressive learning activities involve the learners in expressing their own ideas [Mellar et al. 1994].

In many situations these modes can overlap. As Mellar et al. point out in the case of simulation and modelling, it is possible to use the respective tools both in an exploratory and expressive mode of learning. With appropriate design features, we think HLMEs now can support all three modes, thus giving teachers and learners maximum flexibility. The different modes of using HMLE all depend on easy and successful orientation and navigation within the information base. It is therefore crucial that the structure of the material is made explicit, using textual or graphical browsers to visualize the individual learning path, the result of a query, the context of the present location etc.

3.4 Information technology component

As HMLE cannot be designed for a limited group with precisely described cognitive abilities - not least due to economic reasons - we need HMLE which are adaptable to various target groups and which allow the application of different learning strategies, thus optimizing the development efforts [Valcke and Vuist 1995). These requirements have repercussion even on the architecture of such systems and must be taken into consideration in all phases of development.

Our prototypical HMLE HyperDisc demonstrates the close relationship between the results of an extensive analysis of the conceptual model components and our design decisions concerning the structuring the information base, representation, layout and screen design, the integration of additional materials, help functions and communication tools. In the following we can only exemplify this with the support functions for expository, exploratory and expressive learning activities.

4. HyperDisc - a prototypical flexible HMLE

4.1 Expository learning activities

The contents within HyperDisc can be structured to support the different prerequisites, preferences and goals of the users. A critical factor is the user with little prior knowledge and little HMLE experience in general with the need for particular support. In this case expository adaptation of the content is a central approach which is implemented by arranging a subset of pages sequentially. HyperDisc covers three types of sequences:

Standard Tour: This tool is made for beginners and allows them a fast overview of the content. The most important pages are collected, annotated and presented as an item list.
Extra Tours: Authors may compile many annotated sequences to condense subjects or reorganise them in their sequences. Implicit connections can be made more explicit.
Sequenced hierarchy: Whereas standard tour and extra tours are excerpts of the content hierarchy here all pages can be read one after the other.

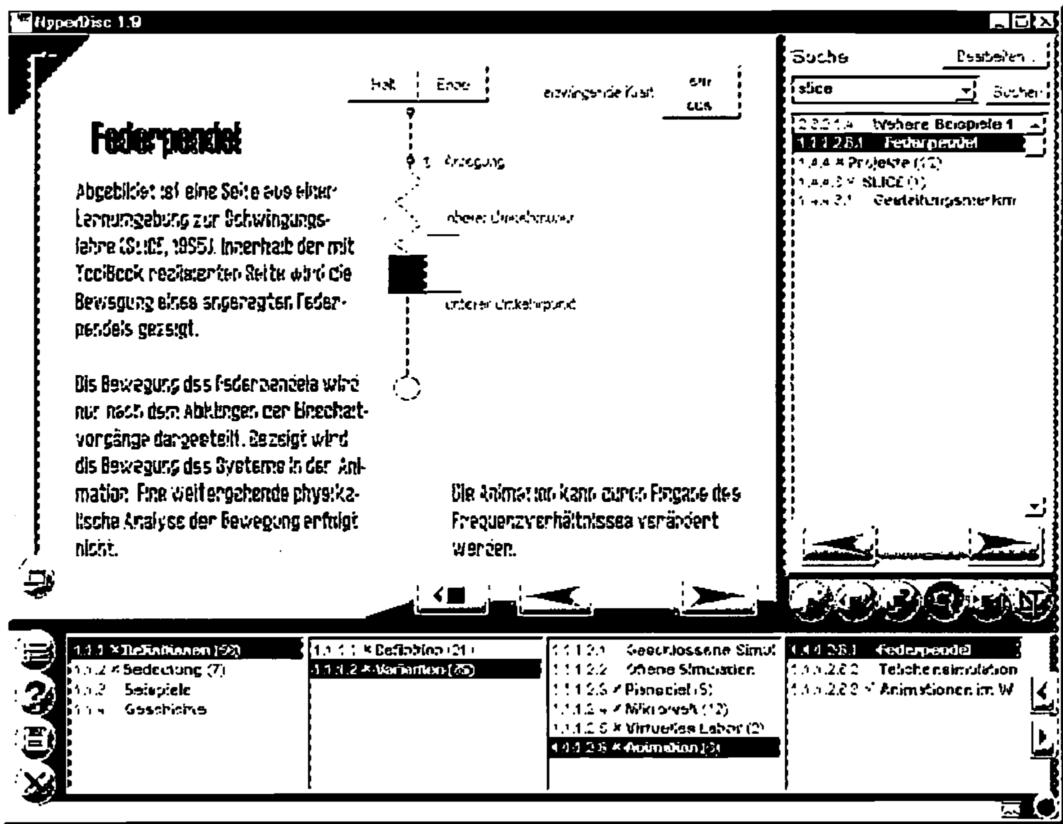

Figure 1: Main screen of HyperDisc. On the upper left is the presentation of the learning material (the example is taken from the chapter on simulation, describing the interactive animation of a pendulum). On the right the tools, which can be switched:, tours, history, bookmarks and the search utility (currently shown). Below the hierarcical browser, showing the context of the page.

4.2 Exploratory learning activities

Of course users may deviate from the tours at any time and e.g. switch to a more explorative mode of learning. Four types of structure, respectively tools, are offered for this case:

Hierarchy: All available pages are arranged hierarchically and are represented in first-order fisheye view in the browser.

Hyperlinks: Located within the text body and popups.
Cross-references: Optionally shown in a seperate menu.
Search: An easy-to-use fulltext search system in which index terms can be used.
History: Running automativcally over subsequent sessions.
Filters: Lists of highlighted pages according to the objective (without having to work through them in a certain sequence).

In order to support self-regulated flexible access to information, information seeking and the associated navigational strategies browsing and searching [Marchionini 1995] play an important role. Existing HMLE present both features without integrating them closely in the manner of Marchionini. However, this integration seems to be most relevant because these processes complement each other, altering permanently and unpredictably due to the changing knowledge and goals of the user during the localisation and learning activities.

As a consequence, corresponding tools and structure representations may be used parallel in HyperDisc on the one hand and on the other hand search results are integrated into all link anchors across the system by displaying different colors and little icons (small hooks and crosses). A particular status within this procedure is ascribed to the browser which allows the restriction of the search results using the hierarchical structure. On the other side, beginning with a single found item, its context may be re-established leading to a quick assessment of its relevance.

This principle of structural overlapping is applicable to all linear structures in HyperDisc, e.g. an extra tour may be used for filtering the hierarchy. This procedure is implemented consistently across the system and allows for drilling down information effectively .

4.3 Expressive learning activities

These learning activities - either performed in parallel or following explorative behaviors - will be supported by:

Bookmark and annotation facilities: According to the rationale of tours, the bookmark-function allows for gathering information and annotations according to definable categories.
Restructuring facilities: Advanced users may switch into the authoring mode in order to reorganize the hypermedia basis for individual needs, e.g. adding links, building up alternative hierarchies (multitrees) designing an individual tour.
Creating and integrating new contents: With the help of an extra editor new content nodes of ToolBook-pages may be generated and implemented into the database of the HyperDisc. In a similar way the links to the WWW may be supplemented.

4.4. Openness

The possibility to integrate and create new contents shows the openness of HyperDisc in terms of subject-matter content. This openness is realized technically by distinguishing three components: the content-nodes, the structure of content and the integrating shell itself. All components may be altered independently. Content-nodes in the authoring mode can be generated by providing the users with a standard Toolbook utility. Thus content nodes as well as multimedia components and external programs can be supplemented with contents of WWW-pages, which may be accessed on-line.

5. Perspectives

HyperDisc can be used to incorporate any topic for hypertextual and multimedia presentation. Our first application is training material for students, decision makers and developers in the field of new educational media. At present HyperDisc Version 1.0 is available, including parts on "Simulation and Modelling" and

"Hypertext/Hypermedia". Additional parts are planned. These versions will be available in 1998 as well as several tools to develop the HyperDisc-applications.

HyperDisc serves as material for our research. We will evaluate the use of Version 1.0 in a distance education course "New Educational Media", run by the Fachhochschule Furtwangen in 1997/98. Evaluative results will be available in mid 1998. In addition we are planning controlled experiments with variants of HyperDisc to investigate the use of different navigational tools in problem solving situations.

Additional information on concept, implementation and availability of HyperDisc can be found at: *http://www.uni-tuebingen.de/uni/dii/A1/hyperdisc/besch/s2.htm*

Comments and critiques are welcome in our discussion forum at: *news://news.diff.uni-tuebingen.de/hyperdisc.**

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"Campus" - an Agent-based Platform for Distance Education

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Abstract: *Campus* supports the communication and co-operation between a distance teaching university and its students in an Internet environment. While students usually connect quite rarely to the Internet, they can continuously be represented in the Internet by their individual autonomous agents which can fulfil a variety of tasks for their owners. *Campus* is being implemented with the help of the Agent Application Programming Interface (AAPI) package. AAPI is an extension of the Java Class Hierarchy and has been developed at the University of Hagen; it supports the design and implementation of systems of mobile, autonomous agents and is based upon decentralised control structures. Derived from the AAPI package, Campus offers a variety of *Campus Intercommunication Agents*.

1 Introduction

The University of Hagen is a distance teaching university with about 55.000 students, most of them spread all over Germany, some of them even over the whole world. Most of these students have access to the Internet, but because of connection costs are linked to the Internet just for short intervals. *Campus* provides an environment in which students are continuously represented by their own personalised, autonomous agents which can fulfil a variety of information, communication, planning and co-operation tasks on behalf of their owners. Each student runs on her computer a *Campus* environment, populated with several Campus Intercommunication Agents (*CIAgents*). The student charges her agent with a list of tasks, briefly connects to the Internet, releases the agent to the network, and disconnects again. According to their tasks, the agents migrate through the network, collect information for their owners, communicate and co-operate with other agents, until they are finally picked up again by their owners as soon as they reconnect to the network. Thus, while students are just rarely connected to the network, their agents can continuously represent them in the network. Beside minimising the student access times to the network, co-operation and communication between agents may stimulate co-operation and communication between students as well. *Campus* and its services are dealt with in more detail in chapter 4. Compared with the traditional server/client paradigm, mobile, autonomous agents in general show several essential advantages: transporting the algorithms to the data and substituting global network-wide communication and co-operation by local communication and co-operation may significantly reduce communication costs and the amount of network resources needed. On the other hand, security, authentication and accounting problems have to be solved for agent systems. *Campus* is being implemented as an agent application on top of the Agent Application Programming Interface (AAPI) package.
In the following chapters, we briefly survey existing mobile agent systems, describe the basic concepts of the AAPI package, introduce *Campus* in some more detail, and conclude with some ideas on future work.

2 Survey of Mobile Agent-Systems

This chapter gives a brief survey of some existing mobile agent system environments. The java-based *Aglet* workbench of IBM [IBM 96] is an extension of mobile java applets. Similar to an applet, an aglet's binary code migrates through the network, but in contrast to an applet, the state of an aglet is transported together with the aglet. States are defined in terms of creation, migration, activation, deactivation and termination events. For each state, the aglet workbench offers the aglet programmer adequate sets of methods. Global and local communication between aglets is realised via the communication mechanisms *Remote Procedure Call* (RPC) and *message passing*. In both cases, aglets have to create so-called *Aglet-Proxies*. These are the aglets' communication stations which also protect aglets from unauthorised manipulation.
Agent Tcl [Kotz et al. 96],[Gray et al. 96] is a mobile agent-system which was developed at the Dartmouth College.

Agents are realised in Agent Tcl, an extension of the scripting language *Tool command language* (Tcl). For communication between agents, Agent Tcl uses the *Agent Remote Procedure Call* (ARPC) or a paging mechanism. To work under non-permanent network connections, Agent Tcl contains the *Laptop Docking System*, which assigns every Laptop a permanent docking computer. When the Laptop is not connected to the network, the docking computer serves as target for the agent. Security services, based on Safe Tcl, protect a computer from malicious agents. Security services to protect agents against malicious environments have not been realised yet.
Mole [Straßer et al. 96],[Hohl 95] is the prototype of an agent system. Stationary *System-Agents* manage the resources and services of one place (set of computers). If mobile *User Agents* visit these places, the *System Agent* assigns special resources or services to these *User Agents*. Mole supports local and global communication [Röhrle et al. 96] with RPC and message passing mechanisms. If an agent wants to communicate globally, it sends its message to a central *Mailbox Agent*, which forwards the message to the other partner.
JAE (Java Agent Environment) [Park et al. 97] has been drafted at the technical University Aachen. JAE focusses on the integration of wireless (e.g. mobile phone) and Internet agent technologies. JAE introduces the concept for Personal Digital Assistants (PDA). JAE distinguishes between *agent servers*, *mobile agents* and *stationary service agents*. A computer based agent server provides an environment for incoming mobile agents, and is supported by service agents. Only mobile agents can leave a computer and travel to another computer. Additional approaches can be found in [Li et al. 96].

All the described agent systems are based upon a central architecture, i.e. one or more servers have to be permanently active and reachable. To avoid bottlenecks and problems with server failures, as well as to gain general experiences with decentralised architectures, the AAPI package is, following the basic Internet paradigm, uncompromisingly based upon a decentralised approach. [Tab.1] compares the described systems and the AAPI package approach:

	IBM Aglets	*Agent Tcl*	*Mole*	*JAE*	*AAPI*
agent migration	+	+	+	+	+
state-of-life-API	+				+
local communication	+	+	+	+	+
global communication	+	+	(+)	+	+
security for the agent	+				
security for the computer		+		+	(+)
non-permament connections	+	+		(+)	+
decentral IP-management					+
authentification					(+)
accounting					(+)
platform independency	+		+	+	+

(+) *:= (planned) quality of the agent-system*

Table 1: *Properties of mobile agent systems*

3 The AAPI Package

The runtime environment for an agent is called an active *context*. Except when migrating between contexts, agents are always embedded in a context. A context can:

- *start and ship its own agents;*
- *dock (i.e. receive, start and ship) foreign, travelling agents;*
- *synchronise several running agents;*
- *communicate with its own travelling agents;*
- *support communication with foreign agents in foreign contexts;*

The agent's statical *profile* is defined by a set of *attributes*, e.g. identifier, creation date, owner, task description, etc.
When the context starts one of its own agents, it defines an initial *route* for the agent's tour through the Internet. Such a route may be a simple list or, e.g., a complex path graph of Internet addresses. During its journey, the agent can extend its initial route.
If the agent wants to move from one context to another, the binary-code of the agent has to be sent together with its profile and route.
Agent, profile, route and binary code are represented as objects which are linked to each other. At the stage of migration, they change their representations into data-streams and, via its Internet address, move to the next site on the agent's route [Fig.1].

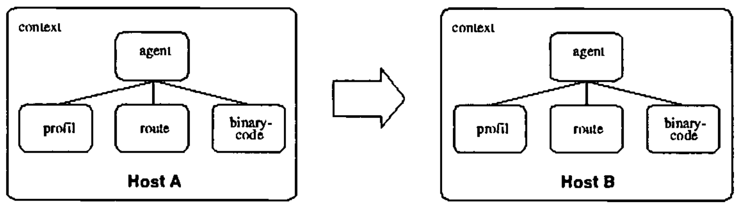

Figure 1: *Migration of an AAPI agent*

Agents working in the same context are represented as parallel threads. They can communicate and co-operate with each other via *ComObjects*. When an agent wants to start a communication with a parallel agent, it creates a ComObject for this agent, which beside the message may contain algorithms in form of binary code to be executed by the other agent. It may also contain structured containers for results. Within its thread, each agent is continuously looking for ComObjects another agent has created for it. Communication between agents across different contexts in different computers works in a similar way. The agent creates a ComObject in its context and sends this object to the context of the target agent, which in turn executes the requested tasks and sends the results back.

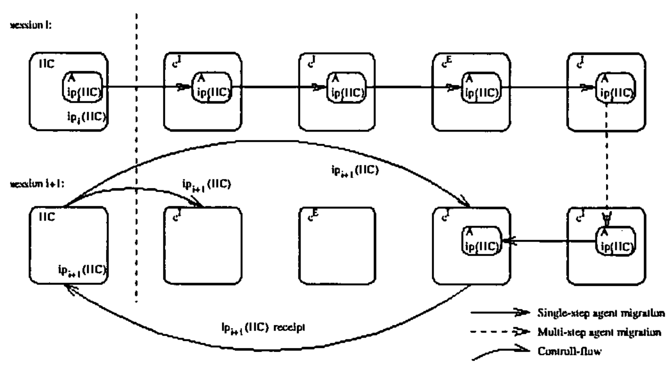

Figure 2: *Reverse routing*

The Internet address of its owning context always defines the last station in an agent's route. As mentioned before, our students' computers are quite rarely linked to the network and may get assigned different Internet addresses for different sessions. In such a case an agent cannot find home and present its results to its owner. The following algorithm solves this problem [Fig.2]: whenever the home context (HC) of an agent changes its Internet address from $ip_i(HC)$ to $ip_{i+1}(HC)$, it immediately informs all contexts c^I on the agent's reverse initial route until it finds the context where the agent is actually working in. This context changes the target station in the agent's route

accordingly and confirms the successful change to the agent's home context.
If the agent has extended its initial route and is actually working in a context c^E that is part of the route extension, the home context can't inform the agent about a changed internet adress. In this case, after the agent has finished working on the extended contexts, the agent migrates to an active context of its initial route, to wait for information of its home context. Here the agent can be reached again, to change the target station in its agent's route.

This reverse routing algorithm assumes that the home context can reach its agent. There are several reasons why a home context may not be able to reach its agent A:

- *unavailability of **A** during the migration;*
- *regular termination of **A's** actual working context;*
- *irregular termination of **A's** actual working context;*
- *interrupted connection to **A's** actual working context;*
- *Agent **A** is working in a context c^E;*

While the first case can be solved by handling the migration of an agent as an atomic operation [Mira da Silva et al. 97],[Klar 96],[Westhoff 97], the second one can be handled by enforcing contexts not to close as long as they contain active agents. The last three cases can only be handled by restarting the reverse routing algorithm after a certain time-out.

The above algorithm assumes that only the home computer of an agent may get disconnected from the network and change its Internet address. We are presently working on an extension of the above algorithm which allows arbitrary computers to change their Internet addresses and to inform all interested computers in the network. To strictly follow the agent paradigm, even short messages between contexts are modelled as agents.
The classes and methods of the AAPI package realise a basic mobile agent, i.e. they support an agent's creation, travelling, working, self-copying and termination. More advanced agents can easily be defined within the AAPI environment by simply overwriting the corresponding methods. Details on the AAPI package and how to use it can be found in [Westhoff 97].

4 Campus

While lecturers as well as all university institutions are almost permanently connected to the Internet with constant Internet addresses, most of the students are quite rarely connected to the Internet; their Internet addresses may change between sessions. Thus within *Campus* we model a two layered network [Fig.3], the outer layer containing all computers which are rarely connected to the network, the inner layer containing computers which are almost permanently connected to the network.
Address changes of computers in the outer layer are not reported to other computers; Address changes in the inner layer are immediately reported to all computers in the inner layer, as well as through their agents to computers in the outer layer as well. Computers in the outer layer send their agents to computers in the inner layer, let them perform their tasks and pick them up again, if necessary via reverse routing. The inner layer provides various service, information and chat 'booths', where agents on behalf of their owners can, e.g.,

- *retrieve actual information from libraries, search machines, faculties' and registrar's blackboards;*
- *exchange information with other agents;*
- *search for individual agents;*
- *co-operate with other agents in setting up individual working groups;*
- *enrol their owners into existing working groups;*
- *arrange dates between their owners;*

Each of these 'booths' contains one context where travelling agents can dock. We are presently developing a

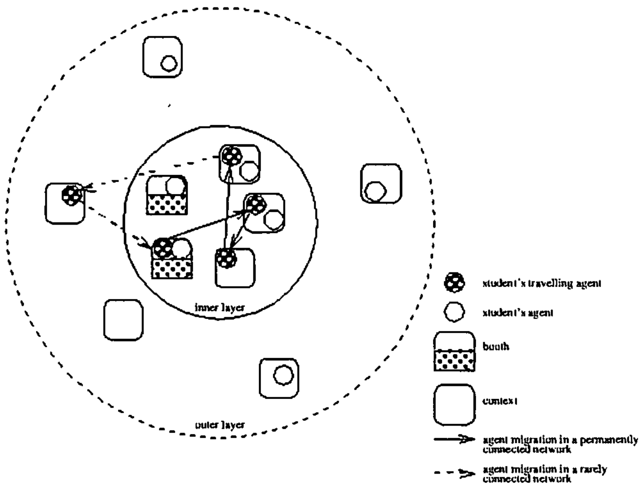

Figure 3: *The two layered network of Campus*

variety of protocols for communication and co-operation between agents and booths.
Campus contains several types of *CIAgents*. They are all derived from the basic agent type of the AAPI package. [Fig.4] depicts the CIAgents' docking- and its route window:

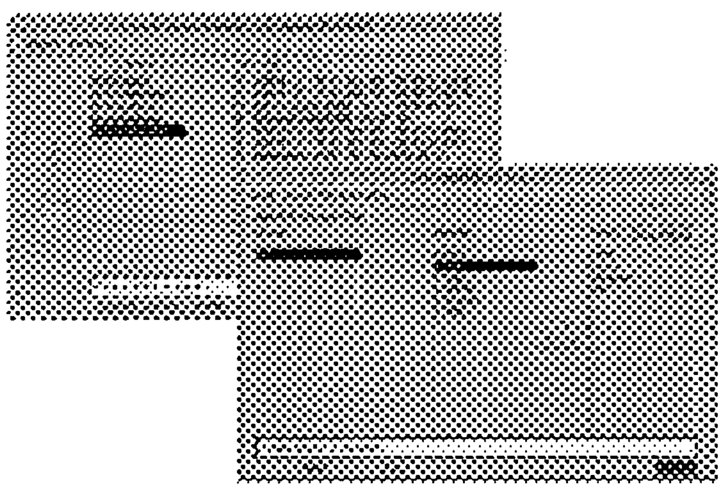

Figure 4: *The CIAgents' docking- and route-window*

The docking window is divided into the boxes *My-CIAgent* and *Docking*. The My-CIAgent box lists the student's personal CIAgents and the docking box gives a view of all the agents that are either working or resting on the student's context. In the *Campus*' route window the student can compose routes for her My-CIAgents, e.g. by selecting members of her learning groups.

5 Conclusion and Future Work

The AAPI package provides a comfortable and easy to use high level interface to implement systems of individual, mobile, autonomous agents in the Internet. It supports decentralised control architectures. With the help of the

AAPI package *Campus* is being realised, a platform that, through a variety of different types of agents supports communication and co-operation between a distance teaching university and its students.
Beside the definition of various protocols for inter agent communication and co-operation, security and authentication problems will be our major future concern: runtime environments have to be secured against malicious agents, agents have to be secured against their embedding environments; secure authentication methods have to be developed. Further more, appropriate accounting mechanisms are needed.

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Critical Practice in the Use of Listservs: A Case Study[1]

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Abstract: This study focuses upon the use made of two separate listservs for professional development—Oz-Teachers and UK-Schools. Both lists are used by teachers in Australia and the United Kingdom, as well as by teachers across the globe, to communicate electronically with each other. The practice of this communication is typically characterised by text messages that pose questions or offer answers; by 'threads' of discussion based around single or combined themes; and by statements of information. In this context, two windows are opened in this study: one shows a dynamic picture of teachers at work and play in the technology of listservs, developing skills and practices in asynchronous communications. The other looks into the content of many of the postings, demonstrating the practices, views, ideas and concerns teachers have with using technology in traditional school and classroom environments. This paper serves to provide an overview of the study, whilst a more detailed report can be found elsewhere (Lankshear, et al., 1997).

1. The net effect

As a global communications network, the Internet provides a range of possibilities for educational use. These are summarised in Table 1. Email is a technology based on the Internet, providing for the sending and receiving of text–based messages as personal communications. A listserv offers a facility for asynchronous email communications between members of a group connected by virtue of a common interest or affiliation, providing a means for public dialogue. The Web is a set of electronic protocols to access and publish information—in the form of hypermedia as well as text documents.

The Internet is, paradoxically, both a physical and virtual embodiment of computers and people. In particular, it is a social construction, where people live, play and work. A listserv is a commonly available Internet technology that provides a computer–mediated forum (a list) for written dialogue in the form of messages or 'posts'. To participate in a list you have to apply to become a member; instructions for both joining a list and managing your activity once a member are similar across most lists—in particular, there is a commonly shared but largely informal set of rules for participation (a 'netiquette').

Table 1: Internet functions

Internet function	Characterisation	Activity
Email	one-to-one messages	personal communication
List(serve)s	one-to-many communication	public dialogue
World Wide Web	information resource	inquiry; publishing

These rules are generally learned by experience, observation and from direct advice; they can also be sighted, in some lists, by reference to an electronic archive set aside for such information by the list owner or originator. A list can function in either unmoderated or moderated forms—a moderated list is one where

[1] This study was conducted as part of a larger research project investigating the interaction of literacy and technology in education, and was funded under the Australian Language and Literacy Policy (Children's Literacy National Projects) initiative, Department of Employment, Education, Training and Youth Affairs, (DEETYA), Federal government of Australia.

messages are subject to vetting by the list owner before being circulated on the list; whereas an unmoderated list allows all messages to be posted directly to the members of the list from someone other than the list owner.

2. Practice of communication

The act of posting messages to Oz-Teachers or UK-Schools falls largely into one of three major categories, corresponding to discussion or continuous dialogue between two or more list members (over at least four postings), the providing of information or the posing of a question. Within these categories, the content of messages may be either technical or educational in focus: technical content typically addresses the operation, function or application of various technologies; educational content is typically related to the practice, theory and administration of teaching and learning. Table 2 provides a guide to the application of this categorisation used in this investigation of Oz-Teachers and UK-Schools.

Of course, in a number of cases a posting can actually be classified across more than one category. In these instances, I categorised messages in terms of their main purpose, rather than subsidiary ones—although such an interpretation can never be entirely satisfactory, it does allow for building a reasonably robust framework for understanding the purpose, nature and content of messages posted to Oz-Teachers and UK-Schools.

Table 2: A categorisation of postings in terms of content

Category	Technical	Educational
Discussion (dialogue)	Four or more messages that address the same topic, usually using the same message header or title. Example themes include: the merits of web browsers; costs and availability of internet provider services; programming strategies in HTML; the best Internet software; the merits of the Windows95 operating system.	Four or more messages that address the same topic, usually using the same message header or title. Example themes include: preferred pedagogies for computer use; government support for computers in schools; using computers for second language learners; teachers as technicians; the value of a computer curriculum; teaching keyboarding.
Information	Single messages describing information of use, either as an answer to a list question, or without premise. Examples include: how to optimise use of a software item, such as Netscape; how to set up an electronic communications network in a school; publicly directing a 'flame' to a commercial message sender who posted to Oz-Teachers.	Single messages describing information of use, either as an answer to a list question, or without premise. Examples include: educational resources available, such as an on line project (eg. Bookrap) or Web site reference (URL); opportunities to get involved in educational (usually on line) projects; lists for discussion of 'subjects other than IT'.
Question	Single messages which pose a question that may lead to a discussion thread, a single answer, or perhaps a set of discrete answers. Examples include: how to set up use of a single modem with a network of computers; how to decode ZIP files; choosing an appropriate laptop computer; choosing hardware to run Windows NT operating system; evidence to support a teacher's request for air conditioning a computer room.	Single messages which pose a question that may lead to a discussion thread, a single answer, or perhaps a set of discrete answers. Examples include: professional development opportunities for teachers in rural schools; survey questionnaires (eg. the number and type of amusement parks visited by teachers and students); government policy on on–line education.

3. Research methods

Investigation into both Oz-Teachers and UK-Schools has been conducted by the collection and content analysis of postings made to each of these lists. To undertake this work, I became a member of each list and collected postings made over a 12 month period, ending in July 1997. A purposeful selection of these postings were then analysed using a content analysis methodology, providing data on numbers of postings, their authorship, and their 'thread'—that is, the discussion they may have initiated or contributed to. In addition, I conducted a small number of interviews, by email, with a selection of members who had made at least two meaningful postings to the list, to obtain data such as reasons for membership, how the list is used, and perceived value of the list. I also interviewed a smaller number of members who had not sent any messages to the lists. I interviewed 15 members of UK-Schools (2.6% of total current membership), and 12 members of Oz-Teachers (1.1% of total current membership)—this included 4 from UK-Schools and 4 from Oz-Teachers, who had not posted messages to their respective lists. I also collected documentation relevant to the lists, that reside on associated Web sites: http://owl.qut.edu.au/oz-teachernet/; http://www.mailbase.ac.uk/lists/uk-schools/

These Web sites also provided access to archives of list postings.

4. Lists in context

UK-Schools and Oz-Teachers are localised approaches to the use of global communications networks for professional development of teachers. Both lists are examples of early attempts to bring teachers into a growing debate centred on the practice and to a lesser extent, the theory of using new technologies in school education. The lists are by their nature, dynamic—membership and topics of discussion change constantly, and their development reflects something of a maturation process. In particular, membership to Oz-Teachers seems currently to have reached something of a plateau (at about 1050 subscribers); whilst the number of postings made to both lists has fluctuated over the period of the investigation (see Table 3). Indeed, a maturation process in both UK-Schools and Oz-Teachers is probably the defining characteristic in the amount and type of postings carried, and this does not seem to be influenced by the numbers of members of these lists.

It would seem that the maturation process in these lists have certain identifiable aspects. For example, maturation includes a growth in the core of membership—those members who maintain an active interest in the list, by either making postings to the list on a regular basis, or who repeatedly use the list for professional activities, such as resourcing teaching, or for references to curriculum projects or for posing questions. At the same time, one sees a constantly changing peripheral membership—those who join for a short time and then leave, or those who join but make little on–going use of the list. Some of the latter includes university students who are pursuing studies in education, who are evidently encouraged to join by their lecturers (who are presumably members of the relevant list) or perhaps by fellow students, but who make little or no use of the lists thereafter. This phenomenon seems to be especially true for Oz-Teachers.

Furthermore, maturation also includes developments in the so–called 'lurker' population. Lurkers are members who make use of the lists by reading postings but who do not make postings themselves. The act of lurking is really a passive use of the list, with lurking apparently being a preferred way of working with or using lists for large numbers of members. Whilst not all list members wish to post messages to the list, most of these still use the list for professional reasons—obtaining information, keeping abreast of issues and dialogue and using references to projects, ideas and literature given in postings. Lurking is not necessarily a mark of immature members (ie. those who don't yet have the necessary confidence to make a posting) but rather a preferred approach to apprenticing oneself to the culture of a list; and whilst some members remain lurkers for prolonged even indefinite periods, others perhaps begin to make postings on a regular or occasional basis. Importantly, however, lurking is not to be seen simplistically as a behaviour of naive list members; and neither is the dichotomy between active and passive users of a list a static picture—it is dynamic, and movement between activity and non–activity for many individual list users is very fluid.

Interestingly, in both UK-Schools and Oz-Teachers but especially in the latter, members are actively encouraged to make postings. Active members appear to assume that passive use of a list is a sign of immaturity and that all list members should become active—in fact, the list owner in Oz-Teachers advises all new members that an introductory message is expected of all those joining the list. There is it seems, no justification for this: the passive members interviewed from both lists indicated, without exception, that they gained value from their membership of the list without feeling it necessary to make postings. Further, all admitted to feeling anxious about making a posting but said that they were likely to do so. Interestingly, a majority of interviewees felt there was some pressure from other list members to make a posting and that this heightened their anxiety about doing so.

Maturation in list activity can also be seen in the content of list postings, where messages of a trivial nature are tolerated less and occur less; and the form of messages increasingly follow the conventions dictated in general rules of 'netiquette', or those created by the list members or owner themselves, usually through practice but sometimes as part of a policy statement. Maturation might also be marked by the establishment of a list archive (which both Oz-Teachers and UK-Schools have) and/or a Frequently Asked Questions (FAQ) database, to which new members can be referred, to obtain information on subjects that have already been discussed or referenced on the list.

5. Lists as culture

Part of the conceptualisation in this study of Oz-Teachers and UK-Schools was that lists operate as communities or groups of people who have come together by virtue of an interest, affiliation or a more basic need or want. The notion of lists as communities is not new—indeed, it has been the basis for a range of studies of computer mediated communications (CMC) and is perhaps an obvious characterisation to infer (Lawley, 1994). Indeed, some of these studies have moved beyond the view of CMC as communities to describe them as cultures (Rheingold, 1993) but without a satisfactory exploration of what is meant by the use of the term, so that a culture can be seen to be different from a community.

What has clearly emerged from this study into Oz-Teachers and UK-Schools, is the notion that these lists do operate as cultures, where culture is something that is collectively created and resides, dynamically, in the constructed meanings of a particular community. In this sense, the culture of a list is generated by its membership through the meanings given to collective practices—the practices of a community. In another yet related sense, it has been possible to discern in both Oz-Teachers and UK-Schools, but particularly in the former, the operation of 'cultural capital', a term coined by Bourdieu (1988), where the capital of a culture is perceived to be that which is held to be of value, and which can be accumulated, earned and exchanged (Bourdieu, 1988). The capital within the cultures of Oz-Teachers and UK-Schools is that of expertise, experience and knowledge, and in the context of a variety of postings and dialogues on these lists, one witnesses the negotiation of cultural capital, and the clear divisions that occur between those with capital and those without it.

6. List activity

The activity of a list can be readily measured by accounting for the number of messages that it carries. The greater the volume of postings, the greater the activity of the list. More importantly, the more threads that occur in a list, the more opportunity there is for reflective and critical dialogue to occur—and it is in this type of dialogic activity that deeper involvement with knowledge can be found, where 'apparent conversational immediacy' is blended with 'tempered thought' (Haley-James, 1993 9), giving rise to what Haley–James has characterised as a 'metacommunicative' event (Haley-James, 1993 10). However, this is not to suggest that in all threads or dialogues, reflective and critical perspectives arise; indeed, an analysis of postings which constitute such threads on Oz-Teachers for example, would quickly demonstrate this is not the case. But there is an increased chance that these perspectives will be found, as part of a 'conversation' between two or more participants, and where there is an interaction between views, understandings and ideas on a single topic or theme. Indeed, this notion characterises previous findings from research into computer conferencing (Henri, 1992; Riel & Harasim, 1994), and underpins current assumptions about appropriate models of learning, especially for professional development (Schon, 1987), and teacher education (Hatton & Smith, 1995); and also for adult learners (Laurillard, 1993).

The relative activity in each of the lists, Oz-Teachers and UK-Schools for the period of this investigation is summarised in Table 3. The activity of Oz-Teachers is considerably and consistently greater than that of UK-Schools, a difference that is not adequately explained by the discrepancy in relative memberships (more members do not necessarily mean more postings). Even when we turn to an analysis of the relative proportions of total messages that occur on each of the lists as threads, or extended dialogue, the differences remain noticeable: dialogue occurs more frequently and in greater proportions on Oz-Teachers than on UK-Schools. It is possible then, although possibly dangerous, to suggest that Oz-Teachers works better as a community of learners within a professional development context, as a result of its heightened activities, but more importantly, because of the greater number of threads or dialogues that occur therein.

Table 3: List activity

	OZ-Teachers		UK-Schools	
Period	Messages	Threads	Messages	Threads
Jul-96	221	10	69	3
Aug-96	272	8	16	0
Sep-96	489	23	43	0
Oct-96	237	6	65	2
Nov-96	342	20	54	0
Dec-96	133	4	20	0
Jan-97	103	2	69	2
Feb-97	241	11	51	2
Mar-97	478	26	51	1
Apr-97	499	31	48	0
May-97	661	29	49	1
Jun-97	487	17	45	0

7. Conclusion

Oz-Teachers and UK-Schools are computer–mediated communities in the making, being shaped by the members of those communities. These virtual communities operate at a number of different levels—at the level of professional development, social grouping, resource and advice centre, political movement—and overarchingly as a Discourse, in the sense that Gee (1990) writes about discourse:

A Discourse is a sort of identity kit which comes complete with the appropriate costume and instructions on how to act, talk, and often write, so as to take on a particular social role that others will recognise... Discourses are ways of being in the world, or forms of life which integrate words, acts, values, beliefs, attitudes, social identities, as well as gestures, glances, body positions and clothes. (Gee, 1990 142)

The lists are both ostensibly about professional development, about teachers learning about aspects of teaching centred on the use of new technologies. But of course, they are much more than this—they operate by virtue of their membership, as communities, both in a sociological and a situated sense. Both Oz-Teachers and UK-Schools have their owners, key .members (the ones most visible and active, through frequent postings), moderating influences, power–plays, politics, rules (tacit and explicit), rule–keepers, core members, peripheral members and silent (passive) members. However, although these lists operate sociologically, they are more readily identifiable as communities of situated practice. For example, both lists have the indelible mark of practising teachers—they are used by teachers to talk and share with other teachers, issues fundamentally (but not always) concerned with using new technologies in classrooms. The culture created in these lists is the culture of teachers as professionals. But the two lists also have cultures of their own, each different to the other in small yet important ways, recognisable by the practices evident within each list. First time membership of either Oz-Teachers or UK-Schools clearly involves an apprenticeship, gradually acquiring the knowledge and skills of the particular practices within the list, using strategies such as observation, participation (interaction) and role playing, and finally becoming completely enculturated within the adopted practices. So, in this sense, we find in both lists the 'communities of practice' that Lave and Wenger (Lave & Wenger, 1990) describe in their conceptualisation of situated cognition.

By and large, discussion and information posted to both Oz-Teachers and UK-Schools has the effect of legitimising and informing, operationally, what occurs and what doesn't occur, in the name of technology use, and especially Internet use, in schools. In this sense the lists work well, providing useful communities within which teachers can work and play. They also function to induct teachers into the practices of computer mediated communication. In addition there are a range of postings where questions are raised regarding applications of educational technologies, from perspectives outside the immediate 'how–to' or 'what-to' pedagogical culture established in the list. This is to suggest not only that the lists provide the means for reflection and reflexive practice—many of the teachers interviewed suggested this was a strength of the lists, particularly those who were part of Oz-Teachers. In addition, however, some postings, usually those belonging to a thread, serve to reorientate the operational dialectic in the list, and establish a more critical perspective. However, these types of postings are certainly in a minority and sit somewhat uneasily amongst the majority.

There is a possibility in the use of listservs, to create vital, energetic and occasional communities for professional development activities, building curriculum and information resource libraries and facilitating informal communicative networks, serving the social, professional and personal needs of teachers. The type of lists investigated here are unmoderated, self–serving and self–censoring, and they appear to work well for a majority of the membership. Topics of postings and the willingness to engage them are decided by the membership, and both these things appear to fluctuate as a list community matures. In particular, such lists appear to generate some limited dialogue which displays elements of a critical perspective—a necessary precursor to developing serious, reflective, engagement with practices, theory and research that should accompany any professional development process.

Oz-Teachers and UK-Schools work well, for the most part, in their current form. However, there are other list formats that have been used to engender dialogue more purposefully—for example, lists have, for some time, been used as 'institutionally sanctioned spaces' as a component of undergraduate and graduate level university courses (Bakardjieva & Harasim, 1997 1121). Similarly, IT–Forum is a list which periodically publishes formal papers, specially written by leading academics in the field of instructional technology, to create a forum for discussion between members of the list and the author of the paper, over a (usually) two week period (Reiber, et al., 1997). In these contexts, dialogue is more structured and arguably provides for greater critical dialogic engagement with the texts of postings (Bakardjieva & Harasim, 1997; Harris & Wambeam, 1996). In this sense, it is reasonable to suppose that as a supplement to Oz-Teachers, one or more lists could be created that provide for more structured discourse. Certainly, this presents a promising professional development model to develop purposeful, new and virtual communities, that bridge the professional gaps that exist between traditional communities of practice.

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Multimedia and Hypermedia Publishing in Computer Science: Vision and Reality

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Abstract: Taking the example of an innovative textbook on algorithm design, we illustrate the problems to be faced in scientific electronic publishing within the context of open educational environments. The issues to be considered are in particular design considerations as well as what kind of media types and document formats should be incorporated. In the main section of this paper, the textbook's production process will be reviewed, which shows that the problems to be faced are due to a lack of author support.

1 Introduction

In the last few years, especially within the context of the popularization of the World Wide Web, numerous efforts have been undertaken to distribute electronically available publications via networks. For many technical areas, where documents are produced using text processing software, it seems reasonable to not only offer scientific publications as paperbound reports, but also to make them available as online texts for quick dissemination among the scientific community. A further step is to systematically offer online publications via digital libraries, including journals, reports, textbooks and others, and to make them searchable via the scientist's network browser. While it is important to provide an appropriate framework for distributed access to heterogeneous documents and databases, it is a challenge to produce high quality innovative multimedia textbooks for open environments, which can be easily used in varying contexts and for different purposes. We will discuss some of the considerations to take by reviewing the production process of a multimedia textbook on algorithm design. While some of the issues may be specific to this publications, we demonstrate that despite the technology available today, scientific multimedia publishing is still far from its possibilities.

2 Design considerations for knowledge-mediating courseware

In conventional educational scenarios, text has always been the main medium to transfer knowledge, whether written, as in the form of textbooks, or spoken, as in classroom teaching. Therefore, we decided to focus on both static and dynamic text-centered documents, namely scientific articles, involving graphics and diagrams, and lecture recordings, enhanced by animations, simulations and video clips. In the same way that pictures serve to illustrate certain concepts, the role of additional dynamic and interactive media may be described as a support to enhance comprehension. According to this, non-static media types were used only if they were able to illustrate certain principles in a more appropriate way than conventional media, namely printed text and diagrams.
It is well-known that the visualization of dynamic processes and the computer-based modeling of scientific experiments is a challenge, which makes it desirable to be able to re-use pre-existing modules, either self-developed or third-party, by integrating them into a piece of courseware. However, this is only possible in the context of open environments which minimize the constraints on combining heterogeneous media formats. By using a modular approach, individual components may also be re-used in other contexts.
While the logical structure of a printed publication, i. e. chapters, sections and paragraphs, is hierarchical and can be visualized as a tree, the relationship between the individual parts of a multimedia product may be arbitrarily complex, thus yielding a directed graph. The former is linearized by generating the hardcopy, where the table of contents illustrates the logical structure to the reader, whose orientation is thus guaranteed. In electronic publishing, the relation between individual modules is modelled by using hyperlinks, whose main role is, in analogy, to ensure the user's orientation. Structural references result from the publication's inherent structure, while logical

references emerge from the logical interdependencies of the individual modules. While hyperlinks may be helpful to associate specific parts of a publication, they may lead to disorientation. Graph visualization techniques, ranging from context-sensitive menus to fish-eye views [5] and three-dimensional representations [10] help the user in constructing a mental model of the structural and logical interdependencies, but as these become more complex, the user's cognitive abilities are exceeded. Therefore, we focused mainly on modelling structural links (see also section 4.4).

3 Media types and document formats

The decision to use specific media types in an electronic publication constraints the set of usable document formats, but does not determine it. As an example, the use of video clips may be in the form of QuickTime or MPEG movie files, or simulations may be implemented in C or Java. A general advice is to use platform-independent software, or document types for which appropriate viewers exist for multiple operating systems. In this section, we first propose a general classification of document formats, which is helpful in the process of document conversions. As textual documents are essential for knowledge transfer (see section 3.1), the problems in transferring documents to a suitable format for electronic publishing are exemplified for the case of static text. In the last paragraph, we discuss the issue of recording telepresentations, since they form an integral part of the multimedia textbook whose production process is described in more detail in section 4.

3.1 Primary and secondary document formats

We call media types that are directly generated as output from a specific software or typed into an editor *primary formats*. All other media types can be assumed to be generated by processing primary formats, or by using export filters in standard tools, e. g. PostScript or image filters. These are called *secondary formats* and are characterized by not being directly generated. In many cases, primary document formats are proprietary, such as Word, Excel, or PageMaker, and therefore cannot directly be created using standard editors, but require special tools, e. g. word processing software or drawing tools. As opposed to this, secondary media formats result from a conversion process from a *source format* to a *destination format*, as in the case of a LaTeXdocument being transferred to PostScript for printing, or a Word document being exported as a HTML file. The source format may either be primary (Word, LaTeX, XFig), or, in case of repeated post-processing, secondary, such as a PostScript document, originating from a DVI file, which is being converted to PDF.

Since an automatic conversion of large documents without manual postprocessing is not feasible, it is crucial to supply the authors with concrete guidelines on document styles and additional mark-up which may be transferred to the publication format to automatically generate navigational support, such as typed hyperlinks. This would save the producer of having to manually adjust changed references in case of source document editing. Most importantly, the individual modules should be delivered to the producer as final documents to prevent repeated manual post-processing.

It is important to note that this classification is related to the process of how a file was generated, e. g. a HTML file may be in primary format if it was directly produced by using an editor, but it may also have been created via an export filter, and thus be a secondary format.

The advantage of primary formats lies in the fact that by editing and saving a document, a current version is directly available, whereas one or more conversion steps are necessary in order to generate other formats from the current version, which may involve a loss of quality. For example, this applies to the process of converting a HTML document with logical markup into a PostScript document, which results in the logical structure of the document being lost. Furthermore, manual post-processing may be necessary in order to generate an acceptable document version in a secondary format, such as in the case of a long PDF document which is enhanced by adding bookmarks in order to ensure the reader's orientation. Thus, in theory, primary formats are preferred when compiling multimedia courseware. However, experiences from library projects, such as MEDOC [2] or LIBERATION [3], show that the available primary formats, used by authors, are mostly not suitable for digital publishing. Therefore, a conversion of documents is mandatory, which proves to be tedious and time-consuming, followed by a post-processing to account for a potential loss of quality, or to optimize the converted document.

Since an automatic conversion of large documents without manual postprocessing is not feasible, it is crucial to supply the authors with concrete guidelines on document styles and additional mark-up which may be transferred to the publication format to automatically generate navigational support, such as typed hyperlinks. This would

save the producer of having to manually adjust changed references in case of source document editing. Most importantly, the individual modules should be delivered to the producer as final documents to prevent repeated manual post-processing.

3.2 Preparing text documents for digital publishing

As we have seen, the use of textual material is crucial for any knowledge transfer. In [2], criteria for hypertext formats were developed, the most important being availability for multiple platforms, typography, cross-referencing, document structure, and navigation. Additionally, the characteristics of HTML and PDF, currently being the only suitable alternatives for text formats in digital publishing, were sketched.

While HTML is widely known as the native language of the World Wide Web and is a primary format if directly produced (e. g. by using HTML editors) in order to generate information pages, most authors use word processing software that does not directly produce HTML output. Thus, in the context of scientific publishing, it is used as a secondary format. In particular, even if an export filter producing HTML code is available, the result does not suffice for direct incorporation into multimedia publications, e. g. if complex typography (as in mathematical formulae) is needed.

The Portable Document Format [9] is usually a secondary format and thus not directly generated. Also, software offering an export filter for PDF, such as some word processors, does not offer the editing features to produce a hyperlinked document for digital publishing. Therefore, even though tools are available to edit PDF documents, manual post-processing is required in most cases to achieve a satisfying presentation, e. g. by adding navigational aids. While it is theoretically possible to post-process PDF documents using a standard editor, difficulties arise in case ofupdating texts, such as the adjustment of hyperlinks, which are stored as geometric coordinates rather than associated with the underlying text or graphic[1].

In short, we note that the primary (authoring) format of a publication is generally different from its final (secondary) format and that crucial requirements, such as hyperlinking, are not met by the tools used by authors. Therefore, serious problems arise both when converting documents which were not intended for electronic publishing, and when the authoring format differs from the publishing format, which can be assumed to be the case except for authors writing in HTML.

3.3 Lecture recording

As mentioned in 2, our aim in producing the multimedia textbook was to enhance the printed documents by recording lectures, delivered by experts on the topic of the individual chapters. However, conventional recording of educational events by using analog media (video or film) do not match well with digital media. Additionally, the enormous bandwidth required for disseminating digital video makes it a questionable option for use within the context of Internet services[2]. Even though streaming technologies (Real Audio, Real Video) may in theory seem to open new avenues, the quality of the data streams as received by the client is in general very low, and the load imposed on the networks is tremendous.

Alternatively, a recording of commands executed at the protocol level may be performed, as done by the MBone VCR [1], which records multicast video conferences, or by the Lotus ScreenCam software, which monitors and stores sequences of Windows commands. While this kind of approach saves storage space, the recording level, is generally too low to allow for extensions of pure playback, e. g. random access of data streams. Another disadvantage is its close relation to a specific protocol, i. e. the protocol of the underlying operating system.

A solution to this is the symbolic recording of a lecture, as it was done within the context of Authoring On The Fly [6]. More specifically, the actions generated by the lecturer annotating his slides on the whiteboard are stored into an object file, which contains not only the parameters of the graphical objects, such as polygons, circles and rectangles being drawn on the whiteboard, but also the file names of the slides and the external applications being used. At the same time, an event queue is written, which associates time stamps with indices of objects stored in the object file. The time stamps can be associated with specific fragments of the audio file, containing the lecturer's speech, such that it is possible to faithfully reproduce the lecture at almost any given moment. In this sense, random access to an online lecture is made feasible. Since the lecturer's video does not add much to

[1] The PDFTEXproject (formerly TEX2PDF) offers a solution to directly transfer documents in LATEX into fully hyperlinked PDF format. This requires to include all hypertext-specific information as macros in the source files.

[2] By splitting large video documents, offline retrieval may be feasible, but browsing through large document repositories results in heavy network load.

the comprehension of the lecture, besides needing a large bandwith, a factor which is relevant for data stream transmission, or teleteaching, it was not included into the final document, but instead, a picture of the lecturer is displayed during replay. The resulting multimedia document can be integrated in various contexts, namely CD-ROM products for offline use, and local networks. In the latter case, a Web interface can be provided, where an ordered list of subtopics is automatically generated with one entry per slide change, including access to externally launched applications. Thus, random access to AOF documents can be controlled both externally, e. g. from HTML documents, and internally, via the replaying software, a technique we call *visible scrolling*.

4 Producing a multimedia textbook

4.1 Authors as content providers

Each chapter of the multimedia texbook consists of a scientific article, whose topic was also expanded in a lecture. The primary format for the articles was LaTeX, which is commonly used by computer scientists. These lectures were delivered by using the MBONE tool *wb* [8], which can be thought of as the computer-based equivalent of a blackboard or an overhead projector. Before giving the talk, the slides of the lecturer, which had been edited using a variety of tools, such as SliTeX, PowerPoint or Showcase, were exported into PostScript format, and the external applications were installed on the local computer, which required writing appropriate shell scripts to launch them from the computer whiteboard. In our case, external applications were either XTango animations, which had been compiled to a program executable on the lecturer's platform, or MPEG movies, which had been generated from individual screenshots or the Maple mathematics package[3]. The articles and animations were available both in primary and in secondary format, the former because the authors supplied us with their source files, including required style files and extensions, the latter because the animations had been developed at this institute using the XTango package [11].

4.2 From lecture delivery to its multimedia reproduction

After having loaded all the slides and optional dynamic applications, the lecture was delivered by annotating the slides while commenting on them, while being recorded using our own software. At the same time, it was also transmitted to remote locations, since the MBONE tools allowed us to use teleteaching facilities. In order to be able to do this, the slides and external applications also needed to be installed at the remote locations. Thus, only the transmission of slide changes as well as start and stop commands for the external applications was required.
The recording yielded an audio file as well as an event queue and an object file, as described in section 3.3. The slides were automatically converted to GIF picture format and stored in the same directory as the other data, in particular the scripts to launch the applications and the applications themselves. In this way, instant replay of the lecture was made possible.

4.3 Post-processing

The main task to be done, besides developing and porting the AOF viewing software and post-editing the textual documents, which is addressed in section 4.4, was to post-process individual modules, in particular editing the lectures, revising the texts and converting the documents to appropriate viewing format.
In order to process the online lectures, a custom editor had been developed [7] which allows for cutting out unwanted portions of the individual data streams involved, namely slips of the tongue or pauses in the audio stream and whiteboard actions, such as scribbles, slide selections or launching of external applications mistakenly performed by the lecturer. In order not to erase any actions performed concurrently to an undesired event, such as in the case of a drawing on the whiteboard during a word repetition, whiteboard actions could be moved in time. In other words, the audio being the most important media stream was taken as a reference, as it is known that speech, being continuous, is much more vulnerable to errors than any other data stream, such as whiteboard actions, which only occur at discrete points in time.
Revising the textual components meant not only proofreading the articles contributed by the lecturers to remove typographic and other errors and adding the modifications to the source documents, which was mostly done by

[3] Any readable or executable document constrained to be dynamic would have been a candidate for inclusion as an external application to a lecture, including Java programs.

one of the authors of this paper, but also adapting the layout to the publisher's specifications. Furthermore, index terms had to be added to the source document, which only a few authors had thought of. Several additional textual documents were added for didactical reasons and in order to ease navigation and orientation, namely

- a short introduction introducing the topic to be discussed
- a lecture overview revealing its structure
- an overview of the applications with reference to the chapters in which they had been used
- a description of the animated algorithms
- dead end pages[4]

In particular, we mention that, since the lecturers did not provide any structuring information for their talks, it was necessary to guess a structure by listening to each of the lectures separately.
Last, we mention the document conversion. In order to minimize the requirements for users, it was decided to use uniform document formats, namely PDF for texts and slides, GIF for images, MPEG and QuickTime for movies. We chose PostScript as the intermediate format, as it was necessary to generate it anyway to send the hardcopies to the publisher master document for the printed version of the textbook. Since modifications on the source document were numerous, this also required going through the document conversion process several times. In this context, in was advantageous to have the sources spread across several documents so that local modifications could be made without affecting the complete publication[5].
As the animations, developed using the XTANGO package, which requires X11 libraries for execution, we would not have been able to include them as they were for the Windows version. We solved this problem by converting the animations to QuickTime movies. In this way, simulations could not be transferred appropriately, but on the other hand, the effort to re-implement the simulations would not have been justified.

4.4 Document integration

With all the individual documents available in their destination format, it was now possible to structure them into a document tree, which would then be burnt onto CD-ROM after relating the documents to each other. In particular, this involved adding structural navigation aids to the textual documents in PDF format, such as links[6] and bookmarks[7], and ensuring correct launching of the document types involved, such as AOF documents, movies and animations, generating so-called *thumbnails*[8] and, finally, generating a fulltext index.
While adding cross-document references was already a tedious process, since none of the source documents contained suitable information to generate these references automatically, e. g. by embedding pdfmark [4] into PostScript output, a major problem was to reflect changes in the sources within the post-processed PDF documents, such as adjusting links and bookmarks.
For each slide change within a lecture, a file containing a timestamp (in milliseconds) had been generated. However, while associating the overview page entries with these starting points, it was necessary to adjust these timestamps so upon clicking a subtopic, the lecture would start at the correct time when that topic was about to be discussed, and with modifications to the AOF document due to post-editing, as described previously, the timestamp also needed adjusting.
In order to prevent the user from getting lost within the electronic document, we focused on visualizing structural relations, namely by using context-sensitive bookmarks to ease navigation between and within chapters, and, to a lesser extent, links, the latter mainly from the overview pages (table of contents and lecture overview). We also

[4] As the audio data for the lectures would exceed the storage available on a single CD-ROM, two disks were needed. The access of a lecture was constrained to the respective overview page. The overview pages for lectures not present on the storage medium was then substituted by a document giving instructions to the user on the necessary steps to view the lecture (i. e. how to exchange the CD-ROMs).

[5] Note that this procedure is more or less applicable to all conversions from an authoring format (if not HTML) to a destination format suitable for electronic publishing (PDF or HTML), since most text formats do not permit the inclusion of hypertext features, notably hyperlinks, which then have to be added in a post-processing stage, as described in the next section.

[6] More precisely, links can either be intramodular references, meaning that source and destination anchor belong to the same module, or extramodular references, with source and destination anchor within different modules, or the destination anchor being an entire document

[7] Bookmarks are either intermodular references, meaning that source and destination anchor are equivalent to an entire module, or intramodular references, where the source anchor is equivalent to the whole document

[8] Thumbnails are a small representation of document pages, which may appear simultaneously with a particular document.

decided to typify the links by using different colors, representing the document types which were accessed (red and black for texts, blue for animations, cyan for simulations, and magenta for video clips. In addition, we used the PDF Notes mechanism[9] to provide literature references in order to prevent the user to move to a different page or document. Also, the images contained within the contributed articles were made available as GIF image documents and linked to appropriate references to figures within the text, because a reference is often located on a different page than the picture referred to (the destination anchor), but the user may want to continue reading on the same page while viewing the image. Thus, by clicking on a reference to a picture, it is displayed externally within an image viewer, which allows for arbitrary resizing of the image. Finally, intra-document references were also made available as (extramodular) links.

4.5 Considerations for multi-platform delivery

While the overwhelming majority of computer literates own or use a Windows-based PC, a large number of computers at scientific institutions are Unix-based. Our aim was to produce a multimedia publication which would be usable in various context, in particular as a CD-ROM product, but also within local networks, such as those found at universities. Thus, our own software, in particular the tools needed to replay the online lectures, was implemented for Solaris (SunOS), IRIX (SGI), Linux, as well as for Windows95/WindowsNT. Again, an implementation in Java was discarded because, in particular, the communication between the various modules replaying the individual data streams would not have been fast enough.

Our first approach was to deliver all necessary components, including required software, animations and movies, on CD-ROM. However, this would have raised considerable problems because of the following reasons:

- most software (shareware or freeware) is only allowed for personal use, but not for commercial distribution;
- updates of the software would have required to send a new CD to all customers for the most current version;
- the supplied software would have needed to be included for all supported operating systems, thus considerably augmenting the required storage space on the CD-ROM.

Therefore, it was decided to separate all platform-independent parts, i. e. all data, which were burned on two CD-ROM disks, from the platform-dependent modules, i. e. the software. More precisely, all textual files (including the fulltext index) and the video clips are found on the CD-ROM, while the software, all simulations and animations and miscellaneous scripts to activate the data and are found in a platform-dependent ftp archive. While the former is not likely to change, except if content-related errors are found, the software is likely to undergo changes and improvements. As an additional benefit for the customer, a direct hotline to the developers (via an e-mail address and a form-based Web interface) is provided. In particular, the following advantages are noted:

- it is always possible to retrieve and use the most current versions of the software from the archives;
- risks are reduced for the publishing house, since it is not liable for modules which are not distributed with the publication;
- software bugs encountered by the customers can quickly be eliminated and any other modifications or improvements result in a new version offered to the customer;
- other platforms may be supported in the future without affecting the CD-ROM shipped with the publication.

Although the required installation steps may seem unusual, we assume that most of the users will be computer science students who usually have easy access to Internet services via their respective institutions, and are thus able to retrieve the necessary archive and are knowledgeable enough to perform the necessary tasks to use the electronic version of the publication.

With a few simple modifications, it is also possible to configure the publication to be executable in local networks. In this case, the required software as well as the data for the online lectures resides in shared d irectories, while all textual documents and the destination anchors of the references to external applications are stored within a Web server. Thus, the transfer of the non-static media is executed via the local network protocol, e. g. NFS, while the static media are transferred via the hypertext transfer protocol.

[9] Notes are visualized as small icons on top of a document page, which are opened as small windows containing arbitrary text by a mouse click

5 Conclusion and future work

We have shown in this paper that a carefully developed multimedia publication is more than just a combination of several media types. In particular, we see the role of new media in education as a complement to conventional educational scenarios, which are based on text and audio. These seem to be crucial for knowledge dissemination, and therefore any other media types are considered to be an optional supplement. On the other hand, considerations for electronic publishing have to be seen in the context of open environments: even if most end users are assumed to work on a PC, this is not the case at universities, where different platforms and operating systems are found. Another issue is re-usability of existing components and publicly available documents and applications in heterogeneous formats. Thus, the effort of integrating individual components should not be overlooked.
The experiences gained here show that powerful and easy-to-use authoring tools for the development of high-quality courseware to support university teaching are still missing when considering open environments. Therefore, we are investigating the possibilities of multimedia authoring with the goal to embed all information relevant to the publication into the source documents, in order to avoid tedious post-processing. Another issue is the possibility of active manipulation and customization of existing courseware, e. g. by providing suitable annotation mechanisms for generic document formats. These efforts are geared towards the development of widely acceptable tools, supporting authors, lecturers and students.

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A Pilot Project in Augmentative Distance Learning...
George Mason University Graduate Course in Biochemistry

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Abstract: Distance Learning program s tend to be thought of as alternatives or replacements for traditional classroom or laboratory-based instruction. We are exploring a third use of distance learning capabilities– to augment and amplify the learning opportunities for part-time graduate students. Many graduate students in George Mason's programs con verge on one of the campuses for brief periodic interactions with the instructor and peer classmates. Between thes e synchronous interactions, the class Web site supports:

- ongoing asynchronous small group interactions with the professor, peer groups, and other scientists through online discussion groups, email and listserv facilities;
- hypermedia presentations on key con cepts, developed for (and often by) the class, and available online for review or correlation to lecture notes;
- imaging and audio interactions offering advanced representations of molecula r structures, using tools that provide a dynamic and easily updated capability beyon d material available in the text.

Introduction

Students of modern bioch emistry today find themselves in what is at once a very exciting and a very challenging situation. Our knowledge of bioch emical systems is increasing exponentially, as the research tools applied in this area become more powerful and more laboratories address biochemical questions in an increasing number of areas. An important driving force for this rapid expansion of knowledge is the advent of an expanding biotechnology industry, in which detailed knowledge of biochemical processes al lows the practical application of this information in ways literally unimagined only a few years ago. That's the good news. The bad news is that students often find themselves ove rwhelmed with the volume of information with which they are confronted, and are often at a loss when trying to make sense of it all.

Objective

To provide students a means of visualizing the molecular aspects of Life's chemistries while pursuing an d acquiring an intuitive understanding of the complex, interactive dynamic systems, upon which all life forms are based.

Background

Biotechnology, as an industry, requires a work force well trained in the cellular and molecular biosciences . Individuals seeking professional careers in the biosciences, need to understand the molecular basis of their science and the tools employed in its pur suit. The impact of knowledge arising from completion of the "Human Genome

Project" in a wide array of academic and commercial applications will increases the need for individuals to understand the "Chemistry of Life." A fundamental understanding of Science is now a critical element in the education of all members of our Society. Advances in the molecular and cellular biosciences have and will produce knowledge, the use of which, will impact individuals in all walks of life. A means of capturing and presenting concepts from the molecular biosciences in a manner useful to students at various levels of preparedness is essential. As course work in Biochemistry is expected to provide the basis for an understanding of life at the molecular level, it serves as an ideal setting for developing enhancements to student acquisition of these concepts. We are employing multimedia approaches in our one year graduate course in Biochemistry at George Mason University, with the end product sought being a fully web-based course. A major theme of the course is the relationship between molecular structure and biological function.

The Internet allows students to access biochemistry information soon after it is made available to the scientific public. This rapid access to new knowledge is unprecedented, and is rapidly changing the way biotechnologists do their work every day. The students receive training in ways to use tools and methods that will allow them to access and analyze this information in an efficient and effective manner. An essential feature of this course is the use of World Wide Web Browsers coupled to Molecular Modeling and Display software on assignments designed to illustrate practical problems and tasks that arise in applied biotechnology. Information describing these relationships were once located only in books and journals located in research libraries. Today much of this information resides on host computers connected to the Internet. Students use Web Browsers connected to Molecular Modeling and Display software to locate and analyze molecular structures of important biochemical systems currently under investigation world wide. This permits us to design a system that provides "just-in-time", "just-in-case" and "just-for-you" solutions for the students.

While the fundamentals underlying any textual presentation in Biochemistry are relatively stable, advances in knowledge and technologies associated with this field are remarkably rapid. Establishing pointers to ongoing research through our web based instructional platform, allows students to fully appreciate this dynamic. It also serves to tie the materials learned in the class setting to real world activities of the moment. The capacity to "see" molecules in a variety of representations, enhances students' abilities to comprehend "structure/function" relationships, especially for the higher order macromolecular assemblages encountered in discussions of Proteins and Nucleic acids and their roles in biological systems.

Nature of the Students Served:

The class composition is made up largely of part time graduate students who are employed full time. These students are mature, and come to the course from a variety of disciplines. Graduate students from the Departments of Biology and Chemistry, and the Computational Sciences and Informatics Institute utilize this course as part of their formal course requirements. Thus, backgrounds are not uniform. This lack of uniformity is addressed through the web site by incorporating pointers to information resources that can both remediate and amplify a student's knowledge in a particular subject domain. Thus students with weak background in chemistry are given pointers to sites of information appropriate to their needs, while students seeking additional information or depth in a topic are pointed to sites of information that meet this opportunity. Given the enhanced role of Bioinformatics in modern biology and biochemistry, additional instruction in the applications of computer-based search, retrieval and computational tools are incorporated as well. This also provides a means of instruction through "doing" that increases the opportunities for students to explore structure function relationships across a wide range of biological and biochemical processes and highlights at the molecular level the concept of "Unity in Diversity" so fundamental to all of Life's forms.

Instructional Advantage:

The course Web site (http://www.america-tomorrow.com/gmu/biochem) is maintained on a commercial server that is available 24 hours a day, 365 days a year. The Web site contains objectives and syllabus for the course, presentations used to augment the text, and student-provided pages dealing with current event topics dealing with

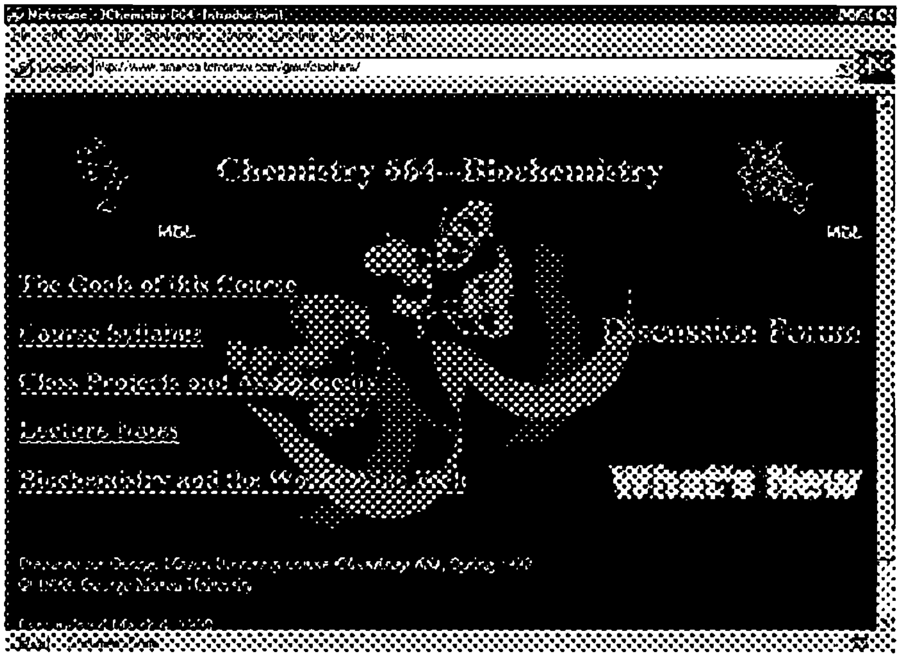

Figure 1: Class Web Site Home Page

Biochemistry, Molecular Biology, and Molecular Genetics. These pages contain links to news items, plus links to background information on research sites dealing with the news topic. For example, news reports on the Pfisteria attacks on fish in the Chesapeake tributaries are linked to the N.C. State University Research reports that identified Pfisteria Piscicida and its unique capabilities to transform into 24 flagellated, amoeboid, and encysted stages or forms. (http://www2.ncsu.edu/unity/lockers/project/aquatic_botany/pfiest.html)

Use of the Internet in class for example, allows capture of detailed, high level information on a subject in response to a question, in a fashion impossible via other means. One can also, move to sites of information appropriate to remediation of background preparation on site and in real time as well. In all cases, having the capacity to present, especially the molecular concepts, in a manner that is easily perceived is a marked learning enhancement for the students. Now, one can see, in color, a molecular representation, that before these technological advances, required of students, a capacity to mentally construct their own "abstract 3D" representations... a skill not shared by many.

Asynchronous communication among groups of students and the instructor is supported with a "List Serve" and extensive use of e-mail for one on one communication, and a class discussion forum implemented on the George Mason University "Town Hall" bulletin board system (an application of the Lundeen Corporation "Web Crossing" software). Group student projects are facilitated by the use of private Chat rooms that allow synchronous communication. Given that most students do not reside on campus and work schedules do not permit extensive face-to-face time, the Chat sessions permit the students to "get together" at any time to discuss project direction and status. We have used private rooms in the Talk/Excite public facilitiy as well as the more limited Chat capability of the University server. Capturing Chat sessions provides a built in documentation that is helpful to the instructional staff in following the development of the project. This facilitates tailoring of instruction, discussion and information retrieval and presentation to individual student's needs.

Student projects are greatly improved through this approach, both due enhanced input and interaction between the student and the instructor during the project's design, and also in terms of the multiple avenues now open to the student for the project's presentation. Every effort is made to move the students toward use of a web based presentation. The electronic linkage of students allows collaborative projects among students whose free time is extremely limited and thus would otherwise be unable to perform projects in a team fashion.

The students also have the opportunity to develop mentor-mentee relationships with more experienced peers, full-time and adjunct professional staff, and expert guests who appear in the departmental seminar series.

Visualizing Metabolism:

One objective of the full year course is the acquisition on the part of the students of an "intuitive" understanding of life processes at the molecular level. In effect, a "visualization" on the part of the student of metabolic processes both structural and informational. The multiplex of information and the hierarchy of linkages between information sets that comprise metabolism in all its forms is now accessible in a fashion that provides a marked enhancement to student learning. Database coupling and linkage produced as a result of the Human Genome Project, allows pursuit of integrative concepts in Biochemistry in a fashion never before possible. The course seeks to utilize these databases and the computational tools generated for their perusal in aiding the student's acquisition of an intuitive grasp of the molecular dynamics of cellular function. It is here that hypermedia presentations become most useful and appropriate. This aspect of the course also provides the greatest opportunity for "learning by doing." It also lends itself to team approaches to projects involving complex higher level biological functions and attempts at understanding these phenomena at the molecular level.

The course has been designed to introduce students to the basic fundamentals of biochemistry. Emphasis is placed upon topics and approaches that are of most practical use to students working in various areas of biotechnology. A major recurring theme of the course is the relationship between molecular structure and biological function. Many important examples of these relationships are given in the textbook for this course. Much more current information exists within databases and other files on host computers all over the world. The advent of the Internet allows biochemistry students to access this information soon after it is made available to the scientific public. This rapid access to new knowledge is unprecedented, and is rapidly changing the way biotechnologists do their work every day. The students receive training in ways to use tools and methods that will allow them to access and analyze this information in an efficient and effective manner. An essential feature of this course is the use of World Wide Web Browsers coupled to Molecular Modeling and Display software on assignments designed to illustrate practical problems and tasks that arise in applied biotechnology.

Information describing these relationships were once located only in books and journals located in research libraries. Today much of this information resides on host computers connected to the Internet. Students use WWW Browsers connected to Molecular Modeling and Display software to locate and analyze molecular structures of important biochemical systems currently under investigation world wide.

Using viewing Tools

Software tools are available to allow biotechnologists to examine details of biomolecular structures. Some of these are commercial products that require very powerful graphics computer workstations. The current versions of Mac and PC computers however have sufficiently powerful hardware and operating systems so that public domain or shareware programs can provide every student with tools quite adequate for learning the important fundamentals of biomolecular structure. Several of these will be provided for students in this course. These include:

Molecular Imaging Software:

- **RasMol** a program for viewing structures whose coordinates have been presented in "PDB" format. Structures may be viewed at various levels of detail and abstraction.
- Chemscape **Chime** a "plugin" for Netscape and other Web browsers that allow you to view and manipulate Protein Data Bank and other molecular models directly from a Web page.

- **MAGE**, a program for viewing images and playing Kinemage Script files. This program and the script language which direct it was developed by David Richardson at Duke University. The journal Protei n Science makes extensive use of this image analysis software.

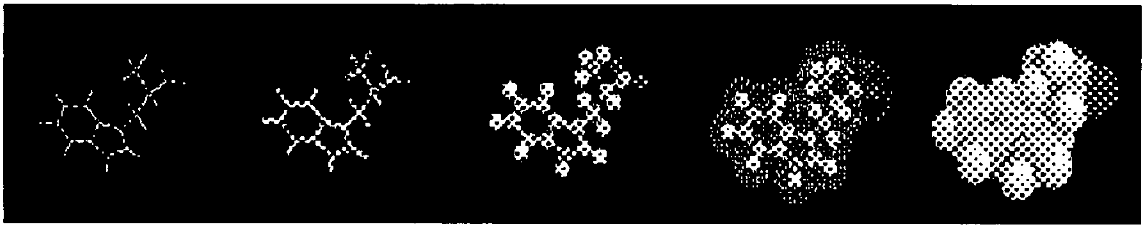

Figure 2: Chime Image Views of the Tryptophan Amino Acid Molecule

Database Browsing and Querying Software:

- 3DB Browser, a program for convenient selection o f Protein and Nucleic Acid structures deposited in the Protein Data Bank
- Klotho is a useful Biochemical Compounds Declarative Database.
- The European Bioinformatics Institute is a source of both nucleotide and protein (SWISS-PROT a protein sequence database) Databases and related software .

Summary

Multimedia technologies allow compilation and presentation of subject matters in biochemistry in a highly flexible and rapid fashion. This provi des the instructor with a ready means of capturing both new and remedial materials on an as-nee ded or available basis. In combination, these capabilities provide a means of tailoring instruction to the individual needs of class members. It also provides a mechanism for capture and distribution of knowledge and insights of the class participants.

Given the importance of computer-based technologies in all aspects of modem biosciences, both theoretical and applied, a knowledge of these tools and the value of their application becomes basic to a student's education in the cellular and molecular biosciences. Bioinfor matics is now an integral element within these areas of study. Our course design and its formulation and presentation as a Web site is intended to both take advantage of and force the students use of, the concepts and tools associated with this evolving discipline.

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Expressiveness and Multimedia Interface Design

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Abstract: Current issues in multimedia interface design are examined and a lack of a proper methodology for such design identified. The concept of media expressiveness is defined and an approach is developed which uses the task-user model-expressiveness triptych to inform on the design process.

1. Introduction

In order to communicate information effectively, the information must be intelligently organised so that the meaning of the stored information can be readily extracted, and the interface to the information must be effective and tailored to the needs and capabilities of the desired audience. Both are needed, because well organised information presented badly, is not likely to be understood, and the excellent presentation of poorly organised information will only emphasise the poor quality of the stored information. Modern data base organisation techniques preserve essential information relationships. Effective presentation, it is claimed, can be achieved through the use of multiple media. This paper will examine how multimedia techniques might actually achieve the latter .

2. Terminology

As soon as one begins to discuss multimedia issues, problems of terminology occur. What do the terms *media*, *channel*, and *multimedia* actually mean ? This question is far from pedantic since inconsistent definitions can, and have, caused confusion. A number of authors have identified this as a major stumbling block in multimedia research [Arens 91], [Stenning 94] and there have been a number of attempts to define a consistent terminology set [Nigay & Coutaz 93], [Arens et al 93], [Frolich 91]. As yet there is no agreed terminology so in this paper we will adopt the following:

medium: representational system with a distinct syntax, semantics and pragmatics, (e.g. graph).
expressiveness: an emergent property of a medium - how much information it can carry;
multimedia: communicating simultaneously using a number of different media;
modality: a human sense, e.g. aural, visual;
multi-modal: stimulates more than one human sense, e.g. visual and aural.

3. Why might Multimedia Interfaces Improve Presentation ?

There have been a wide variety of claims about what multimedia interfaces can offer to the interface designer. Some claims are:

• *Increased information bandwidth*: The variety of media which are available allow the allocation of information to multiple visual and auditory channels. This increase is described as increased information *bandwidth*.

• *Improved 'attention getting'*: The new media provide unusual representations of information, useful in environments where obtaining a user's attention is essential, e.g. control rooms.

• *Increased realism*: The use of realistic media such as still/moving video allows the interface designer to represent real-world situations directly and effectively.

Advances in technology have not been matched by parallel developments in a supporting design methodology, so the use of media in interface design is still problematic and uninformed. With more media choice, the risk of selecting an inappropriate medium has greatly increased.

4. A Characterising Framework for Multimedia Research

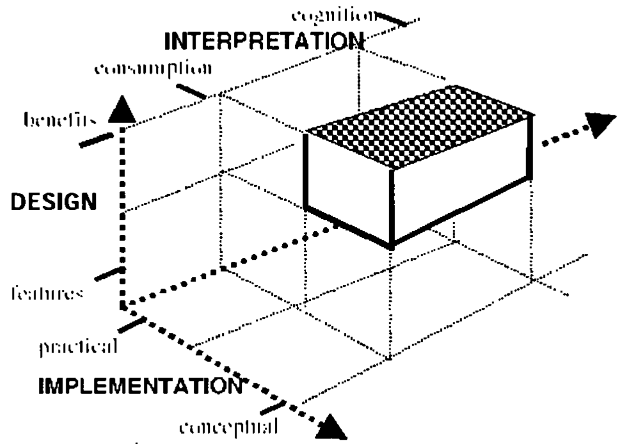

Figure 1: Three Dimensions of Multimedia Research

Research in a variety of fields from social science to computer science has identified important ingredients for the development of a multimedia design methodology. Whilst some are not computer-based, in every case the goal of effective communication is paramount. There has been work concerned with goal and task descriptions for interactive and didactic systems [Casner 91], [Maybury 93], [Alty et al 93], data descriptions [Roth & Mattis 90], [Mackinlay 86], [Arens et al 93], automatic presentation design [Casner 91], [Mackinlay 86], perceptual characteristics of users [Casner 91], characteristics of media [Bertin 83], [Alty & Rijkaert 93], [Lohse 90], hardware constraints [Alty & McCartney 91], terminology [Frolich 92], [Arens & Hovy 93], [Nigay & Coutaz 92], demonstrates the multi-disciplinary nature of multimedia research, each group having it's own motivations and goals. In [Fig 1] we suggest a three-dimensional framework for analysing multimedia research issues. The dimensions (together with their extremal values) are:

- Design (features--> benefits) What are the main motivations for design?
- Implementation (conceptual --> practical) How important is implementation?
- Interpretation (consumption --> cognition) How important is cognition in media selection?

4.1 Design: Features --> Benefits

So often, in highly technology driven application areas, the situation is characterised by solutions looking for problems. [Alty et al 92] stressed the need to separate technological features from user interface benefits pointing out that the latter should dominate interface design, and [Mayes 92] has commented, "Multimedia systems are not primarily defined by their data-structures, but by the nature of their communication". An example of innovative technology not driven by user benefit analysis was the Bell Lab Video-phone. A lack of clear user need, probably caused the product to fail.

At the opposite end of the *design* dimension are investigations which add value to the interface design process. These approaches assume the existence of an adequate technology-base, and so focus on issues which would normally come later in the design process. It is only by addressing these issues, that the technologies can be integrated into a design *rationale* which considers both users cognitive characteristics and the nature of their tasks. The characterisation by [Alty et al 93] provides a useful basis for measuring this dimension (features to benefits).

4.2 Implementation: Conceptual --> Practical

This second dimension addresses the division between theoretical expositions and implementations, which may be prototypes or products. The conceptual work is related to issues of representation [Arens & Hovy 91], terminology [Frolich 92], [Nigay & Coutaz 95], and task descriptions [Alty & Rijkaert 93], with no discussion of enabling technologies. What makes such discussions necessary is the lack of theoretical under-pinning which accompanies the majority of multimedia interface design methodologies. In this case the central issues are the cognitive capabilities of users and the conceptual description of tasks. However, a higher percentage of research is carried out with a view to implementing systems. This covers automatic media allocation, automatic dialogue design and 'widget' selection, and modelling of multimedia interaction.

4.3 Interpretation : Consumption --> Cognition

This final dimension is based on a distinction made by [Stenning 95], who suggested the separation between work on information presentation research [Mackinlay 86], [Roth & Mathis 90] and that concerned with the cognitive effects of different representation methods. Stenning points out that in information presentation research, "All of these (authors above) are concerned with improving the consumption of information. However, there is very little theory which underlies the choice of design and spans a wide range of information expressions". By 'consumption', Stenning means the transfer of deterministic domain data to the viewer or consumer.

The design of 'Management Information Systems' inspired early work in this consumption approach. Most of this research compares tabular to graphical methods which became readily available with the development of cheap displays. One basic question is how best to present the data to the decision maker. Most studies made the assumption that graphical methods such as functional graphs and bar charts were inherently better in the support of decision making. However, as [Pearce 83] pointed out, "Many extraordinary and unsubstantiated claims are made about the educational potential of computer generated Cartesian graphs.". The assumption that mappings are independent of task and user have not been validated.

[Mackinlay 86] showed that a horizontal axis could be used to encode single variable values, and provided a notation to explain how. Such systems are concerned with representating information so as to aid managers in decision making. The emphasis is on quantitative measures of the use of standard media (e.g. charts and tables) in decision making, rather than investigating the cognitive explanations behind these performance differences. The focus is on consumption.

The other extreme of the dimension is a focus on cognition, and investigates the efficacy of representations in conveying information with respect to their congruence (or not) with cognitive processes such as human memory [Stenning & Levy 88]. A key issue is how knowledge of cognitive effects of media can be used to support media selection. This goes deeper than allocating media on the strengths of their form alone, as suggested by [Arens et al 93] and [Alty & Rijkaert 93]. Form is important, but only in the context of the cognitive and task landscape of the interaction.

4.4 Use of the Framework.

Generally speaking, approaches near the origin of the framework are less likely to succeed in the long term. For example, one might argue that the Bell Video Phone was Consumption rather than Cognition (Features rather than Benefits, Practical rather than Conceptual). Many interface design approaches are concentrated at the Features/Consumption end of the spectrum.

Much current research from the top end quadrant of the Framework approaches the problem of interface design using a *top-down* design approach. What distinguishes these approaches is their *a priori* analysis of many of the user/interface/domain tripartite issues of interaction. A number of authors see the main problem of providing multimedia representation as the adequate representation of domain data, which is achieved by providing a formal definition of domain data types. Database theory provides a rich basis for this classification and a number of data taxonomies have been suggested. [Arens & Hovy 93], [Arens, 91] provide a comprehensive taxonomy of data types from the perspective of single values and types. At this stage, the world *knowledge* is used to suggest that the *data* is required for the solution of some specific problem. Knowledge is classified in three ways at varying levels of abstraction, from individual values through to characteristics of types, and the density of these values in the world. An example of such a taxonomy is a photograph. Arens and Hovy view the photograph as a collection of points which have infinite dimensionally (intensity), are permanent, vary continuously, and are densely populated. This description is intended to help the interface designer match the photographic medium to some *interface world*. Ideally this *world* would be populated by densely packed points which took on values which varied continuously. The method lacks a description of how data is to be used. Data has its own properties, e.g. density, which can affect which media should be chosen, and medium selection should allow for this.

[Roth & Hefley 93] make the traditional distinction between data types such as *nominal, ordinal* and *quantitative* and the *meta*-dimensions such as *co-ordinate* and *amount*. Unlike Arens and Hovy, Roth and Hefley describe *relationships* within their data framework, such as *binary* and *complex ternary relations*. They also suggest the use of intra-data element, meta-information, to allow aggregation and partitioning along some dimension. A third view of data characterisation is provided by [Alty 94]. His data types are nominal, ordinal and quantitative but the work offers a different perspective on building up complex data elements. Knowledge is treated in an *object oriented* way using data objects and inheritance. Three levels of data are defined, **primitive** elements e.g. temperature, **derived** e.g. density and **complex** elements e.g. co-ordinates {x, y, z}. These are further described in terms of Name, Type, Cardinality, Range, etc. The description provides a robust description of data, but struggles with complex structures such as a photograph.

When a representation of the domain has been achieved, designers then need a rationale for mapping domain knowledge to particular output media. The APT system [Mackinlay 86] is based on the ability of media to present a given domain *effectively* and *expressively*. He defines *Expressiveness* as the ability of a graphical language to present a relational type with its associated source and target domains (in other words can the output medium represent the data or not?). *Effectiveness*, on the other hand, is the ability of a graphical language to encode all the members of the data set so that information processing can take place efficiently. Other techniques have tagged media with inherent qualities e.g. graphs and trending [Alty 94]. Some workers have tried to isolate variables such as user education, experience and personality, medium characteristics, and task dependent variables [Jarvenpaa 89, but the number of possible variables is large.

5. Multiple Media and Problem Solving

Most people use computers to solve problems. Indeed one might argue that Human Computer Interaction is mainly concerned with the "design of artefacts to provide new human problem solving strengths in computer mediated domains" [Williams 96]. The representation of the artefact through the interface presents the problem-solving space, and supports navigation through this space to allow the user to achieve tasks. The relationship between problem representation and the user's cognitive apparatus is an important part of this process.

But how can appropriate media provide new problem solving strengths? To answer this question, human problem solving must be discussed with the emphasis on the effect *representation* has on the support of this activity. In fact there are two representations we have to be concerned about - the domain and the interface. The domain representation within the computer is important but we will concentrate upon the interface representation. The new application area of "scientific visualisation" is an implicit statement about the important role of media in an interface, and visualisation workers are coming to similar conclusions to our own. In a recent panel at ACM SIGCHI'96 [Gershon et al 96], experts in visualisation argued over the state of the art and visualisation of hyper-spaces in particular. They concluded - " There is a need for a definition of task semantics in order to inform the choice of visualisation. For example, in hyperspace visualisation, the focus should be on the meaning of information, rather than on the *structure* of the network representation, i.e. visualising nodes and links". They also emphasised the need for a more systematic evaluation of different visualisations.

So, visualisation literature is reporting the same malady as the multimedia literature –a focus on new visualisation technologies and algorithms rather than justification for their use in terms of tasks. (Features rather than Benefits). The lack of formal descriptions of available representations is in evidence. Also, no consideration is given to the role cognitive structures play in the task solutions, and how these will be affected by different representations (Consumption rather than Cognition). A key issue in this higher-level matching process is the notion of *abstraction*. This describes the amount of encapsulation of domain information into some higher form capturing commonalties between constituents. As an example, consider understanding the executing of concurrent and distributed programs. They can only be understood by abstracting over different aspects of the program's behaviour and structure. [Tab 1] below illustrates the abstraction range of which could be utilised. Each level points to a particular type of task which requires a specific abstraction level. Efficient problem solving is achieved by matching abstraction level with task type.

Clearly, the dominant principle should be a matching of the abstraction level with the requirements of the task. In the right circumstances higher levels of abstraction reduce the operational state space and support effective task performance.

Increasing Abstraction

- Direct Representation: map program elements directly to an image
- Structural Representation: conceal/encapsulate program information
- Synthesised Representation: display derived information which is not actually in the program:
- Analytical Representation: focus on correctness and completeness properties of the program:
- Explanatory Representation: an "aesthetically pleasing" narrative description of program behaviour.

Table 1: Levels of Abstraction and Problem Solving

When solving problems, it is reasonable to assume that users hold some form of internal representation in their head. The correct choice of abstraction level (and hence medium) must match up with the user's internal model. Since user cognition internalises the external interface representation, so multimedia interface design should focus upon the cognitive effects of different media As [Mayes 92], asks "will the user's mental model be improved by a more realistic or dynamic representation ?". The design solution therefore lies in relating the interaction triptych of *task—external representation—internal representation* to media allocation. How do different media encode information ? How are different mental models induced by different media

6. So what is "Expressiveness" ?

The process of abstraction is concerned with the coalescing of domain states into larger chunks, thereby reducing the complexity of the search problem [Williams et al 96]. Some media readily afford this process, others do not. The representation of button icons for activating features in WORD cannot be readily abstracted, whereas points displayed in a graph can be abstracted to higher levels such as clustering or trends. We therefore relate expressiveness to this higher level abstracting ability. A medium which supports many levels of abstraction is "highly expressive". However, the appropriate level of abstraction needed to support user problem solving will depend upon the experience and expertise of the user. Thus the trick, in allocating media effectively, is to match the expressive requirement of the user with the maximum expressiveness of the medium. We say "maximum expressiveness" because too expressive a medium could inhibit the problem solving process. People find graphs useful because they are at the right level of expressiveness for many problems. A more expressive medium would be natural language, but the description of a graph in natural language usually is less useful than the graphical form, which is less expressive.

In summary, the multimedia interface designer must take into account all three aspects task, user abstraction need, and media expressiveness, when allocating media, and the expressiveness level chosen should be that which best fits the user's current mental model. Media should then be chosen which can deliver that level of expressiveness but not more than needed. We are currently carrying out experiments to check the effect of media, using different levels of expressiveness, on users' mental models. Early results indicate that expressiveness does induce the expected user models and that in more complex situations the more expressive media, the better they support problem solving.

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Examining How Middle School Students Use Problem-Based Learning Software

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Abstract: A nagging problem concerning school-based learning is the difficulty many students experience in applying what they have learned to everyday situations. Problem-based learning (PBL) emphasizes solving authentic problems in authentic contexts and has been shown to be an effective instructional method. Though literature supports the efficacy of problem-based learning and the benefits of problem-based learning are obvious, little research exists which investigates the types of tools or features that are effective in supporting students working in PBL environments. This study examines how middle school students use and interact with a computer-supported PBL environment.

1. Research Framework

Historically, schools have attempted to teach the content and skills essential for individuals to function in society. Since the Industrial Revolution schools have emphasized the learning of basic skills. Yet today it is clear that this type learning is not enough. More jobs than ever require problem solving and critical thinking. Dewey [Dewey 1938] argued that intelligence is the ability to clarify a goal and develop a plan for its attainment. Authentic learning environments such as problem-based learning embody this in its problem definition and resolution.

With the shift from a behavioral to a cognitive perspective of learning, researchers have become increasingly interested in cognitive processes and their effect on the construction of knowledge [Driscoll 1994]. Many cognitive psychologists and constructivists believe that learning cannot be separated from the learning activity and context [Bednar, Cunningham, Duffy, & Perry 1992].

A nagging problem concerning school-based learning is the difficulty many students experience in applying what they have learned to everyday situations. Many schools are concerned with the transfer of abstract, decontextualized concepts where knowledge is viewed as a discrete object residing outside of the individual [Brown, Collins, & Duguid 1989]. Increasing amounts of research indicate that the inability of students to apply concepts learned in formal contexts is due to the abstraction and decontextualization of learning [Cognition and Technology Group at Vanderbilt 1992]. Spiro and Jehng [Spiro & Jehng 1990) argue that the decontextualization of knowledge creates inflexible understandings. But it is not the abstraction of knowledge as such that distracts learners, but that the abstractions are not illuminated with examples in context. Understanding is a product of the context and activity [McLellan 1993].

Context provides a framework which guides and supports the learner. The context naturally structures knowledge in a way that suggests its proper use. Traditional instructional design attempts to simplify learning by dividing the content into components and teaching them separately. Situated cognition argues that learning is simplified by embedding concepts in the context in which they will be used [Brown &

Duguid 1993]. The context provides the much needed support when working at the edge of one's ability. Yet authentic context alone is not enough to support student learning. Situated cognition argues that learners must engage in authentic tasks as well [Winn 1993]. Authentic activities are the ordinary practices of the experts in that domain [Brown et al. 1989]. The learning activity is an integral part of what is learned. An activity in which all domains engage is the solving of problems. Experts utilize tools to support problem-solving in context. Active use of a culture's tools provide learners the opportunity to view knowledge from the experts' perspective [Brown et al. 1989]. Active learning in the context of a domain's culture allows the gradual "fleshing out" of concepts over time. Each use of a concept or tool will further develop the learners' understanding.

There has been a growing body of research on authentic and situated learning environments utilizing the problem-based approach to learning [Spiro & Jehng 1990]. Problem-based learning (PBL) emphasizes solving authentic problems in authentic contexts. It is an approach where students are given a problem, replete with all the complexities typically found in real world situations, and work collaboratively to develop a solution. Problem-based learning provides students an opportunity to develop skills in problem definition and problem solving, to reflect on their own learning, and develop a deep understanding of the content domain [Lajoie 1993] [Jacobson & Spiro 1995). This approach was developed in the fifties for medical education, and has since been used in various subject areas such as business, law, education, architecture and engineering. Most recently, there is a growing interest among educators to use problem-based learning in the K-12 setting, and a growing need for problem-based educational software to facilitate the development of higher order thinking skills via technology.

Though literature supports the efficacy of problem-based learning and the benefits of problem-based learning are obvious, little research exists which investigates the types of tools or features that are effective in supporting students working in PBL environments. In order to design an effective computer-supported PBL learning environment, it is important to understand the tools and design features included in the software, and their impact on learning. It is, therefore, the purpose of this study to examine and understand how middle school students use and interact with a recently available computer-supported PBL environment developed by a major publishing company.

2. Research Questions

This study investigates the use of tools and design features as employed in a problem-based learning environment and their effectiveness on middle school students' learning of science concepts. Specifically, the study asked the following questions: (1) What is the effect of the computer-supported problem-based learning environment on the achievement of middle school science students?, (2) What is the effect of the computer supported problem-based learning environment on the middle school students' attitudes toward science?, (3) Is there a relationship between students' math or reading ability and their achievement in the problem-based learning environment?

3. Design of Study

3.1 Sample

The participants of the study (N = 115) were students enrolled in seventh grade science at a middle school located in a medium-sized city in the southwestern United States. The school has a high percentage of minority students. The participants in the study consisted of 66% Hispanic Americans (N=76), 12% African Americans (N=14) and 22% white (N=25). The age of the students ranged from 12 - 14 years. Of the participants in the study, 50 were male and 65 female.

3.2 Treatment

The treatment consisted of three groups: computer-supported PBL environment, paper-based PBL, and a control group. Students from three intact classes were randomly assigned to each of the conditions described below. Because the treatment was included as a part of the regular science classes, complete random assignment was not possible in this case. There were 59 students in the computer-supported PBL environment, 38 in the paper-based PBL, and 18 in the control group.

3.2.1 Computer-Supported PBL

The computer-supported PBL group used problem-based learning software recently developed by Holt, Rinehart and Winston Publishing Company. The CD-ROM-based program contains eight activities on different topics developed to support the middle school science curriculum. Upon starting the PBL application the students find themselves in a virtual science laboratory. Immediately on entering the laboratory a short video segment plays in which a scientist provides important details about a scientific problem she is working on and solicits the students' help in developing a solution. The activity used in this study is concerned with the classification of a microorganism and was selected because it was related to the topic being studied in the classes participating.

The students are supported in finding a solution to the problem by the availability of tools in the virtual laboratory. An *expert scientist* built into the virtual laboratory provides information about the scenario and takes on the role of a mentor in which she provides hints and feedback during the activity. The *inbox* provides a printed version of the problem scenario thereby supporting students in defining the problem. A *lab manual* provides important information on the use and importance of the tools found in the lab. The lab also furnishes a *computer database* which contains information that is essential for solving the problem. A *notepad* is also provided to support students in note taking during the activity. Most students are able to complete the activity in approximately forty-five minutes.

3.2.2 Paper-based PBL

Other students worked through a problem-solving activity, equivalent in content and available resources to the computer-based software, except that the information given (including the information in the database and the pictures) was print-based. Though identical in the resources provided, the computer and the paper-based PBL are different in that (1) the computer-based version allows interactive access of information while the paper-based does not, and (2) the computer-based version provides information in multimedia format while the paper-based does not.

3.2.3 Control Group

A third class was included as a control group. Students in this class learned the same content on microorganisms using the traditional approach (mostly lecture-based).

3.3 Dependent Measures

There are three dependent measures in the study: (1) achievement, (2) degree and frequency of access to the tools/features, and (3) attitude toward learning science. Students' knowledge about microorganisms was assessed through a pretest and a posttest. Their use of the tools and various design features in the computer version was recorded. Their attitudes toward science were evaluated through a questionnaire entitled "Attitude Toward Science in School Assessment." This attitude questionnaire addresses students' feelings about science as a subject and consists of 14 Likert scale items, with a reported reliability of .95 [Germann 1988]. In addition, the students in both the computer and paper groups were asked to record their steps in solving the problem. Interviews with students from all three groups and with the teacher were conducted. The triangulation of the quantitative and qualitative data sources will help to answer the research questions with richer and more detailed information.

3.4 Procedures and Analyses

Each of the 5 classes involved in this study was assigned randomly to one of the treatment conditions. For students in the computer and paper PBL groups, the entire treatment consisted of two phases. First, the teacher modeled the problem-solving process using another activity from the computer software (for the paper group, the information was presented through paper and pencil). Then the students were divided into groups of four or five and asked to work through the activity on microorganisms collaboratively. Literature on PBL shows that providing necessary scaffolding is a critical step in making PBL successful. The purpose of this teacher modeling phase was to introduce students to the steps of problem solving and provide them with guided practice. This phase was included in both the computer-supported and paper-based environments because we felt that the modeling should be part of problem solving regardless of the media involved and our primary interest in this study was to find out if the hypermedia environment could provide additional support for the students. Therefore, the instruction of the two conditions were held to be same. The control group worked through the regular instruction on microorganisms with no intervention.

In order to answer the first research question, "What is the effect of the computer-supported problem-based learning environment on the achievement of middle school science students?," a two-factor mixed ANOVA was run with the grouping (computer, paper and control) as a between-subjects independent variable, and the data collection points (pre vs. post) as the repeated measure independent variable. The dependent variable was the pre and post achievement scores in the science content test.

In order to answer the second research question, "What is the effect of the computer supported problem-based learning environment on the middle school students' attitudes toward science?," a two-factor mixed ANOVA was run with the grouping (computer, paper and control) as a between-subjects independent variable, and the data collection points (pre vs. post) as the repeated measure independent variable. The dependent variable was the pre and post scores for the attitude questionnaire.

In order to answer the third research question, "Is there a relationship between students' math or reading ability to their achievement in the problem-based learning environment?," a multiple regression was run with students' math and reading ability, measured by their most recent Texas Assessment of Academic Skills (TAAS) as the independent variables and their achievement test as the dependent variable.

In addition, students' use of tools in the hypermedia environment and the problem solving steps students taken in the computer and paper groups were analyzed descriptively. Students were selected for the post interviews after they completed the study. The purpose of the interviews was to find out (1) what the students liked and disliked about the environment; (2) what they found most useful in the environment; (3) what they thought about the process in general. Interviews were included as part of the data sources in order to provide more information on the study and substantiate the quantitative analyses. The interview data will be analyzed according to Miles and Huberman's framework of qualitative data analysis [Miles & Huberman 1994]. Such descriptive analyses and the findings from the qualitative data are being conducted at this point and will be added to the conference presentation.

4. Results and Discussion

The results of the two-factor mixed ANOVA on achievement indicated that there was a significant two-way interaction between the grouping (computer, paper and control) and the data collection points (pre vs. post) for the achievement scores: $F\ (2, 96) = 5.50, p < .01$. All groups increased their achievement scores from pre to post. The gains from pre to post were significantly greater for the computer and paper groups than for the control group [Tab. 1] [Fig. 1]. The gain differences between the computer and the control groups, and the paper and the control groups were significant at $p < .05$ level based upon the Fisher' s PLSD post hoc tests. The gain difference between the paper and the control groups was also significant at $p < .05$

level for the Scheffe post hoc test. This finding shows that both the computer and paper groups have significantly improved their achievement scores after they participated in the study while the increase for the control group was not significant. In other words, there was an effect of the problem-based learning environment on the achievement of middle school science students. Yet the difference between the computer-supported PBL and paper PBL was not significant.

The results of the two-factor mixed ANOVA on attitude indicated that there was not a significant two-way interaction between the grouping (computer, paper and control) and the data collection points (pre vs. post) for the achievement scores: F (2, 95) =.26, p= .77. Although there was a small increase in attitude from pre to post for all groups, there were no differences among the three groups [Tab. 1]. In other words, the treatment did not have an impact on the students' attitudes toward learning science.

	Achievement			Attitude		
	N*	Pre	Post	N	Pre	Post
Computer Group	50	12.7 (12.52)	31.58 (20.7)**	48	28.23 (12.19)	30.00 (14.10)
Paper Group	32	8.22 (12.53)	28.38 (18.43)**	17	31.91 (9.98)	34.76 (11.34)
Control Group	17	27.35 (12.64)	32.47 (13.35)	33	25.82 (8.90)	29.82 (14.33)

* N indicates the number of students who turned in both the pre and post evaluation forms for each group.
** significantly different from the control group, $p < .05$

Table 1: Mean and Standard Deviation (in Parenthesis) on achievement and attitude for the Computer, the Paper and the Control Groups

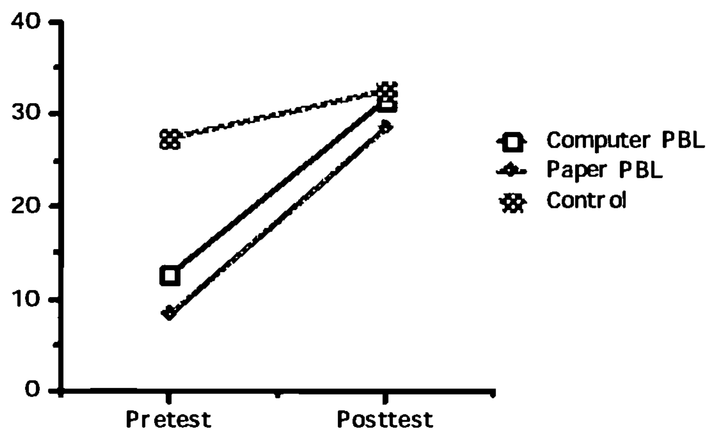

Figure 1: Achievement scores for the groups from pre to post

R	.59		*t* -values	
R2	.35		reading ability	3.46, $p < .1$
F	14.9, $p < .01$		math ability	1.26, p =.21
intercept	4.13			
Beta			Beta Weight	
reading ability		.42	reading ability	.47
math ability		.19	math ability	.17

Table 2: Results of the Multiple Regression Analysis

We were interested in finding out if there existed a relationship between students' math and reading abilities and their achievement when working in PBL environments. Students' scores in reading and math from a most recent TAAS test were used. TAAS is a state-wide testing system that assesses the overall academic achievement of all students in Texas at different grade levels. It provides information on students' reading ability, math ability and writing ability. The results of the multiple regression analysis showed that the significance of the relationship was moderately high among reading ability, math ability and the achievement scores for students using PBL: $r = .59$, $p < .01$. This significant relationship was mainly attributed to students' reading ability $t(72) = 3.46$, $p < .01$ [Tab. 2]. That is, students' reading ability is a better predictor for students' achievement in a PBL environment than their math ability. A PBL environment relies much on problem identification, presentation, problem-solving and student reflection. Though mathematical ability is obviously very important in problem solving, being able to read and comprehend the problem is critical. This finding provides some evidence on this issue and suggests that in order for students to be successful in a PBL environment, we, as teachers, need to make greater efforts to increase students' reading levels.

The findings of this study suggest that problem-based learning can influence the middle school students in their learning of science. When students were exposed to the PBL environment, they increased their achievement scores more than those students who learned the same content in the traditional classroom. Consistent to the literature on PBL, the results of the study provide some evidence in supporting the use of PBL. The findings also suggest that both the computer-supported and paper based PBL are equally effective. An interest of this study was to find out the types of tools or design features that can support students when working in a computer supported PBL environment. Although there was no significant difference between the computer and the paper groups on achievement, initial examinations of the problem solving process by the computer and the paper groups show some differences in the steps and use of available resources/tools. The use of tools/resources are currently being analyzed. The findings of the analyses for tool use and the qualitative data will be added to the result and discussion section for the conference presentation. Together, the findings will provide more insights as to how the tools can or cannot support problem solving in computer-supported PBL environments.

No significant differences among the three groups were found on the middle school students' attitude toward learning science. That is, the middle school students' attitude toward learning science was not affected by the introduction of PBL, computer-supported or paper-based.

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Dealing with the Designing Idea of PCAI (V.2)

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Abstract:

The key item of science and technology of our country--the development of the upgrading version of PCAI (v.2) is being undertaken. The key designing idea of the item is to make the software adapt the teaching mode facing the future. The software covers the main contents of college physics, including historical material, theoretical teaching, experimental demonstration, examples, exercises, tests and so on. It is based on WWW, makes use of the technology of Java and HTML etc. and takes advantage of hypermedia technology to endeavor to attain the international advanced level in technology. The software is open, expansionary and integrated. The development of it embodies that Chinese physics teaching is working for great teaching reform, trying to set up a completely new teaching mode and change the passive learning state of students. Education is walking towards democratization, lifetime, variety, personalization, efficiency and internationalization.

1. Preface

In March, 1995, [Physics Computer Assisted Instruction System (PCAI)], developed by twelve colleges and universities of our country, was completed and passed the appraisal by State Education Commission. It was authorized that the software chose a large scale of subjects and was powerfully systematic, so that it was the first set of complete physics CAI software of college of engineering and attained the domestic advanced level of CAI software.

The main characteristics of PCAI are:

(1) PCAI lays stress on accuracy and vividness of its technique of expression.

The use of PCAI will promote raising teaching efficiency. It is very difficult to express a lot of physics concepts, such as the shrink of length in the special theory of relativity, stationary wave, Doppler effect, magnetic focusing, polarization, and so on, clearly in words or in pictures on the blackboard. By means of animated drawing demonstrations, PCAI can cut down the lecture time in class and enable students to understand physics concepts more quickly.

The use of PCAI will enable students' left brains to be opened up together with the right ones, thus raising his study effect.

The use of PCAI will be good for making use of the students' unconscious attention and let them study with ease and joy.

PCAI software is welcome by vast numbers of lecturers. It is unquestionably the capable means of engineering physics teaching at present.

(2). PCAI software takes notice of the influence of non-intelligence factors and does its best to inspire the students with enthusiasm for study from all sides, stimulate the students' interest for study and foster their tenacious, challenging spirit to study.

University students, who are distinct from middle school students, have greatly decreased the dependence on their lecturers. Since their personalities are progressively independent, they are eager to study gradually through their own efforts. PCAI fully respects this very character of university students in both the demonstration of physics concepts and the manufacture of examples. In the light of the requirements of subject, PCAI can fully make use of the function of heat key and lead the students to go deep into physics field step by step, so that they can independently learn to solve some practical problems by means of the theories of physics.

In the course of study university students have got a characteristic that they like to exchange opinions one another. A good many conversations between students and computers in the examples can be the match for discussion when the students study on their own.

University students pay attention to the appraisal from others. The appraisal of exercises and tests, which is made by the computer, including praise, encouragement, hint and criticism, enables the students to receive the feedback about their study in time and obtain an impetus for study.

University students, like ordinary young men, are apt to get excited and feel nervous. Sound, colours and good animated drawings can attract their attention and sharpen their ability of thinking. Reckon the time inversely in a test, marking the students' papers and giving an objective appraisal after the test, raising the atmosphere for examination, which are convenient for the students to look squarely at themselves, are indispensable links in the course of study.

After 2 years of the spread and use of PCAI, it proved that the software had played a good role in assisting the teaching of college physics. But the fast development of science and technology and the requirement of the education of the society make us obviously feel the urgency of upgrading PCAI. In the summer holidays of 1996, the work of upgrading PCAI spread in an all-round way. At the beginning of 1997, this item was among the key items of science and technology of our country, and it was planned to be completed at the end of 1997.

The upgrading version of PCAI, also called PCAI (V.2), covers the main contents of college physics, including historical material, theoretical teaching, experimental demonstration, examples, exercises, tests and so on. It is based on WWW, makes use of the technology of Java and HTML etc. and takes advantage of hypermedia technology. The key designing idea of PCAI is to make the software adapt the teaching mode facing the future.

Modern education is the product of modern production and should also adapt to the need of the development of production. So the teaching mode facing the future must impel education to realize democratization, lifetime, variety, personalization, efficiency and internationalization, and make education be the base of the development of social productivity. In the upgrade of PCAI, how do we try our best to have the choice of physics topic, computer software tool, script writing and interface designing etc. fit for the characters of modern education to design the teaching mode facing the future?

2. Reasons Based on WWW

WWW is abbreviation of World Wide Web. It's an inquiring and browsing system on Internet. With the guidance of its corresponding interactive software, users can easily inquire different kinds of information distributed to each node computer of different places, which can be shared by everyone. At present, there is no systematic Chinese teaching software on Internet. PCAI will fill the blank in 1997. Its page will enter some nodes of Internet in succession. People of the same occupation and people interested in it can all make inquiries, communicate with one another and create conditions for internationalizing education.

Because there are not only people of wealth but also people of poverty and regional difference in human society, the implementation of democratization of education is often rather difficult. The software based on WWW will help more students to get equal opportunity of receiving education at less cost.

In 1990, NCFC (The Nation Computing and Networking Facility of China) project was under construction. NCFC was divided into two layers. The lower layer was school net including the Academy of Sciences of China, Beijing University and Tsing Hua University; the higher one was the school net connected with other domestic scientific research and educational units, and the backbone net of NCFC connected with international Internet. In 1992, the CASNET, TUNET and PUNET were completed. By the end of 1993, the backbone net of NCFC had been set up, and it connected three nets of the Academy and Universities by high-speed optical cable and router. The special line (64kbps) linked with Internet was opened regularly in April 1994. On May 21, 1995 the configuration of the CN main server which is of the highest domain name and the link of TCP/IP with Internet were realized, and the whole functional service of Internet to the members of NCFC could be provided.

In 1994, CERNET (China Education and Research Network), invested by State Planning Commission, presided over by State Education Commission, started, and the first period of project was completed in December 1995. Up to now over 100 colleges and universities have realized the connection with CERNET.

According to statistics, 11282 computers had been connected with Internet by July, 1996, which increased by 1003% in July, 1997, while the increasing ratio was 92% in the United States and 82% in Europe. The number of Internet users of China amounted to 50,000 in June, 1996.

In 1994, ChinaNet (China Public Computer Internet) invested by Ministry of Posts and Telecommunications of China started. As the first period of project, Beijing node and Shanghai node opened 256kbps and 64kbps separately.

The backbone net of China covers the large-scale data communication network of all the provinces throughout the country by TCP/IP Internetworking technology.

Today, with the continuous renewal of knowledge, lifelong study is an import means for anyone to learn how to exist. The basic construction of Chinese computer network develops very fast, and PCAI (v.2) will be the software that anyone who wants to study can study. In short, the reason PCAI chooses WWW as its network carrier is as following:

(1) WWW develops quickly with the popularity of Internet.

(2) WWW browser provides direct picture interface for users.

(3) WWW has platform independence. HTTP and FTP etc. are application layer agreements that are of good transplantation.

(4) WWW supports transmission of multimedia.

(5) WWW also supports the integration with other service of Internet.

3. The Basis For Choosing Technology

Users who dial to Internet with the help of telephone line and Modem hope that the faster the speed of transmission is, the better it will be. AVI of data stream or MEPG shows the image at the speed of only 1-2 frames per second at most. But if you utilize "GIF Construction Set" to make animation, you can realize simple animation on WWW.

Java is used in the programs of physical pictures of the software which makes the software have good capabilities of trans-platform and interface. You can execute the program of Java so long as you have the WWW browser to support Java on the operating platform.

This software seamlessly links some relative contents into a systemic non-linear net-structured Hypertext by HTML.

In fact this is an interrelated net of multimedia materials. There are two patterns so far as linking pattern is concerned:

- According to playing sequence
  - Sequential link (Link according to the physics teaching sequence that is in common use at present.)
  - Link of detailing (Link the information of physics that is extended and deeply described.)
  - Link of jumping (Link with other knowledge.)
  - Link of side branch (Link with interrelated part of the same knowledge.)
- According to information type
  - Link of text
  - Link of sound and image
  - Link of programs

In order to realize integration of multimedia data such as pictures, writings, sounds and images, the software utilizes some writing tools of HTML. For example, both FrontPage 97 of Microsoft and HotDog of Sausage support visual programs and a variety of multimedia information patterns like mov, avi, au, wav, jpg, gif and so on. Besides, you can control multimedia data simultaneously with the interface defined by CGI and ActiveX and description of VBScript and JavaScript.

The use of the latest computer technology guarantees the execution of the software on WWW without fault, and the incarnation of integrity, complexity and interrelation of knowledge, therefore the software will be guaranteed to realize the teaching function expected.

4. Significance of the Opening of Hypermedia

Many software developers notice that the development of teaching software should take consideration of the status of teachers and students. Most of software they have developed has good interface and is easy to use and coincide with the learning psychology of students. So the software has obvious teaching effect. For example, PCAI (v.2), taking full consideration of scientific teaching method, is welcomed by learners. But most software has a common shortcoming that the software is a system that is sealed off from teachers. Once the maker fixes the content of the software, the teacher who uses it can not add his (or her) content. This kind of software decreases the opportunity, making use of which one school ,one course or one teacher can show its (his) teaching character□thereby it will affect the enthusiasm of the use of software.

The software of PCAI (v.2) can be expanded and integrated, and the software is made up of three layers: storage layer, logic layer and application layer.

•Application layer

In this layer you can read hypertext information facing a dynamic and interactive interface.

•Logic layer

In this layer you can link and organize multimedia materials.

•Storage layer

The multimedia data such as texts, pictures, sounds and video in storage layer are content-relative elements that consist of software. But from the point of view of software structure, if a teacher is not content with some of these elements and wants to modify them, he (or she) can do it.

The freedom of information stream in opening system enables teachers to be satisfied with teaching, so as to accelerate teachers' breaking away from the tie of traditional habits and help them to form the idea of modern teaching.

5. Conclusion

PCAI (v.2) reflects the rules of physics vividly and accurately, which is welcomed by the teachers of physics and students throughout the country. The coming out of PCAI (v.2) will certainly make radical changes in physics teaching mode.

•On the pattern of information transmission, we should change the traditional method of expository teaching. The source of information no longer a teacher, nor is the linear transmission of pictures, sound recording or video recording, but the physical multimedia information world, in which action with stillness and sound with image take place, and both space and time can extend. The teacher giving lessons is a cooperator and organizer of physical information and guarantees the quality of information of teaching.

•On the pattern of acceptance, we create different conditions of software and hardware for the students, enable them to choose all kinds of modes, such as studying individually, studying cooperatively and having lessons collectively etc. It can exert the students' subjective capability, So that quality education can be infiltrated into physics teaching.

•On the pattern of the organization of information, teachers make use of network to store and search educational information, take advantage of computer technology of database and hypermedia to realize the structuralization and systematization of knowledge of information, embody the opening, relativity, complexity and dynamics of practical knowledge even better.

With the development of computer technology, there will be newer and better physical teaching software emerging in large numbers. Physics teaching activities will certainly coincide with human psychology of knowing and understanding matters more and more reasonably and adapt to the need of modern production better and better.

Lecture and Tutorial via the Internet - Experiences From a Pilot Project Connecting Five Universities

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Abstract: During the summer semester 1997 five German universities participated in a telelearning pilot project where a telelecture and -tutorial was held via the internet. Within this pilot project, we evaluated the m-bone based video conferencing tool as well as the applied didactic concept. The video conferencing tool provided insufficient quality of transmission and was deficient regarding its functionality as well as its interface. Concerning the telelecture we found reduced attention of the remote participants, and a lower level of interactivity between lecturers and students. Positive feedback regarding the tutorials which tried to encourage interactivity among the participant and regarding newly didactic elements within the lecture indicate that telelearning requires new teaching and learning approaches to compensate for its obvious constraints.

1. Introduction

Telelearning holds the premises of increased availability and reduced cost of education. Nevertheless the given technical constraints may reduce the efficiency of the learning processes. Each setting for telelearning faces this basic contradiction in a very specific manner. The basic challenge when arranging for any telelearning setting must be to gain the mentioned benefits without losing quality. Meeting this challenge requires an adequate technological infrastructure, an appropriate didactical concept, and a beneficial organizational embedment of the telelearning activities.

To analyze critical success factors in telelearning settings, case studies are required. In the following we will report about the experiences made in a pilot project connecting computer science departments of five German universities via the internet. The University of Freiburg is the only university in the south west German state of Baden-Württemberg where an institute is specialized in "Computers and Society". To allow students from the other locations to take a course in this subject, we offered to connect their universities by means of the internet. Thus, a lecture and a tutorial in "Computers and Society", normally just given in a face-to-face setting, were transmitted via an Mbone based video-conference application. Four universities (Constance, Mannheim, Suttgart and Ulm) decided to join this pilot project.

There are already quite some case studies which report on telelearning projects in the German university environment based on the same technological infrastructure (e.g.: Stucky et al. 1995, Eckert, Geyer and Effelsberg 1997). Nevertheless our case is specific concerning the following focal points:

- the rather big number of universities involved and its technological, didactical, and organizational implications,
- the combination of a telelecture and a teletutorial,
- the distinct didactic concept of the tutorial.

2 Didactical Approach, Students and Technological Infrastructure

During summer semester 1997 the authors carried out twelve lectures and seven tutorials on a weekly basis. To benefit from the rather favourable traffic-load in the internet, we hold the sessions in the earlier morning (8.15 a.m.-9.45 a.m.).

Regarding the telelecture the didactic concept was to give a conventional lecture and provide additional material via the WWW. The tutorial was intended to ground selected aspects of the lecture. As the education of computer scientists typically does not stress the development of communicative competence and as we assumed that this ability is nevertheless crucial for computer professionals, we tried to promote it by the way we set up the tutorials.

The tasks to work out in the tutorials asked the students to input statements which in some cases had to be prepared by carrying out interviews. These input statements were discussed in the following. We asked the students at the single locations to form groups to work out the tasks. Moreover, we established a mailing list in which all the participants were supposed to register for intergroup discussion. Finally the lecturers gave their telephone number and e-mail address to answer questions which could not be solved among the students. The students were supposed to deliver their solutions to the tasks via e-mail or by sending a http-address.

The number of participants (students and local support) at the fife different locations varied for the lecture between 22 and 8 with an average of about 15 and for the tutorial between 17 and 7 with an average of about 11. In the lectures as well as in the tutorials the highest number of participants joined the first session. The number declined gradually towards the end of the semester (cf. Wulf and Schinzel 1997).

The lecture and the tutorial were carried out based on a Mbone (Multicast Backbone) based videoconferencing toolset. Mbone protocols were running on top of the IP protocol of the Internet which had a bandwidth of 34 Mbps between the universities. Within the individual sites a typical configuration consisted of a university networks (FDDI, 100 Mbps) and a local network (Ethernet, 10 Mbps). The video conference toolbox contained an audio tool (vat), a video tool (vic), a shared whiteboard (wb) and an additional tool to synchronise the display of the shared whiteboard (wbimport) (cf. Eriksson 1994). We favoured this freeware toolset compared to commercial ones because we could run it on different hardware platforms.

In Freiburg and Ulm the sessions were hold in a lecture room. Thus, the screen of the connected workstations was - fully or partly - projected by a beamer. The audio was by loudspeakers, while microphones registered the local voices. The video was at each location caught by a single camera. In Constance, Stuttgart and Mannheim the participants followed the sessions in front of workstations which were placed in specific rooms. Thus, there was not any beamer display. While some of these workstations were equipped with a video camera (Mannheim and Stuttgart) and with headsets (Stuttgart), others were just equipped with microphones and loudspeakers.

3 Research Method

To evaluate the telelearning pilot project we have applied several qualitative methods. After each session the authors have written a report documenting the most important events. Moreover, we asked the local students in the end of each session to give us feedback. Following their feedback, we interviewed them individually or in small groups several times during the semester. In the second part of the semester, we used the video conference toolset, to get feedback in the end of the session from the remote participants.

One of the authors travelled once during the semester to each of the remote sites. After the corresponding session he had a group discussion with the students and the local support. In the last lecture we used the video conference toolset to discuss the experiences made with this type of telelearning. We used the shared whiteboard to ask the participants to type in anonymously positive and negative impressions on one slide. Based on this input we discussed advantages and disadvantages of the telelectures and -tutorials. In the second part of this lecture we discussed five thesis which the authors had distributed before via e-mail. The results of this discussion were documented and evaluated. Additionally we have achieved the e-mails exchanged and have written notes of the most important phone-calls concerning the lectures and the tutorials.

4 Experiences

4.1 Video Conference Toolset

The Mbone based toolset allowed us to hold the lecture as well as the tutorial during the whole semester, but nevertheless we experienced a lot of technical problems which challenged the patience and motivation of the participants. During the 19 sessions, we had four complete breakdowns of the Mbone-net which interrupted the connection to all external locations for 15 up to 45 minutes. The connection with Ulm was - especially due to frequent drop-outs of the voice channel - that bad that these students stopped participating after the first four weeks. The connection among the other locations were characterised by occasional problems of the voice channel especially in the second part of the section (after 9 a.m.) (cf. Wulf and Schinzel 1997). To reduce the netload, and thus to improve the quality of the audio channel, we often abandoned the video transmission in the second part of the session. It turned out that already short drop-outs of the voice channel can lead to serious misunderstandings (cf. Wulf and Schinzel 1997). Based on the given infrastructure (bandwidth of the different networks and router capacity at the time of the study) there are severe problems in transmitting telelearning sessions by means of the Mbone-protocol. To allow for an undisturbed transmission between multiple locations bandwidth reservation seems to be indispensable (cf. Geyer, Eckert and Effelsbrg 1997).

Moreover, running the Mbone protocol requires the cooperation of actors administrating the different subnets who do not necessarily value the success of telelecturing in a sufficient way. These incongruent interests can lead to considerable problems. For instance, lacking attention of one of the local network administrators caused one of the complete breakdowns of the transmission. A sixth university did not participate due to lacking cooperation among the different network administrators.

Looking at the video application toolset, we found severe deficiencies in the design of the surface interface as well as of the functionality. Looking at the surface interface the design violates almost every principle of the ISO 9241 part 10 standard. For instance, the surface design is inconsistent between the individual applications as well as within single ones, e.g. the meaning of the mouse buttons differs within the audio tool. This inconsistency led to problems in communication within the first sessions because one of the authors occasionally failed to activate the audio channel when speaking. Moreover, the functionality of the toolbox is badly documented. For instance, it took us several attempts of cooperative exploration to build up an appropriate mental model of the different transmission modes of the audio tool and their mutual interrelations at the different sites.

Beyond the surface interface there were severe deficiencies of the toolsets' functionality, as well. The design of the audio tool's transmission modes inhibited the interactivity in the lectures and in the tutorials (cf. chapter 4.2). As the ambient noise resulting from the loudspeakers could not be suppressed automatically, formalised turn-taking protocols had to be applied which required to press a button before speaking. Neil (1997) reports about similar problems with videoconferencing tools when providing telelearning courses in a companies setting. Thus, research should be directed to allow for full duplex audio links.

The functionality of the shared whiteboard proved to be deficient, as well. The drawing functionality of the whiteboard is rather restricted. It mainly allows to annotate slides which have been imported. Its functionality is not sufficient to draw fully new slides. Nevertheless in the tutorial it turned out that there was a strong need to create slides spontaneously to visualise aspects of the discussion or to present multiple input on the screen (e.g.: technique described in chapter 3). Thus, the functionality of the shared whiteboard should be extended to the level of regular graphic editors. To collect multiple input, different turn taking protocols should be implemented in the whiteboard (cf. Greenberg 1991; Dommel and Garcia-Luna-Aceves 1997). This would allow to evaluate them in different learning scenarios.

Moreover, one should reconsider the given restriction to the keyboard as the sole input device. Electronic whiteboard with pen input devices would greatly encourage the simultaneous participation of different actors in creating graphics. Moreover, it turned out that typing on the keyboard and synchronously speaking is a difficult task. Here again a pen based input device would ease participation. Such an equipment would also encourage acceptance in scientific culture whose lecturing style is more based on blackboard than on slides (e.g. in mathematics).

The design of the shared whiteboard does not transmit the position of the pointer and movement of graphical elements to the remote locations. This design decision obviously limits the amount of data necessary to transmit. Nevertheless, it turned out during lectures and tutorials that the ability to spontaneously point to a graphical element or to encircle parts of a slide are very helpful in telecommunication. The implemented substitutes (creation and deletion of annotations) are not sufficient. Thus, in an new version movements of cursors and graphical elements should be transmitted at an appropriate level of granularity.

Moreover, the postscript based import-function of the whiteboard was not only badly documented but also badly implemented. It took us long lasting attempts involving various conversions and manipulations to import files created on Windows, Macintosh and Unix systems. Such problems are prohibitive for users who do not have a profound computer background.

Carrying out the lecture and tutorial it turned out that there is a need for additional tools for meta-communication. To compensate for the problems of the audio tool and to encourage interactivity, one should integrate a tool which allows remote participants to make the speaker aware of questions or remarks. Connecting just two locations Eckert, Geyer and Effelsberg (1997) have extended the video-conference toolset by implementing a "putting up of hands" tool. This tool should get extended to cover multiple locations. Meta-communication is needed furthermore to optimise technical aspects of the transmission among the different sites (e.g. position of the cameras, quality of the voice channel, transmission rate of the video channel). A potential communication tool to use in these cases is the shared text editor which is included in the Mbone tool set.

4.2 Didactical Approach

As we have applied specific didactical approaches in the lecture and in the tutorial, we will look individually at the different experiences.

The first remarkable observation concerns the speed of lecturing. We were not able to present as many topics as in a face-to-face lecture. This fact is primarily caused by the many bigger and smaller technical breakdowns (cf. chapter 4.1). Beyond this we used additional time to collect verbal feedback from the remote locations (e.g. concerning: quality of transmission, attention and understanding). In a face-to-face situation this feedback is either not necessary or it can be implicitly collected by watching the audience. Feedbackwise, the video stream transmitted could not replace the physical presence of the auditorium.

Moreover, the participants at remote locations reported about a lower level of attention compared to face-to-face lectures. Those who followed the lecture from a terminal reported that they occasionally used their mail tool or their web browser during the lectures. Neil (1997b) hints to similar experiences when teaching in a multinational company. Obviously telelecturing implies the loss of social control which typically is imposed by the physical presence of the lecturer. Thus, the lecturer faces a stronger competition for the attention of the participants.

Like Geyer, Eckert and Effelsberg (1997), we experienced a low level of interaction between the lecturer and the participants. The first question of a student occurred after almost two months and was facilitated by a technical breakdown of the transmission. There are several reasons for this phenomenon. One of the local students in Freiburg stated that he did not want to disturb all the participants at the different locations by posing a question. A student from one of the remote universities explained that she hardly could recognise the appropriate moment for posing a question. In her eyes this problem is more severe if there is not any video of the lecturer. By contrary the lectures' failed in rising the interactivity when trying to pose questions to the remote participants. Due to a lack in context information, they were not able to detect the appropriate moment and the "right" partner. Moreover, the inappropriate transmission-modes of the audio tool and missing tools for metacommunication influenced the interactivity between lecturer and audience negatively (cf. chapter 4.1)

To increase the level of attention and interactivity, it turned out to be helpful to integrate additional slides into the lecture which asked the students questions about the content of the preceding chapter. These questions had to be answered immediately by textual input using the shared whiteboard. Based on the input we initialised a discussion especially when answers were wrong, incomplete or missing. This technique encouraged participation and gave us valuable feedback about the performance of the students.

The approach taken in the tutorial to encourage (tele-) communicative competence was appreciated by the students - especially in Constance and Ulm. Besides the considerable technical deficiencies of the video conference toolset, the students were able to give smaller talks which increased in quality during time. Moreover, they were able to participate in the occasionally controversial discussions. The participants especially appreciated the exchange of ideas with students from other universities which were often of rather different opinion. To start discussions it turned out to be helpful to ask the participants to express their point of view by typing text into the shared whiteboard (cf. chapter 3).

Due to the design of the audio tool, formal facilitation of the discussions was necessary (cf. chapter 4.1). Nevertheless there was a lack of context information which made it difficult for the facilitator to pass the right to speak among the participants. As not all of the sites were equipped with video cameras, it was impossible to see who puts up the hand to create a list of speakers. Furthermore it was difficult to predict which participant could contribute most appropriately to a current discussion. This led to problems in maintaining the focus of the discussion. Thus, to support tutorials which are strongly based on mutual interaction high quality video and tools for metacommunication seem to be indispensable.

Though we had asked the participants to introduce themselves within the first session of the tutorial, the students later reported about a feeling of anonymity towards each other. Occasionally they could not identify the speakers at the other sites or relate them to the introductive statements given in the first session. Thus, they reported about a feeling of emotional distance. Some of them suggest a face-to-face meeting of all the participants involved which should take place after the first month of lecturing. Nevertheless it was doubted whether there were sufficient resources of time and money for such a meeting. Thus, the students suggest to combine face-to-face and telelearning elements. Preece and Keller (1991) report about experiences with such a hybrid approach.

The perceived anonymity is contradictive to finding of Neil (1997 a and b) who used multiple technologies like videoconferencing, audioconferencing, and a variety of Internet-based conferencing to hold teleseminars in a multinational company. She found that students were surprisingly familiar with each other in the end of the class. However their seminar lasted only four weeks with sessions, typically scheduled three times a week for two hours. Thus, the contradictive findings may be explainable either by the shorter duration and higher density of Neil's teleseminar or by an in this respect more successful didactical approach. Anyhow, further research seems to be necessary in this point because the building of social networks is a crucial factor for the success of telelearning. In this respect the tutorial did not turn out to be successful. Neither within the different sites nor between the sites, the students built groups in solving the tasks of the tutorial. Moreover, the common mailing list was not used by the students to discuss between the sessions. It was merely used for announcements of the organisers.

Looking at the general attitude toward the telelearning pilot project, we found a significant difference in the attitude of the students in Freiburg compared to the remote sites - notably Constance and Ulm. From the beginning the students in Freiburg complaint about the disadvantages of telelearning:

- disturbance due to technical problems,
- interruption of the current lecture due to meta-communication with the remote sites,
- reduced attention of the lecturers towards the local students.

As they had regular courses in "Computers and Society" at their faculty, telelearning did not enlarge their curricula. Moreover, several of them had already experience with telelearning because this topic is a research focus of the Freiburg faculty (cf. Bacher and Ottmann 1996, Ottmann and Bacher 1995). Thus, we could not draw on their curiosity, either.

By contrary, the students at the remote sites appreciated the lecture and tutorial as an enrichment of their curriculum. They had a significantly more positive attitude toward the experiment though they suffered most from the technical breakdowns and deficiencies. Interestingly, Eckert, Geyer and Effelsberg (1997) also found that the students at the site where the lecture was held before in a face-to-face ensemble gave lower ratings than those at the remote sites. We believe that this attitude is rational because under the given circumstances the local students are losing quality of education without gaining an enrichment of their curriculum. To encourage their motivation one has to provide benefits to them like increased asynchronous availability of the lecturers or didactically elaborated material.

In carrying out both the lecture and the tutorial we experienced a significant higher workload for the lecturers compared to traditional courses. If one does not mention the overhead caused by the evaluation presented here, the following reasons have led to an increased workload:

- development of appropriate concepts for telelearning,
- higher standards for the layout of the material, e.g. slides,
- additional presentation of all relevant material by means of the web,
- higher efforts in asynchronous communication when supporting remote students,
- coordination with the local support at the remote sites,
- tests of the technical infrastructure,
- preparation of the organisational setting (contacting the remote faculties, arranging the time-table, booking lecture rooms etc.).

These additional tasks have to be kept in mind if one discusses the potential for cost reduction in education by means of telelecturing. Moreover, local support at all the remote sites is indispensible. As the preparation of didactic material is rather resource intense, there is the danger of an too extensive reuse of this material over time. This may lead to an outdated contend of telelearning courses.

From our experience it is crucial to plan and prepare courses in telelearning early in advance. We started to contact the remote faculties about four month before the first session was supposed to take place. In some cases this time span turned out to be insufficient. For instance, it was too late to get our course included in the printed programs of these faculties. As the faculties had planned their programs already, it was moreover difficult to get resources for the local support.

To develop new ideas for the use of the video conferencing tool in telelearning, the feedback of the students and of the local support proved to be very helpful. Quite some ideas presented here resulted form group discussions after the sessions. Moreover, it proved helpful for all of the participants to join a presentation of an experienced speaker. In our case a collegue providing local support in Mannheim had profound experience in telelecturing. His presentation in one of the tutorials was a source of inspiration for the following speeches. This experience hints to the fact that lecturers should be supported by specialists transferring teleteaching experience. Especially in the beginning such a support seems to be crucial to develop appropriate didactical concepts for telelearning.

5. Conclusion

We have reported about experiences gained form a telelecture and teletutorial on „Computers and Society" carried out in summer semester 1997 connecting five German universities. We evaluated the applied toolset as well as the didactical approach taken. It turned out that bandwidth reservation is indispensable to support our didactical approach. Moreover, the video-conferencing toolset proved deficiently designed concerning its surface interface as well as concerning its functionality. The telelecture turned out to lead to a lower level of attention and interactivity. To us it is an open question whether new didactical elements like the ones presented here will overcome these problems. The positive perception of the tutorials hints to the fact that telelearning requires new didactic concepts which involve the students more actively than lectures typically do.

Nevertheless our experiences are based on just one case. Our results are influenced by factors such as the topic of the courses, the personalities of the actors and the technology applied. Thus, these results have to get compared to further case studies. Tackling the problems presented, synchronous telelecturing has the potential to make education more easily available. Nevertheless, it is doubtful whether it will be more lecturer-time efficient than traditional face-to-face approaches. We believe that the quality of education requires the integration of interactive elements which restricts the maximal number of participants considerably.

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ATM Technology Adoption in U.S. Campus Networking

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Abstract: ATM is an emerging technology in computer networking. The technology provides potentiality for universities to build their networks based on the future vision of uniting voice, data, and video communications on ATM-technology-based equipment. A review of the literature revealed that minimal evidence exists to indicate whether the size, type, financial factors, and information processing maturity of a university affect a university's high-tech innovation adoptions. The purpose of this study was to determine the relationships between ATM adoption and four organizational variables: university size, type, finances, and information processing maturity. The results of the study provided evidence to show that ATM adoption in campus networking is significantly related to university size, type, finances, and information processing maturity.

Introduction

Today, information and telecommunication technologies have elevated human communication, information, and information resources exchange to the highest stages they have ever been. As requests for additional and the latest information in education increase, institutions of higher learning are striving to provide the latest information and information resources for university faculty members, researchers, and students. To meet the challenge of the need for information, higher education institutions are compelled to continue adopting state-of-the-art technologies to information and telecommunication systems to upgrade their information processing facilities.

ATM (asynchronous transfer mode) is an emerging technology in computer networking, which in turn is the physical media of information systems and networking/telecommunication (N/T) systems. The major benefit of ATM is of its potentiality for users to build networks based on the future vision of uniting voice, data, and video communications on ATM-technology-based equipment [McDysan & Spohn 1995]. Having realized the significant values of ATM on current campus networks and the potential of ATM to improve performance and lower overall network, equipment, and operating costs in the long term, some higher education institutions have adopted or are planning to adopt ATM in their campus networks. However, a review of the literature revealed that, in university settings, there is minimal evidence indicating whether the size, type, financial factors, and information processing maturity of a university would affect a university's high-tech innovation adoptions. No research of this nature has been found in any study of ATM adoption in any institutions of higher learning, nor has any research of this nature been undertaken by other organizations, either.

Purpose of the Study

The purpose of this study was to determine the relationships between ATM adoption and the following factors: university size, university type, university finances, and university information processing maturity. Another purpose of the study was to identify the current status of ATM adoption in campus networking.

Methodology

The research design for this study was correlational since this method permits one to analyze the relationships among a number of variables in a single study [Borg & Gall 1989]. The sample subjects were selected from the population of university domain LAN administrators in the United States. The list of the user address of these university domain LAN administrators in the United States was accessed electronically by using the InterNic.

The total student enrollment of a university was defined as university size and was obtained from National Center for Educational Statistics 1996 database. University type was specially defined as Research Universities and non-research universities for this study. The list of Research Universities was obtained from the technical report published by The Carnegie Foundation for the Advancement of Teaching: *A Classification of Institutions of Higher Education: 1994 Edition* [The Carnegie 1994]. The percentage of a university's overall information technology expenditures that is expended for the university's campus N/T budget is defined as university finances. It was obtained from two sources. One source was the *Report on 1994 and 1995 Budget Information* [CAUSE 1996] by CAUSE Institution Database Service. The other source was a researcher developed instrument, which contained questionnaire items designed for obtaining the data.

The questionnaire was posted on the World Wide Web. Internet e-mail was used to distribute the cover letter of the questionnaire to each university domain LAN administrator. A total of 554 user addresses were actually sent through via the Internet. From the 554 user addresses sent through, a total of 208 responses were received for a response rate of 37.55%. Out of the 208 responses, 9 were unusable, leaving 199 usable, yielding a usable response rate of 35.92%.

Logistic regression was used to study the relationship between the selected organizational variables and ATM adoption in a university's campus networking. Nested Models were designed for analyzing the data in the study.

Findings

Categorical Statistics

ATM Adoption Status

Of the 199 responses received, 58 universities stated that they had adopted ATM technology, which was almost 30% of the responses. Of these 58 universities which have adopted ATM, 51.7% were Research Universities, 22.4% were Doctorate-Granting Universities, and 25.9% are neither Research Universities, nor Doctorate-Granting Universities. The frequencies for ATM adoption are shown in [Tab. 1] and [Tab. 2].

Status	Freq.	Percent
Adopted	58	29.1
Non-Adopted	141	70.9
Total	199	100.0

Table 1: Frequencies for ATM Adoption Status I

University Type	Adopted		Non-Adopted		Total
	Freq.	Percent	Freq.	Percent	
Research	30	51.7	16	11.4	46
Doctorate	13	22.4	23	16.3	36
Neither	15	25.9	102	72.3	117
Total	58	100.0	141	100.0	199

Table 2: Frequencies for ATM Adoption Status II

Descriptive Statistics

Descriptive statistics (mean and standard deviation) for both the dependent and independent variables are reported in this section. Means for Overall IT Budget (m = 6.81) and Budget for Network/Telecom (m = 15.97) indicate that in universities an average of 15.97% of the overall Educational and General (E & G) budget that is expended for information technology is allocated to campus N/T. [Tab. 3] depicts the descriptive statistics for the predictor variables.

Variables CDATA, CUDMK, CDEPTDMK, CSTRUDMK, CUNSTRDM, and CLRNSCH are based on a scale of 1 to 6, with 1 = Strongly Disagree and 6 = Strongly Agree. High values represent high information processing maturity. Similarly, but in the opposite direction, CUDMK, CDEPTDMK, and CSTRUDMK are based on 1 (Strongly Disagree) to 6 (Strongly Agree), with low values representing high information processing maturity.

Variable	Variable Label	Mean	Std Dev
ADOPT	Adoption Status (Dummy, 1=Adopted)	.29	.46
ENROLLMT	Enrollment	11722.85	9661.26
UTYPE	University Type (Dummy, 1=Research)	.23	.42
ITBUDGET	Overall IT Budget	6.81	7.74
NTBUDGET	Budget for Network/Telecom	15.97	15.16
CDATA	Data/Information Handling	*4.32	1.49
CUDMK	Univ. Level Decision-Making	*3.11	1.29
CDEPTDMK	Dept/College level Decision-making	*3.27	1.30
CSTRUDMK	Structured Decision-Making	*3.15	1.35
CUNSTRDM	Unstructured Decision-Making	*3.55	1.28
CLRNSCH	Learning/Research	*5.05	1.18

SPEED	Speed, Bandwidth, Efficiency Improvement (Dummy, 1=Improved)	.93	.26
PLAN	ATM Plan (Dummy, 1=Planned)	.55	.50
COST	Dollars on ATM up to date	835425.53	2423261.55
YR1	Planned Money for 96	354046.51	407255.68
YR2	Planned Money for 97	381428.57	358069.49
YR3	Planned Money for 98	457972.97	897998.90
YR4	Planned Money for 99	549687.50	644806.72

Note: * Scale of 1 to 6 (Strongly Disagree to Strongly Agree).

Table 3: Descriptive Statistics for the Predictor Variables and Categorical Variables

Logistic Regression Results

Variable	Model 1		Model 2		Model 3		Model 4	
	(	Exp (()	(	Exp (()	(	Exp (()	(	Exp (()
ENROLLMT	.00008***	1.0001	.00003	1.0000	.00002	1.0000	.00002	1.0000
UTYPE			1.6733***	5.3297	1.6505***	5.2095	1.5204**	4.5740
NTBUDGET					.0528***	1.0542	.0526***	1.0540
MT1							.6980*	2.0098
MT2							.3479	1.4161
Model (^{2}	23.979		37.519		53.953		59.618	
Df	1		2		3		5	
Significance	.0000		.0000		.0000		.0000	

*p<.05; **p<.01; ***p<.001

Table 4: Logistic Regression Coefficients and Goodness-of-Fit for the Nested Models

Nested Models were used to analyze model variables. The logistic regression coefficients for the Nested Models are listed in [Tab. 4]. According to Norusis (1994), the logistic coefficient can be interpreted as the change in the log odds associated with a one-unit change in the independent variable. The logit (the log of odds) is represented by the coefficient under (. Since it is easier to think of odds rather than log odds [Norusis 1994], the logistic model uses *Exp (* (exponential function of coefficient) to represent odds, interpreted as by increasing the value of the independent variable's coefficient from 0 to 1 the odds are increased by a factor of the value under *Exp (*. If the independent variable's coefficient value (is positive, this factor will be greater than 1, which means that the odds are increased; if (value is negative, the factor will be less than 1, meaning that the odds are decreased. Based on this rule of thumb and the coefficient values revealed in [Tab. 4], the interpretation of these models is stated in each of the individual sections to follow.

Model 1

Variable ENROLLMT (university enrollment) was entered in Model 1 as the independent variable. The regression coefficient for ENROLLMT is .00008 and the exponential function of the coefficient (*Exp ()* is 1.0001. The coefficient is positive and significant at the .001 level. Therefore, it can be concluded that there is a statistically significant relationship between dependent variable ATM Adoption and the independent variable ENROLLMT. The odds ratio = 1.0001 indicates that (without size classification) larger universities are 0.01% more likely than smaller universities to adopt ATM.

The model chi-square tests the null hypothesis that the coefficient in the current model, except the constant, is 0 (Norusis, 1994). This is comparable to the overall *F* test for regression. If Model (^{2} is statistically significant beyond p = .05, it indicates that the predictor variable contributes no chance to the explanation of the dependent variable [Menard 1995]. In this model, a Model (^{2} of 23.979 relative to one degree of freedom is obviously statistically significant beyond p = .05, which indicates that university size is significantly associated with ATM adoption.

Model 2

Model 2 included independent variables ENROLLMT and UTYPE. The (coefficients for ENROLLMT and UTYPE are .00003 and 1.6733 respectively. The *Exp (* value for ENROLLMT is 1.0000, for UTYPE is 5.3297. The p-value for ENROLLMT is p > .05, indicating that, controlling for variable UTYPE, there is a weak relationship between university size and ATM adoption.

The p-value for UTYPE is p < .001. Therefore, we can conclude that, irrespective of university size, there is a statistically significant relationship between ATM Adoption and UTYPE. To be more specific, the odds ratio 5.3297 shows that, net of university size, the odds of adopting ATM for Research Universities is 433% greater than for non-research universities.

Model 2 has a Model (^{2} of 37.519 relative to two degrees of freedom, which is statistically significant beyond p = .05. Compared to Model 1, Model 2 improves the goodness-of-fit (37.519 - 23.979 = 13.540) (2 - 1 = 1). As a result, Model 2 is better than Model 1 because variable university type further improves the fit by ((^{2} = 13.540 relative to one degree of freedom.

Model 3

Variable ENROLLMT, UTYPE, and NTBUDGET were involved in Model 3. The p-value for ENROLLMT is p > .05, indicating that, controlling for variables UTYPE and NTBUDGET, there is a weak relationship between university size and ATM adoption. The p-value for UTYPE and NTBUDGET is p < .001. A p-value less than .001 allows us to conclude that, regardless of ENROLLMT and NTBUDGET, there is a statistically significant relationship between ATM Adoption and UTYPE; that, regardless of ENROLLMT and UTYPE, there is a statistically significant relationship between ATM Adoption and NTBUDGET.

The odds ratio for UTYPE is 5.2095, which indicates that, net of university size and N/T budget, the odds of adopting ATM for Research Universities is 421% greater than for non-research universities. The odds ratio 1.0542 for NTBUDGET indicates that, net of university size and university type, the odds of adopting ATM for universities with higher networking/telecommunication budget are 5.42% greater than for universities with lower N/T budget. It is apparent that both university type and N/T budget are significant predictors of ATM adoption in campus networking, university type in particular.

Model 3 shows a Model (^{2} of 53.953 relative to three degrees of freedom, which is statistically significant beyond p = .05. Compared to Model 2, Model 3 improves the goodness-of-fit (53.953 - 37.519 = 16.434) (3 - 2 = 1). As a result, Model 3 is better than Model 2 because variable N/T budget further improves the fit by ((^{2} = 16.434 relative to one degree of freedom.

Model 4

Variable ENROLLMT, UTYPE, NTBUDGET, MT1, and MT2 were entered in Model 4. The p-value for ENROLLMT is $p > .05$, indicating that, controlling for variables UTYPE, NTBUDGET, MT1, and MT2, there is a weak relationship between university size and ATM adoption. The p-value for UTYPE and NTBUDGET is $p < .001$. A p-value less than .001 allows us to conclude that, regardless of ENROLLMT, NTBUDGET, MT1, and MT2, there is a statistically significant relationship between ATM Adoption and UTYPE; that, regardless of ENROLLMT, UTYPE, MT1, and MT2, there is a statistically significant relationship between ATM Adoption and NTBUDGET. The odds ratio for UTYPE is 4.5740, which indicates that, net of university size, N/T budget, MT1, and MT2, the odds of adopting ATM for Research Universities are 357% greater than for non-research universities. The odds ratio for NTBUDGET is 1.0540, which indicates that, net of university size, type, MT1, and MT2, the odds for universities with a higher N/T budget are 5.4% greater than for universities with a lower N/T budget. The p-value for MT1 is $p < .05$, which indicates that, irrespective of variable university size, university type, N/T budget, and the second index variable, there is a statistically significant relationship between ATM Adoption and the first index variable, namely the germane application of information system in university settings. This indicates that information processing maturity is statistically related to ATM adoption, which means that universities with germane application of information system are 101% more likely to adopt ATM than universities with immaterial applications of information system. The p-value for MT2 is $p > .05$. Therefore, it can be concluded that there is no statistically significant relationship between ATM Adoption and the second index variable, namely the immaterial application of information system in university settings. This conclusion supports the logic assumption that most universities have germane application of information system.

Model 4 submits a Model (^{2} of 53.953 relative to two degrees of freedom, which is statistically significant beyond p = .05. Compared to Model 3, Model 4 improves the goodness-of-fit (59.618 - 53.953 = 5.665) (5 - 3 = 2). As a result, Model 4 is better than Model 3 because variable MT1 further improves the fit by ((^{2} = 5.665 relative to two degrees of freedom.

Enrollment Size Model

A model separate from the nested models was performed for each independent variables in the nested models, namely, variables university type, finances, and information processing maturity (MT1 and MT2) using logistic regression. The results were very much similar to the results shown in the nested models, and they are not listed in tables for that particular reason. It was interesting to notice, however, that university size showed much less significant relationship to ATM adoption when compared with other variables. This is because variable ENROLLMT was used as a continuous variable. In reality, university size varies greatly from about 1,000 up to 50,000. Built on this fact, an additional model, Enrollment Size Model, was performed to analyze variable ENROLLMT based on the variable's enrollment classification of size: Small, Medium, Large, Very Large. The detailed analysis of variable ENROLLMT of Model 1 in [Tab. 5] revealed farther information about the relationship of university size and ATM adoption, and the results of this detailed analysis were far more informative and significant than Model 1 of [Tab. 4] in explaining the relationship of university size and ATM adoption. [Tab. 5] shows the logistic regression coefficients and Goodness-of-fit for the Enrollment Size Model.

Variable	Size Model	
	(	Exp ()
ENROLLMT		

Size1	.00008***		2.0940
Size2	1.7716***		5.8800
Size3	2.7932***		16.3333
Model (2		24.288	
Df		3	
Significance		.0000	
*p<.05; **p<.01; ***p<.001			

Table 5: Logistic Regression Coefficients and Goodness-of-Fit for Enrollment Size Model

As discussed above, variable ENROLLMT is significant in the nested models as shown in [Tab. 4], but its odds ratio is low, almost equal to 1 (Exp (() = 1.0001). This is because ENROLLMT was used as one variable, disregarding the different size of each university. In the current model, however, enrollment size classification was involved and the odds ratio increased dramatically for Medium, Large, and Very Large categories, with reference to the Small size category. [Tab. 5] indicates that Medium size universities (Exp (() = 2.0940) are 109% more likely to adopt ATM than Small size universities. Large size universities (Exp (() = 5.8800) are 488% more likely to adopt ATM than Small size universities. Very Large size universities (Exp (() = 16.3333) are 1533% more likely to adopt ATM than Small size universities. It is evident that university size does seem to be significantly related to ATM adoption. When classified, university size is a very good predictor of ATM adoption in campus networking.

Conclusion

Logistic regression statistical analysis shows that the variables university size, university type, university finances are all predictors of ATM adoption in campus networking. The MT1 index variable of information processing maturity is also a predictor of ATM adoption. Of these variables, university type is strongly associated with ATM adoption in campus networking. The statistics suggests that Research Universities are 357% more likely to adopt ATM than non-research universities, as shown in Model 4 of [Tab. 4]. University finances, namely Networking/Telecommunications budget, is also a good predictor of ATM adoption. The statistics indicate that universities with a higher N/T budget are 5.4% more likely to adopt ATM than universities with a lower N/T budget, as shown in Model 4 of [Tab. 4].

Statistics for MT1 shows that germane application of information systems is a significant predictor of ATM adoption, which indicates that universities with germane application of information systems tends to have higher information processing maturity. What this means is that universities with germane application of information systems, namely, germane application of information systems to support data and information handling, unstructured decision-making, and learning and research, are 101% greater to adopt ATM than universities without germane application of information systems. Thus, it is cognitive to conclude that information processing maturity is significantly related to ATM adoption.

In sum, the results of the statistical analysis support all the research questions of the study. Thus a conclusion is drawn: there is a statistically significant relationship between university size and ATM adoption; that there is a statistically significant relationship between university type and ATM adoption; that there is a statistically significant relationship between university finances and ATM adoption; that there is a statistically significant relationship between university information processing maturity and ATM adoption.

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It Takes More Than Two To Tango: A "Team Building" Model for Educational Technology

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Abstract: The teaching /learning process does not occur in a vacuum. No instructor, support staff or administrator can single-handedly create an optimum learning environment for many students with different learning styles. When technology is added in the teaching/learning environment, a fundamental "team" commitment is required from the students, instructor, technology support staff and university administration. Music is a very accessible means to discuss many interdisciplinary teaching/technology applications. Thus, our presentation will demonstrate how the "team" commitment at UW-Stevens Point has enhanced the creative development of UWSP music students. Our panel presentation includes Daniel Goulet; Professor, Department of Mathematics and Computing and former Director of Academic Computing Services; Charles Rochester Young, Assistant Professor and Coordinator of Music Theory and Composition; and Patricia Ploetz, Multimedia/Instructional Technology Coordinator.

1. Setting the Stage:

The thesis for the session is:

For the use of technology to blossom in the teaching/learning environment, there must be a fundamental commitment by the campus to develop and support a technologically rich environment that fosters creative teaching/learning for students and faculty. This fundamental commitment must include a "teaching/learning team" of students, faculty, support staff and administration.

We will develop our thesis using the ideas of 'message' and 'medium.'

- In short, the *faculty member should focus on the message* and not have the medium that carries the message stand in his/her way.
- The *administration should focus on the medium* and create the technologically rich environment for the faculty member.
- The *support staff should focus on bridging the gap between message and medium,* that is, framing the teaching/learning message through a technology medium.

And these three foci are the content for our session.

2. Focus on the Message: Music Theory/Composition Demonstrating the Message

2.1 Teaching the Whole Person: Multiple Levels of Apprenticeship

"It is my belief that the purpose of teaching is to allow and guide students to becoming successful without the teacher. Another way of looking at this issue is 'if the student BECOMES the teacher, then they will not need a teacher.' Many successful and enduring teaching/learning models are based upon this ideal. Apprenticeships have served in this teaching/learning capacity in the arts and sciences since the dawn of time." [Charles Rochester Young].

For the students (apprentices) to become their own teacher, they must first have the same experiences as the master. In other words, they must manipulate the same tools and materials as the master, recreate the master's decision making processes, eventually learning to think like the master. Michelangelo expressed this idea, saying that "you cannot surpass that which you cannot equal." In other words, you cannot surpass your teacher/master until you can equal them.

The master/apprentice relationship ideally exists in many levels. An ideal example would be an environment where the students (apprentice) study with a faculty member (middle level master), but the faculty member (middle level master) may also be studying the work of a luminary in the profession (high level master) concurrently. This scenario allows both the student (apprentice) and faculty (middle level master) to learn and grow individually, while also establishing an important link between the luminary in the profession (high-level master) and the student (apprentice) through faculty/student interaction. Technology can enrich this interaction in ways that were previously not possible.

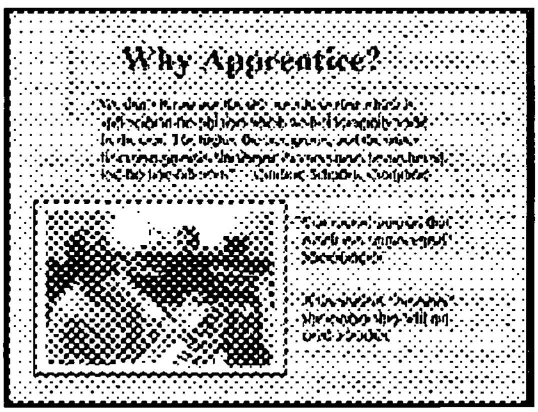

Figure 1: Why Apprentice?

2.2 Apprenticeships using Technology

Composing music and performing music are each extremely complex processes where numerous choices must be made. The decisions that are made by a high level master composer and/or performer are critical for achieving a particular musical result. Using archived musical scores and performances on a computer, students can use the vast editing capabilities of the computer to redesign structures and re-create the decision making processes of the high level master composer or performer--literally dissecting the music and putting it back together again, not unlike what one might find done to a frog in a typical Biology course! The educational thesis for this exploration and discovery is: "You can't understand the creative process if you're always looking at the creative PRODUCTS! You must strive to re-create the PROCESS!"

Through these processes, students learn stylistic elements of a particular performer and/or composer and also learn from the "inside out" how the musical results are achieved. With thoughtful guidance by the faculty member (middle level master), the student ultimately learns how to think like that high level master.

While these types of activities were impractical before, the digital environment is perfect for these realizations, being much easier and faster than cutting and pasting the music with scissors and tape. The students can also hear the results of their inquiries immediately WITHOUT having to copy off the music, find willing musicians to rehearse it for weeks or years before performing it.

2.3 Sample Classroom Activities for the Musical Apprentice

2.3.1 Example One: Performing

The educational goal is for the students to learn how to make a performance more interesting through their interpretation of the printed music. The idea is to have the students realize that there is more to music than the realization of dots and lines on a printed page!

The students are given the printed music for George Gershwin's *Rhapsody in Blue.* They are then asked to listen to three different performances of the same excerpt while following the music. Before the recorded examples are played, the students are told that one of the performances is by George Gershwin (the composer), another performance is by a member of the UWSP faculty, and another performance is played by a computer. The students are told that the computer version has no human interpretation at all and is strictly a "technical" performance devoid of any human expression. The students are asked when they listen and follow the music to see if they can identify which of the three performances they are listening to.

Once we have listened and identified each of the performers, we use the computer to explore subtle nuances of each human performance such as pedaling, key velocity (touch), and variations of tempo. The computer is ideal for this because it can visually and aurally capture details and resolution that often escape human aural perception and musical notation systems. We then compare how the two human performances compare with one another and also how the computer performance compares to the two human performances. Since the computer performance is uninteresting, this gives students an idea of how subtle nuances of human interpretation are essential in achieving an interesting performance.

Additionally, students are asked to perform the same excerpt on their respective instruments so that they may apprentice with both of these master performers. When performing the students utilize a technology that we developed at UWSP, called a PORTABLE PRACTICE UNIT. This unit allows the student to record themselves playing alongside the master performer and gives them an objective vehicle for comparing their interpretation with those of the master performers. The final stage in this learning process is for the students to actually compose and perform their own pieces based on the principles of interpretation that they have discovered in their study of these masters.

2.3.2 Example Two: Studying the Science and Structure of Music

The educational goal is for the students to learn how composers vary and develop the themes in their pieces and organize those variations into a larger composite structure.

The students are presented with a digitized version of a theme from a piano piece. (NOTE: At this point, the students have NOT been issued the published music for the famous piece--they only have the digitized theme.) They are instructed to compose variations upon this theme and save each of their variations on the computer. During this time, the faculty member provides individualized instruction to each student as they write their variations.

Once the students have successfully composed a small number of variations, the faculty member takes ALL of the collective variations that were written by the students and posts them over the local access network, so that students can discuss and evaluate the work of their classmates. The next stage is to have the students take this collection of variations and put them into an order that they find suitable. Since these variations were not connected to each other before, the emphasis at this stage is having the students create "seams" between the variations that allow each variation to flow smoothly into the subsequent variations later in the work.

The next stage involves the students comparing their respective sets of variations with those of their colleagues. The students are encouraged to discuss the various solutions for the problems that they all faced. Next, the students are given the published music and a recording for the piano piece and asked to compare their solutions with the solutions of the master composer. At this point, students are encouraged to re-write sections to compare with the choices of the original composer. Sections or various structures are also removed by the students to see how integral they are to the overall design of the work at large. Finally, students are also encouraged to make changes in the score that their classmates must be able to identify as mistakes.

Having walked in the composer's footsteps and having re-created their various decision making processes, the students ultimately will have a illuminating and meaningful experience studying this masterpiece and its composer!

3. Focus on the Medium: UWSP's Strategic Direction

The basic thesis here is that faculty and students should not be working at this level.

3.1 The Strategic Direction

As the graphic below depicts, and paraphrasing the UWSP Information Technology Strategic Plan Vision Statement[1], we want all students, faculty and staff to have *what they need, where they need* and *when they need* Information Technology resources in a *24 x 7 environment.*

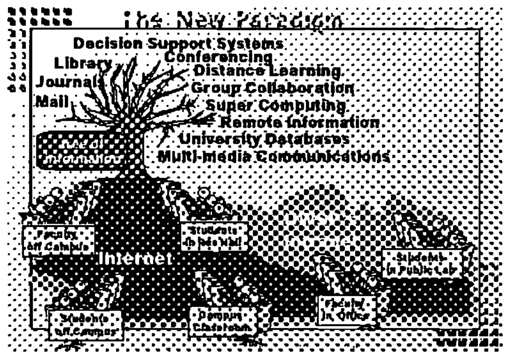

Figure 2: Graphical View of the UWSP Information Technology Strategic Plan Vision Statement

3.2 What They Need

Faculty and students need access to software resources, both specialized for their discipline specific applications and general applications for productivity tools and communications. The latter are provided through a campus standard called the Comprehensive Software Environment which specifies a Windows 95 environment, Microsoft Office 97 as the standard productivity software, Microsoft Exchange as the single email system. The former are specified by the faculty and made available through a central campus service. All applications are launched via a campus common user interface.

Faculty and students need access to computing hardware. Each faculty member has a microcomputer in hers/his office, 90% are Intel based and 10% are Macintosh, both of recent models. A campus-funded replacement policy updates each faculty microcomputer every four years. Campus public computing labs located in the academic buildings, as well as in the residence halls, provide microcomputer access for students.

3.3 Where They Need

Access to information resources are needed everywhere. On-campus, a universal cabling plant connects every office, classroom and residence hall room to an optical fiber and copper campus network backbone. A single network operating system, Microsoft's NT, connects all locations into a single, ubiquitous communications network.

3.4 When They Need: A 24 x 7 Environment

All hardware, network, and software systems are available in a 24 hours-a-day, 7 days-a-week environment, providing resources when they are needed, i.e., time and place independent.

[1] The Vision of the UWSP Information Technology Environment is for all students, faculty and staff to be connected in an electronic environment that is one of the basic elements in UWSP's educational fabric. From their normal working environment (including residence halls, laboratories, and offices), students, faculty and staff will have the computing power and voice/data/video communication links needed to accomplish their work. However, the technical aspects of the environment will be transparent to the non-technical user.

3.5 The Faculty We Focus On

At UWSP, we subscribe to the 80/20 rule. Thus, as can be seen in the following graphic, our energies and resources are targeted at a particular subset of faculty; those faculty who will have the greatest impact on the teaching/learning environment, but who will not drain the institution of all the financial and human technology resources.

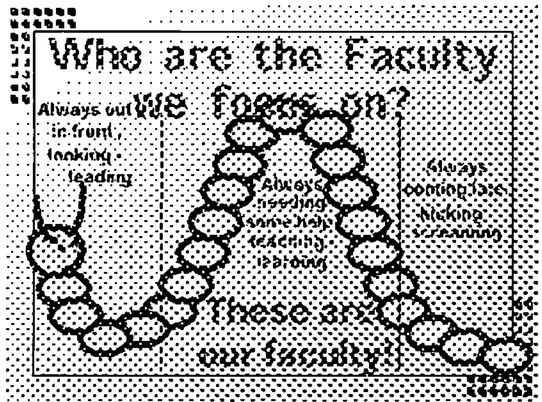

Figure 3: The 80/20 Rule for Faculty Technology Support

4. Focus on Translating the Medium to the Message:

We take many approaches to support faculty using technology in instruction. For this discussion, we respond to the title theme, **"It Takes More than Two to Tango: Translating The Medium To The Message,"** by exploring methods and ideas adopted when working with faculty new to the instructional technology environment.

4.1 Ground Zero

In order to entice anyone into doing something that is different, it is essential that the person -- in this case a faculty member-- be shown how a suggested change represents an evolutionary step along a path. This is related to how change can take place in an orderly fashion with small amounts of learning being spaced out over a long enough period of time to minimize the potential for negative impacts, like taking one away from family, favorite pastimes, and other important professional activities. Our way of encouraging this "evolutionary step" is to take a four-stage approach. However, in order to begin this process we need to first identify the working environment.

4.2 Creating an environment that supports change.

Whether we realize it or not, we are asking faculty to change the way they work. Therefore, any program dedicated to providing faculty support must be "customer service oriented". With that attitude in mind the first contact, whether a telephone call, a chance meeting in the hallway, or an email for information, becomes a critical point in establishing a supportive working relationship.

4.3 The First Stage

More often than not, a faculty member's first contact with the department is a request for help to scan an image or a slide. Once a request for support has been received, an appointment is made (generally within 24 hours) and they (the faculty member) learn how to scan. By meeting their immediate needs as quickly and efficiently as possible, we build a reputation for excellent customer service and are often able to identify some new technological activity that moves the relationship into the second stage of instructional development.

4.4 The Second Stage

While the scanning process itself is easy enough, taking that task to the next level through image editing, networking, and CD development leads to a whole new world of exciting educational technologies. When faculty can begin to see the possibilities technology has to offer the teaching/learning environment, they (faculty), become the force for change. It is at this point that learning can be promoted, demonstrating how change can take place in an orderly fashion. What was once an insurmountable task, becomes several functional and useful steps that ultimately lead to significant changes.

4.5 The Third Stage

By examining just a few of the activities that needed to take place in the scanning process above, we can see an increase in knowledge that supports the move to a new level of learning

- understanding file extensions
- manipulating large files,
- using networking, compression, and new storage mediums (CD's)
- working with image editing software,

These activities become a series of steps leading to the development of presentations and web pages; the preparatory steps to authoring technologically enhanced courseware.

4.6 The Fourth Stage

As faculty move into the fourth stage, they are learning the skills required to refine the context so that students can interact with the resources, that is, make up their own way through the resources, or take one of several faculty guided excursions. They (faculty) begin to critically examine the content through assessment. This assessment leads to refinement and refinement to new assessment asking the question: "Is technology enhancing the educational process, and thereby accomplishing its task?"

Eventually faculty, who were new to the instructional technology environment, become " the experts" and are invited to share their experiences with other faculty through workshops, conferences and in-house presentations. These new experts become a resource for both peers and students and the team adds a new member to the collaborative process.

5. In Summary, The Team:

The Team Building Model:

- Is achieved through faculty, staff and student collaboration.
- Supports efforts to enhance the teaching/learning environment through technology by building bridges where there are none, and enhancing those that already exist.

Team development begins when faculty, staff and students, working toward a common goal fill a need that the individual cannot. The product that results is more than the sum of the parts.

The Team:

- Moves from one place to the next, contracting and expanding as the need arises.
- Is created in need, and ends when that need no longer exists.
- Is an agreement, formal or informal, between its members, to collaborate on a specific project.

In this instance, the *project* is the meaningful and effective use of technology in the classroom.

A QUALITATIVE STUDY OF LEARNERS' USE OF AN INSTRUCTIONAL MULTI/HYPERMEDIA PROGRAM IN AN EDUCATIONAL TRAINING ENVIRONMENT

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Abstract The purpose of this study was to investigate how AC members interacted with and perceived a CD-ROM-based instructional program integrated in their training context as a supplementary tool. The theory of constructivism was examined to frame the theoretical foundation of this study. A qualitative case-study approach was employed and data were collected through video/audio tapes, questionnaires, follow-up interviews, and field notes. Six female AC members of diverse background were recruited on a voluntary basis. Major findings of the study reveal that: (a) participants felt they situated themselves in an authentic learning environment that engaged them in a meaningful learning situation; (b) the CD-ROM was perceived to be a very interesting, appropriate, useful, helpful and good supplementary medium to adapt to heterogeneous learners' learning styles, needs, situations, expectations, and previous computer experiences. Discussions of findings concerning learning from constructivist viewpoints and human-machine interactions are presented.

1. INTRODUCTTION

A combination of the state-of-the-art technology and the recently rising learning theory rooted in constructivism makes Vannevar Bush's dream early in 1940s become a reality nowadays [Smith 1988; Marsh & Kumar 1992]. Multi/hypermedia, a merger of text, graphic, animation, video and sound into a computer platform providing information in non-linear formats, is an attempt to provide a learning environment enriched with a wealth of information to allow learners to construct their own knowledge without requiring them to physically leave the environment in which they are working [Marsh & Kumar 1992]. This medium offers more learner control in the learning process than other traditional media presentations [Marchionini 1988]. Moreover, the beauty of interactive multimedia is that it can be designed to provide a variety of paths to learners, making it one of the best media available for dealing with heterogeneous groups of learners [Schwier & Misanchuk 1993].

2. THEORETICAL FRAMEWORK

Technologists' constructivism. Learning theory/psychology has undergone a major revolution during the past few decades [Cooper 1993]. Constructivism is not a completely new approach to learning theory. Most constructivists [Duffy & Jonassen 1992; Bednar, Cunningham, Duffy & Perry 1992; Ertmer & Newby 1993] hold that there is a real world that individuals experience uniquely. Therefore, they argue that meaning is imposed on the world by individuals, rather than existing in the world independently of human beings. Constructivists hold that there are many ways to structure the world and any event or concept should bear many meanings or perspectives. Generally speaking, constructivists do not deny the existence of the real world. The way we know the world is from individual's meaning making, interpretations of our experiences. Since there are many possible meanings to know based on individual experiences, we do not have to strive for a predetermined correct meaning [Duffy & Jonassen 1992; Ertmer & Newby 1993].

In the constructivist view, learning is an active and constructive process in which the learner builds an internal representation of knowledge from the individual experiences and interactions with the world. This representation of knowledge is constantly open to change [Bednar, Cunningham, Duffy & Perry 1992]. In terms of the constructivist learning approach, learners are encouraged to actively explore complex environments in which knowledge is linked to a context under study and to the experiences that the learners bring to the context. Cunningham points out [Cunningham 1992] that a major difference between objectivists and constructivists is that objectivists expect and require acceptance and closure of a world view, while the constructivist anticipate and encourage debate.

Constructivism and instructional design. The information-rich age and advanced technology capabilities, as identified by [Duffy and Jonassen 1992], have caused us to revisit constructivism, to reconceptualize the learning process and to design new instructional approaches. Cooper states that "changing the learning environment to incorporate a constructivist view adds complexity" [Cooper 1993, p17]. Because constructivists focus on the design of learning environments rather than instructional sequences, designing constructivist learning environments is much more challenging and difficult than designing objectivist instruction.

Jonassen points out that a constructivist design is more process-oriented than product-oriented and accordingly suggests that the design process should be concerned with designing environments which support the construction of knowledge and a meaningful, authentic context for learning and using the knowledge the learner constructs [Jonassen 1994]. Winn says that in order to accommodate instructional design to constructivist environments of learning we require a change in the assumptions about how people learn and about how instructional decisions are made [Winn 1992].

An emphasis on learning rather than on performance and instruction. Under constructivism, learners select their own learning strategies, and their own goals and objectives, unlike traditional instruction in which goals and objectives are set by curriculum developers and instructional designers and thus the learning content and strategy are imposed on the learners from the outside. Consequently, the learner has to assume much of the responsibility for selecting what to learn and how to learn it. The function of the instructional system is to support what the learner decides to do and the role of the teacher becomes a coach or a facilitator.

3. RESEARCH QUESTIONS

The foci of this study were to understand, describe and interpret how AC members interacted with and perceived a CD-ROM-based instructional program on interactive writing. Two sets of questions guided this study: **Question set #1:** How did AC members interact with this CD-ROM-based Instructional Program on Interactive Writing? What were the variations? What factors seemed to account for the variations? **Question set # 2:** How did AC members perceive this CD-ROM-based Instructional Program on Interactive Writing? And how did this change over time? And did they perceive they learned about interactive writing?

4. METHODOLOGY

The methodology here includes background of the study project, research design, the participants, the study site, the procedures of data collection and data analysis.

Background of the research project. A CD-ROM (running on a Macintosh platform) entitled "Interactive Writing" is an interactive hypermedia instructional program developed as a cooperative project between the program of Instructional Design and Technology at a University in the mid-west of the States and the AC Project [a national service project funded by the U. S. government since 1994] from autumn quarter 1994 through winter quarter 1995. The purpose of the project was to produce an instructional aide which supported the training of AC members who were to learn about interactive writing techniques in 1995 –1996 training settings. The CD-ROM was composed of two major part: "Let me learn about it" which was a slide presentation of detailed information about interactive writing and "Let me try it" which was a simulation of the interactive writing process, designed to allow learners to apply the factual knowledge they gained from the "Let me learn about it" to a real-world-like context with three virtual students."

Research Design. A qualitative case-study approach was employed to obtain a rich, in-depth and holistic account of the research events. Within the postpositivist paradigms [in Lather's term 1991], this study was described as interpretive and descriptive in nature, and utilize a case study method. As Patton points out, "cases illustrate the value of detailed, descriptive data in deepening our understanding of individual variation" [p. 17]. The design was flexible and emergent [Patton 1990].

Participants. Six AC female members were recruited on a voluntary basis and divided into three dyads/cases while they were interacting with the CD-ROM for three times. Their age range was 18 to 37 with a mean of 25 years old. Compared with the other two teams, team one was the oldest team with a mean of 35.5 years old. The age means of teams two and three were very close to each other at 20.5 and 19 years old respectively. Among the six participants, only one of them had already completed her Master's degree while the other five were working on baccalaureate degrees at a state University, four full time and one part time. Their majors were Business Management, ESL, Engineering, Psychology, Physical Therapy, and Management Information Systems.

Study site. The study site was the place where AC trainers conducted their training programs and where the members went to teach the young children. Once the intensive training workshop was completed, all of the members were assigned to three local urban elementary schools in Columbus, Ohio. Since the use of interactive writing program on the CD-ROM was intended to be part of their on-going training process, there was a computer setup in each of the three elementary school's libraries.

Procedures of data collection and analysis. AC training schedule was divided into two phases: a three-week intensive training and an on-going regular training held on every Friday morning. Interactive writing session, given on the first day of AC on-going regular training, was the only session that provided AC members the necessary Interactive Writing techniques. A follow-up questionnaire was administered to the participants right after the session in order to collect the participants' starting experiences and knowledge about the Interactive Writing.

Shortly after the participants had received the interactive writing session in their training, each team started to use the CD-ROM for three times in the following three consecutive weeks. For the purpose of data triangulation, three sets of follow-up questionnaires were used to collect more information and to verify other data each time right after the participants used the CD-ROM. The questionnaires were mainly intended to help them gather their thoughts on the use of this technology and what content they learned from the CD-ROM program.

Several methods such as prolonged engagement, persistent observation, triangulation and thick description, peer debriefing, and member check were used to establish trustworthiness [Lather 1993; Merryfield 1990; Lincoln & Guba 1985] and to legitimate the research project. Reflexive subjectivity on the part of the researcher was continuing throughout the process of data collection and analysis. The data were gathered from the fall quarter of 1995 through winter quarter of 1996 and analyzed from winter through summer quarter of 1996.

The data analysis was guided by the research questions. The analysis evolved around the data reduction, organization, matching, generation of categories and coding as a result of the study of all data sources. The categorized data eventually assisted the researcher in data interpretation and drawing conclusions.

5. RESULTS

5.1 Major findings related to the first set of questions

Participants felt they situated themselves in an authentic learning environment that engaged them in a meaningful learning situation. Evidence from observations revealed no general pattern in terms of behaviors was found across dyad's interactions with the multi/hypermeida program but some phenomena were observed in their interactions with each section of the computer instructional program. Various factors were identified to account for the multiple variations in behaviors. They were: participants' starting knowledge and experiences with interactive writing; personalities [active, passive, outgoing, or introverted; frustration tolerance levels]; personal learning styles [auditory or visual learners]; personal role [being a mother or a student]; intra-team interactions; comfort levels and familiarity with the computing technology; grade levels of their focus students; and curiosity about the innovative technology.

Additionally, In terms of seat arrangement and mouse manipulation, a pattern was discerned across three teams. The study showed that the participants were more likely to sit on the right side with the mouse if they were more active, comfortable with the operation of the mouse, preferred working individually, or liked to take the leading role in their learning or to control the advancement of the CD-ROM. Otherwise, the participants would like to sit in the left seat if they were shy, introverted, preferred working in pairs, or liked to be guided by their teammates.

Each team took different pathways and learned at its own pace. Each team took different pathways to get through this virtual world. Each participant felt that she learned at her own pace and most of the time she had control over the program except in the mode of "Let me try it" when she got stuck being unable to figure out some meanings of the language in the "Help" mode. It appeared that, most of the time, in the section of "Let me learn about it," each team could make sense out of the meaning of each button and branched to different parts based on their own content knowledge, individual expectations, computer experience and team interactions and decisions.

5.2 Major findings related to the second set of questions

Overall, there was a unanimous agreement among the six participants about the multi/hypermedia program's primary purpose. That is, all of the participants perceived the CD-ROM program to be a very interesting, appropriate, useful, and helpful medium to adapt to heterogeneous learners' individual needs and their learning styles and, further, a good supplementary tool to be used in the AC training program.

The participants expressed that the program refreshed and reinforced their learning about the interactive writing techniques. In addition, the participants pointed out that they experienced some changes in their understanding of interactive writing after they used this CD-ROM several times. Participants constructed different knowledge, and gained in-depth information depending on the individual learning styles, needs, situations, expectations, and previous computer experiences.

6. DISCUSSION OF FINDINGS AND IMPLICATIONS

6.1 Discussion of learning from constructivist viewpoints

This study demonstrates that learning is a matter of individual knowledge construction and meaning making. It confirms the view [Bednar, Cunningham, Duffy, & Perry 1992] that learning is an active and constructive process in which the learner builds an internal representation of knowledge from the individual experiences and interactions with the world. The way a learner knows the world is from individual meaning making and interpretation of personal experiences.

In addition, the study also supports Zucchermaglio's claim [Zucchermaglio 1993]. Learning with the CD-ROM, evidently, the participants were not merely empty vessels waiting to be filled up with the information from the computer. Instead, they had to actively interact with the screen and with their partners, to make sense out of the interface and language used in the program, then to make a shared decision before they moved forward to the next screens to explore further information.

This study correlates with other researchers' claim [Jonassen, Meyers, & McKillop 1996] that learning with hyper/multimedia requires learners' mindful engagement in the tasks provided by the technologies. Through the capabilities of the technologies and learners' intellectual partnership, the learners will enhance their thinking and learning. The participants showed evidence of being able to enhance their learning through the use of this CD-ROM program. They expressed that they learned more in-depth information which they did not gain from the AC training session and according to the data collected from the questionnaires the information each participant picked up from the technology was not the same. They also experienced changes in their understanding of interactive writing after they used this CD-ROM several times.

6.2 Discussion of human-machine interactions

The participants in this study demonstrated that their path taking was different and at the very beginning they did not use the directional arrow to advance their learning as the designers had intended. In addition, each team had various degrees of difficulty in interacting with the section, "Let me try it", due to being unable to figure out some language employed in the "Help" mode and unable to recognize some button icons. This finding corresponds with a study conducted by [Suchman 1987] concerning how novices interacted with a Xerox machine. Suchman points out although the designer assumes that the preplanned information is clearly and adequately designed and, thus, would be used by the individuals while they are interacting with the system, the predictive model is insensitive to particular circumstances [Suchman 1987]. This is the fundamental problem in human-machine interaction.

As a matter of fact, the users, based on individual prior knowledge, need for exploration, and expectations, have both their own intent, which is not always following the procedural instructions assumed by the designer, and their own way to interpret the information which is made on a moment by moment basis in their particular situations. Suchman observed that "because instructions were sometimes read by the users differently from the way they were actually written on the displays, the reader will find some inconsistencies between sequences and the displays to which they refer" [Suchman 1987, p. 122]. Because language, common sense, and ongoing discussions, etc., will appear contextually related with the procedural information presented on the screen as part of the ongoing activity, Suchman explains that the users/learners, not the predictive model of instructions, will determine their actions through their own interpretation in particular situations. Significantly, the research finding corresponds with Suchman's study. When the participants referred to the "Help" mode in the section of "Let me try it", they interpreted the word "Student" as a "Student's portfolio", while the designers meant a "Student's picture". Their own interpretation suggested that they were to click on the icon of "Student's portfolio" instead of that of the "Student's picture".

While interacting with a program, as Norman points out, usually the users cannot talk directly with the designers, and all communication takes place through the system image, which involves the use of language and symbolic representation [Norman 1990]. If the system image does not make the design model clear plus the user constructs his/her own meaning and knowledge based on his/her prior experiences and knowledge, then the user's mental model does not match the designer's model. As a result, the user gets stuck. Norman's claim similarly corresponds to Suchman's finding. This study reveals that some participants did run into this type of problem. The participants' mental model, being not identical to the design model, resulted from the user's different meaning construction which, at times, hindered them from further advancement in the program.

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Free Access To „Hands On“ Experience In Technology, Communication And Multimedia

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Abstract: The Computer Clubhouse Esslingen was founded in 1996. After two years of operation the first experiences are compared with the early concept and the goals. Experiences with mentors and professional equipment in multimedia and communication areas are looked at. Further developments of the Computer Clubhouse idea are discussed.

1 Introduction

The Computer Clubhouse Esslingen was founded in autumn 1996 as a third party project (without government money) in the Softwarelabor of the Polytech of Esslingen (FHTE[1]) following an idea of the MIT-Media Laboratory [2]. It is the first application in Europe. Therefore, it is necessary to adapt the principles to the German framework of education, technology, sponsoring and bureaucracy.

The principle aims are: strengthening kids in a non-school environment, improving their ability to be successful members of the economy, enhancing their explorative activities in the world of new technology and researching the possibilities of applying „animative didactic“[3] in conjunction with new media and digital technology. This effort is based on cooperation between the FHTE and the College for Social Sciences (HFS[4]).

2 Background

Students of the MIT led the way in the late seventies in transferring computer technology from military applications to the people. Later emerging companies like Apple Inc. also began to push towards these aims. Cheap access to computer technology in the middle and late eighties led numerous people become *nerds* and *geeks* in computing. The majority studied the digital technology by themselves. They met in computer clubs, on bulletin boards and so on.

In the nineties computing started to enter more and more the areas of normal life. Nowadays knowing how to use computers has started to be widely accepted as a new „cultural-technology“. Therefore, technology has started to be used in schools [5] and other areas of education. In these environments the new technology has to subordinate itself to the traditional didactical forms. Project work, open environments and free access are not standards.

This contradiction between history and the present age gave birth to the idea of Computer Clubhouses. During the eighties most kid's experience was either „a lot of time and no money to buy the tools“ – or other way round. The open didactic and drop-in character of a clubhouse, the absence of schedules and the availability of hi-tech professional tools overcome these problems and open a playground for interested kids, boys and girls. That's why our kids think it's grand to be here.

In the past few years the explorative character of learning has been recaptured in a lot of different fields. Learning in projects has started to become more and more attractive. Since multimedia emerged at the same time, it is just a small step to utilise the synergy of these fields to make learning in projects more successful. Since the multimedia and the digital technology fields are extremely versatile but still accessible through the same hardware, this opens a the possibility for any kind of mind to develop its own interests. The limits are set mainly by time and software, which is a good reason for using professional software with fewer limitations.

3 The Computer Clubhouse Esslingen

The aim of the Computer Clubhouse Esslingen (CCE) [6] is to link know-how from three different areas: industry, education and technical science represented by sponsors and the polytechnics of the fields of technology and social work.

The CCE provides an area which is open to kids between 10 – 16 years 5 days a week at afternoons. These young people are linked by a club, which is open to everybody, and mentored by students, trainees and volunteers of every age (14 – 104 years).

The room is equipped with 9 multimedia computers, instruments for robotics experiments (LEGO [7], Bricks [8], Crickets [9]), multimedia-professional programs (Photoshop, Pagemaker, Frontpage, Premiere, Office, Director, Navigator) and a professional communication connection (DFN, 34 MBit) and programs.

Opaschowski's theses on animative didactics are the basis for the free and open learning environment provided by the CCE. The main principles include the encouraging our members through mentors, the voluntary participation of both members and mentors, the informal surroundings and the choice between alternatives.

The mentors support the members by providing a role model, including educational, social and technical know-how. They work animatively and support the members in their motivation to create and to follow their own ideas.

3.1 Principles of the Computer Clubhouse Esslingen

3.1.1 Free access

In order to take advantage of the new prospectives offered by technology, communication and multimedia and to prevent the marginalisation of certain parts of society, the computer clubhouse was developed with the aim of addressing in particular children and youth from underserved communities. This means primarily that cost or know-how barriers should not determine access to new technologies.

Free access refers not only to the cost barriers but also to the pedagogical approach. In accordance with the principles of animative didactics, the Computer Clubhouse offers a many facetted program in which each individual can find his or her niche.

3.1.2 The building blocks of the animative didactics

- *freedom of choice:* means to act spontaneously according to one's own personal inclinations without pressures or obligation. The children and youth are free to choose whether to come or not and whether to deal with a particular topic or not.
- *informality:* means to be able to act naturally, to be free from pressures to perform and succeed, and it means the absence of competition. An open situation without undue external regulation is offered as a field for activity.
- *free use of time:* The participants are allowed to divide their time as they choose and use it flexibly. They may determine for themselves the duration, tempo, intensity and interruptions of their activities. The only limits come from organisational parameters such as opening hours.

3.1.3 These three building blocks are supplemented by three principles

- *choice:* means the possibility to choose between alternatives.
- *decision:* means the ability to make one's own decisions, to follow one's vision, to know what one wants, to be able to use the freedom of choice. Nevertheless choice options must be structured so as to not overtax the participants.
- *initiative:* means that one develops initiative, either alone or with partners, that trust in one's own potential is given room for growth, that one experience opportunities to practice self-organisation.

Thus free access also means the inner freedom to set one's own goals.

3.1.4 Free access and Gender

It is well known that women and girls have a different approach to technology than men and boys do. An empirical study [10] has established that only a small percentage of girls actively use new technologies, such as the internet. In the light of our previous discussion of the fact that media competence is a prerequisite for active participation in today's society, we devote special attention to making these competences accessible to girls.

Through the institution of a „girl's day" we were able to double the participation of girls in the CCE (from 20 to 40%).

3.1.5 Rules

CCE offers children and youth the opportunity to develop in an atmosphere characterised by self-determination. Of course, there are some basic rules that all the members of the Computer Clubhouse must agree to abide by.

- Respect for other people.
- Respect other peoples' ideas (there are no stupid ideas, there are only stupid remarks).
- Handle the equipment with care.
- Team spirit is a matter of honor.

3.1.6 Mentoring

The members of our clubhouse are accompanied by our mentors, as they explore the new technologies. These mentors have the role of coaches, social catalyzers, advisors and sources of ideas for new projects. They work on their own projects and encourage club members to join them. At present there are 25 mentors working as volunteers at the CCE. In the past year and a half some of those currently working with us have grown up from the ranks of our members. Just as children and youth grow into the roles of mentors, in the CCE young and old, girls and boys, grammar school children, high school students and college students, volunteers and staff, Germans and non-Germans and professionals of both pedagogical and technical areas of competence work together and learn from one another. The approach is to integrate across gender, generations, school and class. And it is to a high degree interdisciplinary.

3.2 Subjects

3.2.1 Media Competence

Work in the CCE bases on the premise that media competence in the near future will be a necessary prerequisite for active participation in community processes.

The open framework CCE is the foundation that allows us to develop media competence. If we begin with the premise that media usage becomes increasingly productive, innovative, competent and critically reflective as the media get used in a supplementary fashion and as media use is tied into an intensive social and communicative context [11], then we must conclude that the mentoring system is a key factor in transmitting the basics of media competence. Our program offers not only the possibility of approaching the new media from the members own perspective but also offers an almost unlimited diversity in the person of the mentors. This generates a learning context that goes well beyond anything that is usually possible in normal daily encounters.

The interaction amongst a diversity of individuals provides insights and opportunities for exchanges amongst different perspectives and value systems. The experiences made with technology are embedded in a social context characterised by tolerance, respect and communication.

Through the fascination of the creative process, the strengthening of one's self by oneself and by the others participating in the process, through experiences in social learning and reflections on its conditions, the participants develop an ability to deal with media autonomously.

3.2.2 Communication

Media, both old and new, change not only working and leisure time, they also influence human communication habits. These include not only speech and interchange, but also the establishment of closeness and distance, of strangerhood and trust, of security and insecurity, of solidarity toward the in-group and boundaries toward the out-group.

That is why this factor is given special attention at CCE. In the Computer Clubhouse we have the facilities for email, video-conferencing, chatting and access to news groups. Few studies have been done on the changes the use of these media induce in our habits of communication.

3.2.3 Creativity

We assume that creative potential slumbers in every human being. By creativity we mean the ability to develop something new, to leave old paths in order to grow and develop and to thus be prepared for the future. Creativity is closely linked to self confidence, to the recognition of one's own strengths and weaknesses and the ability to use these and to change whenever necessary.

Especially today when the dominant orientation towards consumption is impeding innovation and progress, the rudder must be turned about and this must be done in the early years. In order to ease the transition from consumption to creativity, we offer access to professional programs in all areas of multimedia. We do not offer access to computer games, though the children and youth are allowed to develop their own. It is quite interesting that they do not miss the games.

4 Experience

The original idea of the CCE was to provide children and youth between the ages of 10 and 16 with the opportunity for a playful interaction with new technologies in order to open new chances for their future. Mentors were brought in to accompany them in this process. In the course of the last six months, a remarkable development has been observed. It turned out that a high potential for the further development of the mentors lay dormant in our project (vis. [What the project gets out of mentoring]).

Currently CCE is frequented by about 50 children and youth per week. Each day 3-4 Mentors are available. As we mentioned above, these mentors come from diverse backgrounds and bring a variety of skills and talents to the CCE. Initially it was important that the mentors be equipped with considerable technical know-how, however that has changed in the past year. Young people who have attended the Computer Clubhouse over an extended period of time are often more skilled in the use of multi-media programs than the mentors. This has led to sharing and communal learning in projects. This mutual give and take promotes growth and development both in regard to the personal as well as the technical sphere.

4.1 Communication

At CCE communication takes place on many levels. Face-to-face communication with team members, mentors and other children plays an important role. It is essential for the further development of projects, for making arrangements, for telling one another jokes, for exchanging experiences, sharing, building relationships, for establishing different points of view, etc..

Shortly after we introduced „chatting" the kids enjoyed communicating with one another via the chat-channel, although they sat in plain view of each other. Sometimes these exchanges were open and sometimes they were disguised in order to tease the other person.

Since then the kids have begun to chat in public chat-channels with whoever is active there. They fib and lie, get annoyed over obscene overtures, and themselves write in vulgar language. They find a pleasant chat partner and make dates for future chats. They enjoy themselves, have fun and a good time. They learn to be selective in their chats, to defend themselves against unwelcome advances and to deal with both pleasant and unpleasant aspects. They struggle to understand and handle the anonymity of this medium and correlate that with their own desire to get to know people and to establish closeness. They try to relate this to their own environment and to integrate these experiences into their own view of the world.

Rejoicing over the abundance of superficial contacts opened by chatting does not last long. Increasingly we observe that stable contacts are being sought. The Computer Clubhouse members are delighted when nickname they recognise turns up and they can get on with constructing a relationship. Some chat contacts develop into pen pal relationships. That happens first through email and then, when the other has become sufficiently defined and is judged reliable, telephone and letter correspondence may follow. The latter are only permitted when the parents give their consent. At times the relationship culminates in a face-to-face encounter.

We want to build on these processes and are encouraging chats with the members of the Computer Clubhouses in Boston and with other youth centres. For this we are implementing a video conference system, because we have realised how much motivation is enhanced by seeing the „face“ of the other.

We are only permitting access to video conferencing for this purpose, because we have unfortunately established that behind most video conference addresses lurk male individuals with sexist intentions. We are trying to encourage students to devote their diploma theses to the study of the changes in our communication habits and potentials which have been brought through communication technology.

4.2 What the project gets out of mentoring

As mentioned above under point 4, the potential for further development of mentors which lies dormant in this project is quite high. Through our contacts to industry, science, small and middle sized businesses, institutions and through their cooperation in CCE projects numerous opportunities for mentors to participate in projects have been generated.

Their membership at CCE also gives them access to international contacts via the Computer Clubhouse Network (CCN). One of our mentors is planning to write her diploma thesis at the Computer Clubhouse of the Computer Museum in Boston.

Furthermore, mentors are entering into cooperation with a regional business and schools to offer courses in digital photography and Internet basics. Following a period of intensive preparation at CCE, they will be developing their own courses. In the process, they will begin to learn to deal with a commercial situation: negotiating contracts, preparing presentation materials, organising conferences, speaking in public before a paying audience.

Other mentors are taking their first steps toward founding their own businesses, contracting out their know-how on the Internet to regional business partners. A mentor found a position as the direct result of the diploma thesis he wrote with us at CCE.

These results surpass our original goals of giving children and youth access to new technologies. People of different age groups are getting unexpected chances. These developmental opportunities are not limited to the technical sphere, they also include an extension of their own social competencies. People who otherwise would have concentrated on the technical area have had to develop extensive social skills in order to work at CCE. On the other hand, people who came to us with extensive social skills have had to expand their horizons and learn competencies in the technical area. We can see how this has enriched their lives but cannot yet fully estimate how this will enhance their professional potential.

5 Conclusions

Mentoring of socially underserved kids needs to be high quality which can only be achieved if mentors are involved in reflection processes which are professionally guided. This can only be done if the project is financially stable. This is one of our major goals for the immediate future.

In practice media competence is formed in the Computer Clubhouse Esslingen. Kids don't explicitly mention what they learn by electronically manipulating pictures. Their parents do (when looking at a manipulated picture in 1997): „Oh, this is possible? So I can't believe in any picture in newspapers nor in TV any more!“. Well, he understood – just a little late. Let's help our kids understand earlier.

After two years of operation, the advantages of a Computer Clubhouse environment have been firmly established. The first fruits have ripened. Kids have begun take over interests from other kids. Mentors are beginning to start their own companies with the new know-how and self confidence they gained here.

As the members start to understand how the financing and sponsoring work, they want to support the CCE-Team in these fields. When sponsors realise the importance of CCE members as a „resource of ideas,“ they try to find ways to participate their development. Preliminary studies for prototypes of products have been realised at CCE, in cooperation between the sponsors, the Polytech Esslingen (FHTE) and the College for Social Science (HfS).

At this stage the project Computer Clubhouse Esslingen is emerging as far more than a project for children. It is a „Think Tank“ and the kids are one of the resources and the motor.

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SHORT PAPERS

A Multimedia Tool for Teaching Geometry at Schools

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This paper describes the work-in-progress of a collaboration project for the development of educational multimedia software. The project involves four partners both from academic and industrial sites and is funded by the Ministry of Education of Greece. The final product is going to be tested and evaluated in 60 state schools which are all going to be connected in a network. Among the development partners, there are two national Universities, the Greek Mathematical Society and a software house company. The content of this paper describes the design of the final product and focuses mainly on the work undertaken by the University partner where the authors belong (University of Piraeus) which is mainly the incorporation of intelligence into the system.

The main objective of this project is to create educational software that is going to be useful to teachers and students in high school classrooms and will be integrated in the school curriculum. The domain chosen has been geometry which has been admittedly considered difficult for students to understand [Senk 1983]. Therefore, we believe that software can provide a lot of help in improving the students' intuition and skills in the domain.

One very important feature of the tool to be developed will be an environment where teachers and students will have the facility to draw geometric figures which will be able to show motion like [Geometer's Sketchpad 1989]. The tool will also incorporate intelligence by using techniques from Intelligent Tutoring Systems [Wenger 1987] that have been proved successful. ITSs have not been used a lot in classrooms although there have been quite a lot of successful evaluations of ITSs [e.g. Mark & Greer 1991] and reports on the successful use in classrooms of ITSs such as ANGLE (A New Geometry Learning Environment) [Koedinger & Anderson 1993].

Teachers are going to be able to use this tool to prepare the presentation of the lesson that they plan to teach and exercises. Students are going to be able to use this tool to read lessons prepared by the teacher, answer questions, draw solutions to exercises and experiment with drawings. The various ways that a teacher and/or a student is going to be able to use the software will be represented as different modes of function:

- *Authoring mode*: In this mode the teacher will be able to prepare the presentation of a lesson and create new exercises in the context of the theory presented.
- *Lecturing mode*: All students in class are going to see in their screen the file that the teacher will have created in order to present a new lesson. In this case, the teacher will be in charge of the operation of the tool, which is going to work in the local network of the class.
- *Experimentation mode*: In this mode the students or the teacher will be able to experiment with drawings, motion and graphical representations. The teacher may need to do this in order to select the best way to present a lesson and the student may need to do this in order to gain better understanding and intuition of geometric proofs. The user interface in this mode will give the user two choices:
  a) Toolbar and menus, such as those used in the authoring mode.
  b) Communication in simple natural language sentences, such as "Draw a circle with centre O(x,y) and radius R".

The facility of natural language processing will give the student the opportunity to practice and improve his/her skill of giving accurate and complete geometric descriptions.

- *Solving exercises mode*: Students are going to solve exercises using the facility of constructing geometry graphics. The educational software is also going to allow communication with a word processor.
- *Answering multiple choice questions*: Students are going to answer multiple choice questions which will help them consolidate their knowledge and assist the teacher in evaluating the students' performance. The students' performance in these questions is going to be saved in a file each time they are in this mode.
- *Recognition of geometric entities*: In this mode the student is going to answer questions concerning the recognition of geometric entities that will be shown on the screen. For example, if a "rectangle" figure is shown on the screen, the student will be asked the question: "What is this figure". The answer to the question will be in natural language. The system will recognise answers such as: "I think that it is a square", or "I don't know", or "It is probably a rectangle". In this mode, there is going to be a diagnostic component which will perform error diagnosis on the student's answer. If the student's answer is not correct the system will try to find out what the misconception of the student has been and give an explanation to the student.

  The diagnostic component will be based on previous research [Virvou 1992] in error diagnosis which explored the utility of a formal theory of Human Plausible Reasoning [Collins & Michalski 1989] in the context of an Intelligent Help System for novice users of operating systems. This research showed that Human Plausible Reasoning could be a helpful tool when employed for error diagnosis. The Human Plausible Reasoning theory was originally constructed to provide a formal model of the reasoning that people use to reach some conclusions about questions for which they do not know the immediate answer. Starting from a question asked to a person, the theory tries to model the inferences made, based on similarities, dissimilarities, generalisations and specialisations that people often use to make plausible guesses. These guesses may be correct as well as incorrect. For the purposes of error diagnosis we exploit the fact that the human plausible reasoning that a student may have used may have led him/her to make an error. The diagnostic component will make use of domain knowledge represented in "isa" and "ispart" hierarchies. An example of an "isa" hierarchy is illustrated in [Fig. 1]. This "isa" hierarchy represents generalisation/specialisation relations among different quadrilaterals. For example, a parallelogram is a special case of a trapezoid, therefore it may inherit some properties from trapezoids. If a student gives an erroneous answer to the question asked then the system will try to locate the student's answer in the hierarchy where the correct answer belongs.

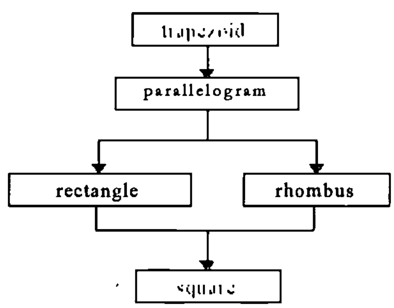

Figure 1: An isa-hierarchy concerning quadrilaterals

Assuming that the figure shown in the screen is a rhombus, an example of interaction between the system and a student could be the following:

System: What is this figure, Chris?
Student: I am not sure.
System: Make an effort...
Student: It is not a trapezoid
System: You are right. Can you tell me what it is?
Student: It is a parallelogram
System: What you say is not wrong. The quadrilateral that you see is a special case of a parallelogram. Can you find what it is?

Student: Is it a rectangle?
System: No Chris, it is not a rectangle. It is a rhombus. I think you should study the definitions of quadrilaterals.

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Improving the Learning Curve in Using an Intelligent Testing Environment during Practical Classes

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1 Introduction

Because of today's big amount of students in practical classes, teaching is, for tutors and students, hard effort. Beneath administrative details (accounts, teamwork) correcting the data needs a lot of time. Usually at the end of semester all data is collected and tested with a one or two weeks effort. This approach has two main disadvantages: too much time is needed for correcting the files and students have to wait weeks for important feedback. Possible problems are found *too* late, mostly after the end of semester. It turns out, that only a few points should be altered to improve the lecture: administration should be easy and mainly of students' responsibility, students should get immediate feedback and students should be able to learn from their mistakes. Finding solutions for that demands will lead to motivated students, better solutions and less work for the tutors.

2 Strategy for improvement

At the beginning of the project our students had to hand in their solutions via floppy disks. Teamwork was hard to manage, because our tutors had to organise the teams and were overwhelmed with group-internal problems. The first job of our environment was to simplify the way of handing in the solutions and to report problems with file formats. To intense the contact with the students an electronically way of feedback, using the WWW, was established. The next milestone was the delegation of responsibility of teamwork to the students. The basic idea was to give students the right to create their own groups out of a pool of students. The administration of groups obeys following rules:

1. every student is able to found a group or to become a member of a group,
2. every student founding a group becomes the leader and takes responsibility. He gets back a name for his group and is able to set a password,
3. every student willing to join a group needs to know the name and the password of the group. Groups can be left at any time.

The rules are quite simple but effective. (So it is possible to exclude a lazy member out of the group by simply leaving the group and founding another one.) It is also possible to find partners for the team using our electronic discussion forum, which is based on Hyper-Wave (see [Kappe 93] for more information). The last milestone was the handing in with feedback. It was reached during the summer semester 1996/97. Our system now consists of a testing environment, a hand-in environment, an electronically feedback corner and a discussion board.

The question *why* students should use the environment, is still not answered. There are several reasons and benefits for students when using our working environment:

1. self-organising groups, so that teamwork (if allowed) is possible,

2. students can solve their exercise using more than one file. They can structurize their solution,
3. immediate feedback (whenever a test is possible), students have the chance to improve their work till a deadline is reached,
4. students can send notes to the tutor and use the discussion board.

Beneath the fact, that tutors can also use the discussion board, there are the following important benefits:

1. the system is platform independent and works across the Internet,
2. the environment is easy to configure (simple to manage users and their data, lectures etc.),
3. the students' data (solutions) are already pre-tested. If no test routines are available at least correct formats are guaranteed and statistics are already generated.

Since 1994 we noticed, that the motivation grew and with it the quality of their work. Administrative work decreased. Students used the feedback corner and our discussion forum to help improving the lessons, statistics and test results helped fixing the marks and our tutors had more time for teaching. They also were able to recognise students' problems much faster and were able to help them *during* the course. The drop-out rate decreased from 20% (average mark 2.1) in 1995 to 11% (with an average mark of 1.6) in 1997.

3 Design and Implementation

In the year 1994 our institute began to improve its lessons and practical classes. In the winter term 1996 we decided to redesign the whole system [see Bollin 95] and to improve our services. All interfaces were reviewed and adapted to the Internet and heterogeneous systems (using Java JDK 1.1). The aim was platform independence and comfort as well as meeting the demands listed above. The system consists of several distributed objects (for a detailed description see [Bollin 97]), a test server including different testing environments, a hand-in server, the administrative client and the hand-in client. All objects are implemented in Java (which is leading to platform independence) and the working environment can be used together with common Internet browsers.

4 Future Work

The system is designed to be modular and easy to extend. The next thing to do is to generate a student's profile out of his or her last trials. The profile data should be used to find the optimal way in assisting students solving the problem. Once a problem is recognised, an educational software should be activated automatically (to assist students in finding a solution by their own). In winter semester 1998 we want to improve the feedback and in the following summer semester we want to be ready to use educational systems in combination with our working environment - to build a *more* intelligent working environment.

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Dissolving the Barriers - Interactions Across Distance: The Creation of a "Virtual Faculty"

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Introduction

Using Chemistry as a test vehicle, several Australian Universities in mainly regional parts of Australia - central Queensland, Northern Territory, southern Victoria and Tasmania collaborated, through the assistance of a national teaching development grant to develop a virtual faculty using videoconferencing. By means of a "virtual faculty " senior Chemistry students in small science departments were able to access classes offered by experts in distant centres.

This project encompassed Universities in four Australian states - Northern Territory, Queensland, Victoria, and Tasmania - spanning an area approximately the size of Europe. Staff and students in Universities such as Northern Territory University (NTU), University of Tasmania (UTAS) and Central Queensland University (CQU) are geographically isolated from other Universities, limiting opportunities for cross institutional staff and student interaction.

It was recognised that students undertaking final year, honours or postgraduate courses in small Universities are frequently disadvantaged because of the limited specialist expertise that may be located within the institution. Chemistry is a discipline which is characterised by a remarkable diversity. Only very large departments, usually located in large city Universities can afford the staff to cover all the areas outside the mainstream. As is the case for most physical sciences, chemistry departments tread a thin line between capital investment in equipment and additional teaching staff. Both are essential for a well rounded chemical education. Most regional institutions have foci of expertise, albeit though small, which if combined together represent a formidable range of teaching talents. The wide scale adoption of telecommunications technologies, such as videoconferencing, across Australian Universities offers a viable avenue for linking together clusters of expertise to form a "virtual faculty".

Questions Asked in the Creation of a Virtual Faculty

The project sought information to gauge student and staff opinion on the following key issues.

- to what extent does a "virtual faculty" enhance the learning experience?
- what are the strengths and weaknesses of a "virtual faculty" as a learning environment?
- what are the most appropriate forms of learning best mediated via videoconferencing?

- what features, from a student's perspective, make the "virtual faculty" attractive as a mode of learning delivery?
- What professional development for staff and students is required to effectively implement the "virtual faculty"?

Feedback todate suggests that the creation of a "virtual faculty" has been viewed as beneficial by participants in spite of some of the difficulties. Difficulties tend to focus around technical and administrative problems and the differences in content background of students at the different Universities.

Challenges in Creating Virtual Faculties

Technical difficulties accounted for a loss of approximately 10% of class time. Approximately 80% of this lost time can be attributed to bridge failures, (a bridge is the electronic device that connects multiple sites in a video or other kind of teleconference). While videoconferencing is generally stable in point to point conferences, multi-point conferences can experience difficulties. The remaining lost time can be explained through problems with other aspects of the technology such as incorrect video hook-ups and difficulties with the operation of the document camera.

Administrative difficulties tended to focus around timetabling issues and differences in semester organisation. Timetabling was a major issue as Universities tend to plan their courses around the timetabling needs of individual institutions well in advance. However, a willingness to work within an extended University day ie from 7.00 am to 10.00 pm can help to overcome this problem. Students surveyed indicated a willingness to operate within more flexible hours as long as they were given sufficient lead time to organise themselves. The students at remote Universities like NTU found that the opportunity to extend their understanding of chemistry and the exposure to totally different ideas and knowledge was a valuable experience.

While overall finding the experience positive, remote students commented on their feeling of being "poor country cousins". There was a strong feeling expressed that because they had different background knowledge to students from the delivering University that they weren't as knowledgeable as their peers. This feeling inhibited the students in asking questions and even presenting ideas for fear of appearing inadequate in front of the larger (distributed) group. Students felt that the small group tutorials where individual University groups worked with the lecturer (from the geographically distant delivering University) was an excellent method in clarifying understanding and enabling interaction and sharing of ideas between lecturer and student.

To make "virtual faculties" effective, both staff and students need to develop skills in working in multi-site distributed teaching environments. Many staff require considerable professional development to acquire a thorough understanding of this unfamiliar teaching and learning environment. There is a need to master the operational aspects of the technology as well as develop the pedagogical understandings to create an interactive learning environment.

Conclusions

"Virtual faculties" have an important role to play in extending expertise in specialised subject areas to students and staff in geographically remote Universities. In spite of some technical and administrative problems, students strongly supported the concept of a "virtual faculty" and hoped to see such opportunities to extend their knowledge of chemistry continue.

Acknowledgments

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The Education Communications Network (ECN) Project: A Strategy to Integrate Educational Telecommunications into Schools in Georgia

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Integrating Educational Communications into Georgia's schools is crucial for giving youth in our country the opportunity to use IT for their activities in the information technology age and to benefit from the collective knowledge of the planet.

The role of IT in education is perhaps more prominent than it has ever been. IT is not only a subject in its own right, it emphasised right across the National Curriculum.

Activities in this direction in our country started in 1979. Scientific Industrial Training Union (SITU) "INFORMATICS" at present is a leading organisation in Georgia in the field. The Main Centre (located in Tbilisi) and the Regional Centres (situated in different cities throughout the country) constitutes its organisational structure.

To support Georgia's Education System Reforming Act, SITU "INFORMATICS" is accomplishing the Education Communications Network (ECN) project, funded by the "Open Society - Georgia" Foundation (member of the Soros Foundations network).

The goal of the project is to combine telecommunications and IT industry standards with specialist knowledge of the demanding requirements of Georgia's schools for providing them with the best of educational telecommunications.

The Project addresses the following major issues:

- Give youth and adults throughout the country an opportunity to use telecommunications and information technologies for the purpose of their educational and professional development;
- Using telecommunications services get access to diversity of educational and decision support information;
- Establish partnership with education partners world-wide.

The project's strategy naturally continues our fifteen year old experience of introducing IT into the education system:

- Personalising the learning process on the basis of educational information technologies;
- Organising groups of educators, instructors and software engineers for development and adaptation of modern educational IT applications;
- Providing intensive training for teachers for implementing teaching and learning with computers in schools.

According to the project's strategy we are planning the following:

- Establish the ECN Sites at the Regional Centres of Informatics and schools in all regions of Georgia, which will give all beneficiaries of the project to interface with each other, see, touch and use the ECN services;
- Develop and implement the Hypermedia Education System (HES) - the ECN-based non-profit state-wide information system;
- Design original multimedia educational applications, essential for the National Curriculum.

In the frame of the ECN project we are accomplishing the "Students are using e-mail" programme.

Major objectives of the programme are:

- To develop creative and critical thinking skills;
- To allow students to accept leadership roles and establish areas of responsibility;
- To provide students with an opportunity to work in collaborative groups;
- To provide students with an opportunity to experience telecommunications firsthand;
- To improve self-esteem by successfully communicating and receiving responses via e-mail.

Students are involved in all aspects of computer-based production of electronic newspaper (e-paper) to be published on the ECN. They are obtaining stories for their e-paper from colleagues at the ECN participating schools and the Regional Centres across the country through e-mail connections. Students write articles for the e-paper, for example: current events from schools' life, advice from home economics, weather reports, statistics and graphs from maths, reports from business/economics, and sports. After examining sample resumes and identifying elements of a resume and cover letter, students from the ECN participating schools and the Regional Centres design and produce using word processing software their own resume and cover letter to apply for the e-paper staff. Prior to beginning work on the e-paper, students work as a research team to survey, interview and observe their target readership. The goal is how to determine what should be included in the e-paper and how to promote it. By this time several students have been "hired" as e-paper staff members (executive managers, advertising managers, public relations managers). The e-paper staff publishes issues monthly.

Accumulated experience will prospect good opportunities for the broadening of schools participating in the ECN project.

The ECN will provide for users from the educational institutions throughout the country the possibility to get access to diversity of educational and decision support information and work together for designing educational software, overlooking or newly creating text-books, curriculum programs, instructional materials. Bridging to external networks will be accomplished as a component of the ECN implementation.

The Project's implementation requires the interaction of technology, people, training and managerial procedures. We create in the frame of the project an organisational mechanism of "Change Management", parallel to IT advances.

The Project will radically change the classroom in three major ways. First off all it will change the way teachers teach in a positive and rewarding manner. In addition the ECN exponentially will increase the resources available for teaching and learning. Finally it will create opportunity for students to learn through meaningful, real-life activities and personal interchanges.

The ECN gives the educational telecommunications national visibility and at the same time demonstrate possibilities of IT-based methods for problem solving, particularly suitable for making transition to an open society.

Using Databases for Dynamic Web Sites: Techniques

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Abstract: Web database tools are one of the hottest Internet technologies of the past year. While companies developing business systems are the prime target for these tools, there are a number of useful ways web databases can be used in educational environments, especially in higher education. This paper describes the general applications of web databases that are relevant for higher education. Two specific projects at the University of Virginia are discussed including an application that helps students use and add to unpublished Civil War research materials and a discussion forum system for student-student and student-faculty out-of-class interaction.

Why Use a Web Database?

One of the hottest topics in the Internet development community in the past year is web-enabled or web-based databases [Spitzer, 1997]. It is no accident that this rise in popularity coincides with the increase in industry and business use of the inter- and intranet. The largest single type of business and enterprise computing application is client-server database transactions — this need is driving the production of a wide variety of web tools for interfacing with and controlling databases. These tools range from add-ons to existing database packages or HTML editors to full-fledged web-based application servers. Though the majority of these tools are designed for traditional database tasks in the corporate environment such as data entry and retrieval, they also provide the opportunity to fundamentally change the way web sites are produced, managed, and delivered.

There are a number of advantages that result from using databases to generate dynamic web sites. One obvious advantage is that information currently in an existing database can be queried to produce web pages "on-the-fly". Databases, however, can do far more than link legacy data to the Web! The content of entire web sites can be stored as data objects and generated as needed for the audience. This obviously saves time spent on brute force page design, but more importantly, it makes it easier to administer, modify, and customize the web site itself. In addition to these benefits, there are a number of novel ways to use web databases to address specific educational tasks, both in and out of the classroom.

Dynamic web content is clearly useful for drawing in new visitors for commercial web sites, but educational web sites have an inherent need for regular change and maintenance. Time and money both affect the regularity of content updating, so any time- or labor-saving techniques have a strong influence on the existence of new content [Helinski, 1996]. Web databases are well-suited for situations where new content fits into a common template, such as images of slides with explanatory notes in an architecture course. In this situation, after the instructor scans the slide and uploads it to the web server, the only remaining step is to add the image filename and the accompanying explanatory text to the course database which makes the new page instantly available to students. Several projects of this nature have been developed at the University of Virginia using commercial and locally-developed web database tools.

If the server load of generating dynamic web pages is too high, or if the appropriate server software is not available, another alternative is to generate static web pages based on templates filled by the database application itself. This case is just like the previous example, except at regular intervals the new entries in the database must be "published". This solution requires more work, but is still much easier than creating web pages from scratch. This method is straight-forward to implement for a single-user and can be used with desktop databases such as Filemaker and Access.

The design components of a web site are the perfect candidate for automatic management tools. Page headers and footer as well as navigation bars are common page elements that need frequent updating. A number of HTML editors now provide the capability to interface with external databases to change, generate, and update these elements dynamically or as a regular batch job.

Databases are also an excellent way to manage the media components of a web site. Educational web sites are rich with a variety of media types, whether they are design components such as backgrounds and logos or the actual educational content, such as images, sounds, and text. Object-oriented databases are best-suited to this task [White, 1996], but even the simplest comma-delimited text file can serve as a useful data-management tool. In our experience, instructional web sites comprise huge numbers of media objects and multiple of content creators; databases make managing this information and longer-term maintenance issues easier to address. The database manages the file names and locations, as well as version information, which not only simplifies administrative tasks, but also begins to document the web development process. This approach is particularly useful when student help is employed in web design since it provides an archive of information about the media objects (original source, processing techniques used) that would otherwise leave with the graduating student.

Educational Benefits of Web Databases

Along with the various administrative tasks that databases simplify for web sites, they offer the educator completely new ways to involve students in learning [Smeaton & Neilson, 1997]. These so far fall into two basic categories: involving the student in a dialogue and involving the student in research. Both prospects are exciting and offer the instructor ways to fundamentally improve both the depth and dynamic of their courses. I'd like to conclude with several examples of each type of application

Many academic research projects, especially in the humanities and social sciences, involve large amounts information, which are typically stored in some sort of database structure. Web databases are useful for giving students access to these growing bodies of research information that are being developed by the course instructor or colleagues. Since this information is usually highly structured, using template-driven web pages to present the data as it is added allows the students to participate in research in real-time. One current research project at the University of Virginia is a catalog of the military records of over 17,000 Civil War soldiers, based on information previously only available at the National Archives in Washington, DC. Students in a Civil War history course taught by that instructor are not only using that data as it comes online (and being among the first people ever to use that data) but they are actually becoming part of the research process itself by adding their own research to this material.

Databases can also be used to fuel web-based applications that allow students to interact asynchronously. One great example is a form-based student response system that facilitates student-professor interaction [Carver, et. al., 1996]. Another example that we are using at the University of Virginia is a discussion forum package run by a web-database system. It is intended to be used as a bulletin board for interaction outside of class-time. This forum provides a place to have students answer each other questions and interact with the instructor. We have also modified the package to serve as a web-based private student journal where the student and instructor can both have instant access to the student's weekly journal assignments.

There are a number of convincing reasons to use web-based databases in education. The advantages of databases as a site- and media-management tool are clear, particularly the reduced need for manual page design work. The applications of web-databases to improving instructional methods, however, is an even more exciting and little-studied area. The Teaching+Technology Initiative at the University of Virginia is starting to shed some light on their uses in education. Our web site, http://cti.itc.virginia.edu/tti/, has more information and links to our current projects.

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Database Aided Publishing of Structured Multimedia Documents

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1. Introduction

In general publishing multimedia data is a very time consuming task which requires skills not commonly available. To make the publishing process more effective we use a database to manage and arrange the parts of multimedia information.

2. Approach

Textual data is currently stored inside the database, multimedia data are stored outside the database in the filesystem. The structure of a document is defined inside the database. An author uses a special entry-form of the database to edit his information (text, image, audio, video). Pictues, audio and video-sequences are prepared with special picture/audio/video applications like Adobe Premiere or Adobe Photoshop. The database is used to arrange the information and to store the relationships between the elements.

The database is accessible via a WWW-Server. For the user, information is accessible via a normal WWW-browser. The final formatting of the information is carried out using format-specifications which offer several layout alternatives depending on the kind of media and structure of information. It is important to state that the formatting rules are seperated from the information and the structure of the document. So it is possible to deliver the same content in different layouts for different needs.

3. Advantages

Editing and storing information and meta-information inside a database offers various advantages:

1. several people can edit simultaneously inside the same structure
2. access rights for authors and readers are managed by the database
3. different views on the stored information
4. (e.g. through tables of content, indices, glossaries which are all generated automatically by the system)
5. the author just enters his content, the formatting is done by the system (no need to learn html or to use a html editor, however basic understanding of url´s is required for linking to information outside the database)
6. high quality user-interface; html-output is produced by the rules of the system, not the author

A demonstration of the system described above is accessible via WWW at the following URL: <http://lomi.e-technik.uni-ulm.de/lanpro>. The demonstration shows content related to a lesson about Local Area Networks.

4. Current Work

Course material like mentioned above is normally based on existing collections. To integrate these resources we started to build a database backed repository for this material.. As a starting point we used a collection of the local physics department containing pictures, videos and descriptions of demonstration experiments and other physics related material.

Our current work will result in a version of LanPro (LanPro is the name of the demo-version at http://lomi.e-technik.uni-ulm.de/lanpro), which will be integrated with our multimedia repository: From the editor it will be possible to retrieve objects from the repository and integrate the results into a presentation.

5. Screenshots

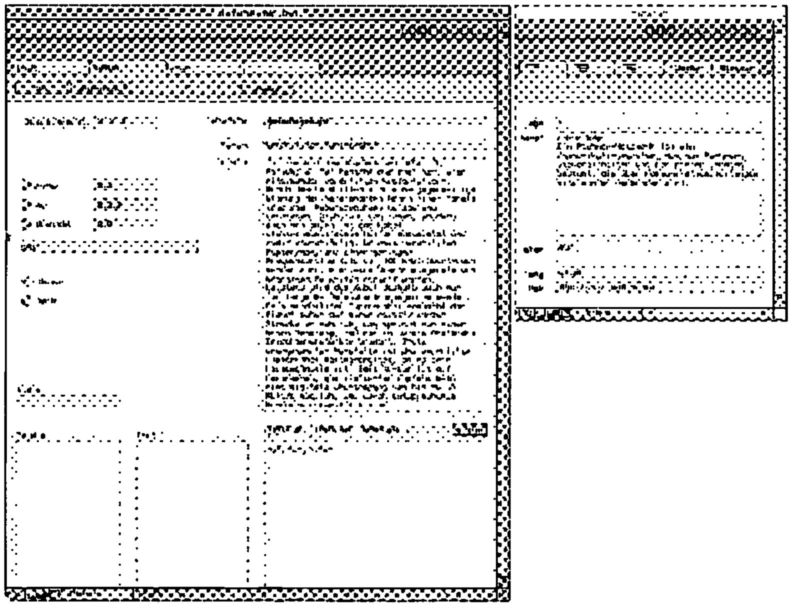

Figure 1: Database editing form showing in the left window a typical entry for a chapter and in the right window an entry mask for the glossary

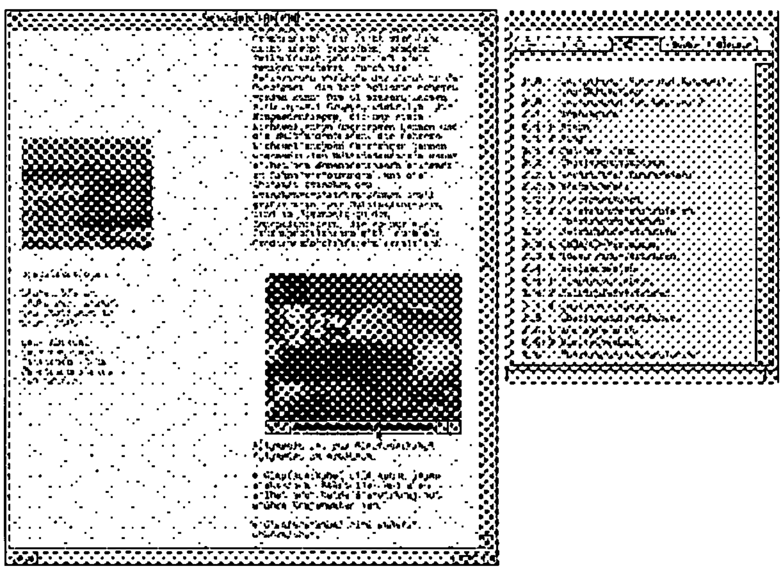

Figure 2: WWW-output showing in the left window a typical chapter and in the right window a view of the automatically generated overview of chapters

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THEORETICAL PERSPECTIVES ON WEB-BASED INSTRUCTION

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In the last several years the use of the World Wide Web for multimedia/hypermedia delivery of education and training has increased substantially. As the amount of development with this medium increases, the need for sound instructional design principles beyond surface page element design also increases. Design prescriptions based upon theoretical principles related to learning are needed to guide this development . Currently, Web-based instruction lacks a strong theoretical base on which to draw instructional principles. Theoretical principles which have evolved surrounding related technologies such as distance education, hypertext and computer-mediated communications can be applied to instruction and training delivered via the World Wide Web. Principles borrowed from theoretical constructs associated with emerging technologies can perhaps provide a strong starting point for establishing a theoretical base which can assist designers and developers in creating instructionally powerful applications for the Web. Working toward an established theoretical base may permit Web-based instruction to become as Ritchie & Hoffman [1997] describe it "... a meaningful learning environment where learning is fostered and supported".

This paper will provide a review of applicable theoretical constructs which are associated with related Web-based technologies. Theory bases related to distance education, computer-mediated communications and hypertext technologies will be reviewed.

DISTANCE EDUCATION

Web-based instruction may be subsumed under the broader framework of distance education and therefore can assume a similar theoretical stance. Unfortunately, the field of distance education is also struggling to define a theoretical foundation [McIsaac & Gunawardena, 1996]. Much of the research and discourse to date involving distance education has been focused primarily on the delivery technologies involved and less on developing a strong theoretical framework on which to base further instructional development. However, a few theoretical constructs related to adult learning and communication theory have emerged such as theories of autonomy [Wedemeyer, 1977] and independence of the learner [Moore, 1973]. More recently, Moore & Kearsley [1996] expanded these ideas into the theory of transactional distance which describes a pedagogical distance between learners and instructors. Through these evolving constructs, researchers and theorists in the distance education field have begun to focus more on the learning process and teaching strategies rather than the technologies involved. These constructs can also serve as a tool to help to view and describe interactions within Web-based instructional applications providing a much needed theoretical base. Designers and developers can then incorporate these useful principles into their sites therefore potentially improving the quality of instruction available with this medium.

COMPUTER-MEDIATED COMMUNICATIONS

A related technology often included in various distance education efforts and also incorporated into Web-based instruction is described as computer-mediated communications [CMC]. CMC can include different types of electronic communication channels such as electronic mail, computer conferencing, discussion lists and bulletin boards. These technologies have been most notably associated with constructivist learning theory due to the "conversational" nature of the medium which can provides a vehicle for social negotiation of meaning [Romiszowski & Mason, 1996]. As a capability within many Web-based instructional courses, CMC represents a means for collaborative inquiry into a specific topic area. Researchers in this area are beginning to examine the nature of collaboration and communication applied to the Web-based environment [Collis, 1997]. Familiarity with the fundamental principles of constructivist learning theory as implemented by computer mediated communications, may provide needed insight into the design of instructional environments on the Web.

HYPERTEXT

The World Wide Web represents the quintessential hypertext environment. A theoretical notion which has evolved associated with the nature of hypertext is cognitive flexibility theory. This theory conceptualized by Rand Spiro and colleagues [Spiro & Jehng, 1988;] addresses the complexity of higher level instructional content attempting to avoid the common perspective of oversimplifying concepts for instructional delivery. The theory provides a framework for addressing ill-structured content through providing the learner with multiple representations of content and multiple opportunities to assimilate complex information by viewing it through different themes. The attributes of hypertext provide a good match for this theoretical approach. Web- based instruction capitalizes primarily on hypertext delivery of information and can therefore benefit from implementing a theoretical construct such as cognitive flexibility theory.

CONCLUSION

As the World Wide Web may ultimately become the delivery mechanism for the majority of education and training worldwide, more emphasis is needed to ground further development in strong theoretical principles related to learning. Much can be gained from existing theoretical constructs which have been associated with related technologies providing a framework from which to expand our thinking related to the new technological delivery of instruction on the Web and sound learning principles.

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Using Macromedia Authorware™ to design Hybrid CD-ROM/Web Course Related Materials

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Introduction

When discussing multimedia development and delivery we come across a heated debate between two different camps. Those promoting and defending CD ROM based technologies and others promoting exclusive Web based technologies. This paper explores some issues surrounding these debates and it looks at the Hybrid CD ROM/Web technology that takes the best from both.

When considering the use of multimedia technologies, issues concerning authoring, delivery and content updates are the most important. In particular, questions focus on whether the authoring tools are powerful and easy to use with both formats and whether there is a real benefit from using this technology. Macromedia Authorware™ was selected as the best authoring software to test these criteria.

Why use hybrid CD-ROM/Web technology?

CD-ROM has been considered by many as a good and inexpensive vehicle for delivering interactive multimedia content. The major criticism of CD-ROM is that its content is static and quickly becomes out of date. On the other hand, Internet and in particular the World Wide Web, offers incredible flexibility, real time information and distributed collaboration. On the negative side, the bandwidth and authoring capabilities are very often criticized and are seen as the major obstacles in the creation and delivery of multimedia content.

It has been suggested (Ozer 1997) that improvement in the Internet bandwidth will eventually kill the CD-ROM. It is also widely agreed that wide adoption of the Web in the developers community will improve the authoring tools as well. If when this happens is open to speculation. Meanwhile, the advantages of utilizing both technologies to create hybrid CD-ROM/Web content should be considered as a bridged solution.

Different types of Hybrid CD ROM/Web Designs

It has been estimated (Cole 1997) that in the mid-1996 there were 350 or more hybrid titles and that by the end of 1997 there was around 3500 titles available. Many are from well established companies such as Microsoft, Voayager, Grolier, Dorling Kinderslay and others. Careful evaluation of these products will allow the separation of marketing hype from the useful tools that will improve the development and delivery of multimedia content.

The major types of hybrid CD-ROM/Web designs to consider are:

1. CD-ROM media content (video, audio, large graphics) accessed directly from web browsers (could be either local or remote mode).

2. Interactive multimedia titles with simple links to a web site by launching a web browser.

3. Interactive multimedia titles with links to the various media content update site or sites (e.g. Microsoft Baseball, Cinemania 97).

4. HTML-based CD-ROM with HTML structured content (e.g. Encyclopedia Britanica 2.0).

5. Shockwave based website with links to CD-ROM media content.

Each format has its own strengths and weaknesses and we can choose those elements that are particularly suitable to our application.

Creating hybrid CD-ROM/Web Content

There are several authoring tools available on the market today. Asymetrix ToolBook II, Allen Communication QuestNet+, MarketScape, WebCD, Macromedia Director 6.0 and Authorware 4.0 and others which embrace the Internet integration more effectively and with various ease-of use. We have chosen Authorware 4.0 for our projects because of our familiarity with the software, its suitability to our particular content design and its cross-platform capability. Also noted should be its student administration and quiz creating capabilities. In particular, Authorware 4.0 offers good integration with Java, so that movies can be embedded as applets. Similarly, Java applets can be played within Shockwave movies. These capabilities offer a number of advantages over other authoring tools.

At the recent Macromedia conference an announcement was made that Shockwave titles will be saved as Java applets. Therefore, with Java you will not need a separate player with your browser. However, the question of delivering large files and the slow speed of Java processing will remain with us (Dinucci 1997).

Conclusion

With the advances in Internet-based technologies, such as VRLM 2.0, proposed HTML 4.0 and XML markup language, improved Java JDK and just in time (JIT) compilers, ActiveX and Java Beans the integration of CD-ROM looks very promising (Gustavson 1997).

At the CITD, we have started to convert two course related titles ÒInvertebrate PhylogenyÓ and ÒRussian Heritage: Its Land, Peoples and CultureÓ. One project includes small video clips, animation and voice-over with many images - media that CD ROM handles reasonably well. On the other hand, fast changing textual information mostly dealing with issues of course administration, is well implemented on the Web. Placing the media intensive part on the CD ROM (such as video and animation) and linking the changing textual information (such as course information, timetables and other information) presently available on the Web site seems to be the best solution for now. At the same time, we are also evaluating the possibilities of using this technology in several distance education projects. Similarly, many publishers today consider CD-ROM not as an exclusively standalone product, but rather along with the Internet, as a hybrid strategy in their publishing effort (Cole 1997).

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Interactive Electronic Technical Manuals: New Opportunities For Learning And Instruction

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Interactive Electronic Technical Manuals

More and more technical documentation on devices and systems is becoming available in electronic format. The question we address is how this information can be used in the training of engineers. The work presented stems from a research project for the Royal Netherlands Air Force (RNLAF) investigating the possibilities of using Interactive Electronic Technical Manuals (IETM's) in training [Barnard & Riemersma 1997]. The complexity and functionality of IETM's may vary a great deal. The least advanced manual is a page oriented, electronic document with a simple index. This can be upgraded by adding hyperlinks and search facilities. More advanced types of IETM's are database oriented systems. The most advanced types can be integrated with facilities such as fault-diagnosis systems. A basic characteristic of IETM's is that the data on the system they describe, are separate from the viewer which present the data on screen. This makes it possible to present the same data in different ways, allowing the possibility to use the data for other purposes than they were created for, such as educational purposes.

Scenarios For Training Maintenance Engineers

Maintenance engineers need to have technical skills in order to be able to perform necessary procedures, they need to have extensive knowledge about the system and they must be able to reason about the system in order to perform fault diagnosis. In the RNLAF helicopter maintenance trainees are given, after an initial basic training, a specialist course for a certain helicopter type. This course starts with several weeks of theoretical lessons about the helicopter components and their functioning. After this, they start to learn the maintenance tasks in practice on the job. At the moment, learning material in the form of a syllabus is constructed from both the paper-based technical manual and from the training course documents provided by the manufacturer. One of the big problems with paper-based learning materials is that if something is changed in the technical system, the learning materials are outdated. Especially in helicopters many changes are made during the system's lifetime.

If the information available in IETM's is to be used in instruction, what kind of instructional scenarios will become possible? We are currently investigating four scenarios in relation to helicopter maintenance training. Although some research (e.g. US Navy) is beginning to emerge in which IETM's are linked to educational applications, there is as yet very little experience in realistic educational settings [Kribs et al. 1996]. Some of these scenarios are easy to realize, and are geared towards facilitating current educational practice. However, the future availability of more advanced IETM's, and the development of innovative educational software, will widely broaden the range of instructional forms but may also change training needs.

IETM as a presentation source: In classroom-based courses, IETM's can serve as a source for presentations by instructors. If the instructors could extract the information, such as a scheme of a part of the technical system, in digital format this will enable them to use it in different ways. The information may be annotated or parts may be highlighted and printed out for the learning materials. It is also possible to use the information to prepare a computer-based overhead presentation, for example in PowerPoint. Presentations may be improved by the possibility to zoom in and out on details of drawings and schemes. More didactic functionality may also be added. One of the problems in technical domains is that many processes in a system are dynamic ones. In manuals these processes are represented in a static way. It is often difficult to explain such processes to trainees. It would be a powerful facility for instructors if static information from an IETM could be animated. For example a spot could be placed in an electronic scheme, which moves along the scheme to demonstrate the propagation of impulses.

Case-based training: The use of IETM's may also facilitate training in which the trainees have to take a more active role, such as case-based training. The trainees may be presented with assignments to find information about components or to find the right procedure to diagnose a fault and to fix a certain component. In this way the trainees become acquainted with the system information as well as with using the IETM. When some parts of the manual are too difficult or too complex, the instructor may add annotations to help and to guide the trainee. The IETM can be used in a computer based learning environment in which cases are stored as well as solutions and solution paths. Such an environment guides the trainees throughout their search in the IETM, gives feedback and suggestions to the trainee and evaluates the solutions. This may be done by letting the instructor input the correct searchpath and comments or by using intelligent agents, able to evaluate the path dynamically. If automatic fault diagnosis becomes available in IETM's, using Artificial Intelligence techniques, then even more opportunities will become available to compare solutions and solution paths between the AI system and the trainee. In this situation case-based reasoning techniques can be used to generate models of both the system and the trainee. Interesting ways of case-based training may be opened up by creating a training situation in which practical work is combined with theoretical learning about the system. This might also be done in groups of trainees learning collaboratively [Leroux et al. 1996].

Computer based training programs: Computer based training programs can be developed which use the IETM as a source of domain knowledge. For example XAIDA is a software tool which offers this possibility [Sorensen et al. 1995]. This means great savings in terms of development effort. The challenge is to make CBT such that it has dynamic links to the IETM. If the IETM is updated, the CBT takes in the new data. This might cause problems because, for example, the texts in the CBT which came from the courseware developer, might then no longer fit the data taken from the CBT. This problem may be solved by developing a facility which warns the instructors about parts of the IETM in which changes were made and allows them to adapt the CBT. In this case the remaining problem might be that many, maybe small, changes are made rather frequently in the IETM. Going a big step further is to develop CBT that uses virtual reality techniques for the presentation of information. Such a system would enable the trainee to 'walk' through the components of the systems or through schemes etc.

Just-in-time and on-the-job learning: The introduction of IETM's offers a great opportunity for developing forms of instruction that integrate learning and working. Maintenance engineers will have the IETM at their disposal at their workplace and will have experience working with the IETM. These conditions make it easy to introduce learning-on-the-job. By using educational applications linked to the IETM, engineers can spend time at their workshop to learn in their own time and pace. By adding the possibility to seek contact with a training centre by different telematic facilities, help and guidance can be provided. Just-in-time learning can be introduced by training the maintenance personnel just before they have to perform a certain (complex) task. This training may take the form of rehearsing what the engineer already has learned before, but it may also concern new information. Learning may not just be restricted to individual engineers, but may take place in the organization as well. For example a large repair job may be simulated with the aid of the IETM by a repair team with different specialists, discussing the different options and learning about possible ways to proceed. More organizational learning will take place when a facility is added to the IETM in which experiences with repair jobs can be stored, both formal experiences, with links to the procedures in the IETM, as more personal notes of the various engineers.

Future Developments

The introduction of IETM's provides the training developer with a large amount of digital information about the system. In the development of courseware (and other training materials such as syllabi), the gathering of domain knowledge forms a large part of the development process. Courseware developers usually spend a lot of time together with domain knowledge specialists in order to get sufficient insight into the domain. Then materials have to be either copied or constructed from the paper manuals. So there is much to be gained in terms of effort and time by having available all the system information in a digital form. Also, the development of more intelligent forms of courseware, such as intelligent tutoring systems (ITS), is always severely hampered by knowledge acquisition problems. Most ITS's therefore are to be found in very small, artificial and/or formal domains. If, however, advanced forms of IETM's become available, this domain knowledge problem might, at least for a part, be solved. The most promising development, in our opinion, is to be found in possibilities for bringing together work and training. IETM's make it possible to have system information and training facilities available always and everywhere.

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Evaluating Multimedia Educational Software

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Introduction

This work briefly sets out the methodology used during the academic years of 94/95 and 95/96 for the evaluation of educational software destined for the teaching of Engineering Thermodynamics in Mechanical Engineering. This research has been being developed since 1991 in the Area of Thermic Machines and Engines in the University of Zaragoza.

The constant need for ratification of the design and performance mechanisms of educational software, as well as measurements of the level of attainment of the educational objectives reached by the students who use these programmes, make it necessary to use systematic evaluation processes which verify the quality and suitability of the software that has been developed. It is worth noting that even though there exists a certain consensus about the varied functions which educational software should perform and about the strategies that it can exhibit, there are no generalised mechanisms which allow us to check the level of efficiency in a determined instructional sequence.

The evaluation of educational software includes two different phases [van der Mast, 1995], one of which concerns the evaluation of the developed product based on its specifications, a *formative* evaluation. The other is one which evaluates the level of attainment of the educational objectives which is proposed with the usage of educational software in determined conditions, a *summative* evaluation.

Formative Evaluation

The objective is to adjust the design to the user's needs. We start from the assumption that the initial refinement, by means of periodic checks, guarantees that the programme is at least intelligible and robust. This evaluation should be on a small but intensive scale. Two subjects have been tested during this research:

- Interface: appearance, navegation, ease of use and functionality.
- Contents: extension, quality of organisation, resources and speed.

The session files which were generated by the system were used for the evaluation as well as the responses to the multiple choice questionnaires, on an evaluation scale, and the interviews carried out with the students who gave extreme responses. With these results we carried out a classical statistical study in order to compare the results of each programme with the rest.

Summative evaluation

This type of evaluation tries to obtain a measurement of the level of the attainment of the objectives posed in the educational design. The results should allow us to establish comparisons with other teaching methods with the aim of providing a measure of the suitability of the proposed teaching sequence. It is necessary to specify in what conditions the software will be evaluated in order to obtain significant results on its introduction and use in the educational ambit. One long term objective is to test the programme under different conditions of use, seeking those which provide the most favourable results.

Measuring the level of attainment in an educational sequence is usually associated with the value of the academic performance that is obtained when carrying out tests [Bisquerra, 1987]. Traditionally, in order to establish comparisons between different instruction sequences, the same instruments used for measuring performance are applied to two or more groups, one of which has followed the sequence which we wish to compare, and it is a question of seeing if there are statistically significant differences between the groups. This type of description does not inform us about how the type of sequence followed influences the final results, it only informs us about whether or not there is any kind of influence.

Most of the cases which arise in the educational ambit, the strict causality between two variables, is an excessive hypothesis. It is more reasonable to consider a more complex system of relations in which a larger number of simultaneous explanatory variables are involved. Depending on the precise objectives of the analysis and on the type of data which is being worked with, we have a large variety of statistical techniques which are currently available, which are increasingly powerful and better adapted to the requirements of information processing in human and social sciences.

Within their large variety, the factor techniques developed by J. P. Benzécry [Benzécry, 1965, 1970, 1973, 1982], which use the properties of Euclides vector spaces to describe individuals as well as variables, stand out as instruments of great use for the study and interpretation of complex phenomena such as educational situations. The quantitative treatment of what is qualitative, and the simultaneous analysis of a collection of variables, define the substantial contributions of these statistical methods.

The basic idea is to consider each element, characterised by a sequence of relative values, with a determined number of descriptive variables. The whole can be represented in a multidimensional space, the different share density of which allows us to look for a smaller subspace which takes into account the arrangement of the whole of the data with the least possible loss of information. For this reason, multifarious techniques, that is the descriptive ones, are tools which facilitate the synthesis of multiple factors in their more significant tendencies.

In order to establish the level of attainment reached in the assimilation of the content, the results from two tests have been used throughout this research. One of the tests is of a theoretical nature, focused on the conceptual content and the other test is of a practical nature, focused on the procedural content.. In the case of the group which uses information technology resources, we also took into account the work summaries from the sessions and the files that were automatically generated by the system in order to add precision to the qualifications. Once all the data corresponding to the two tests had been collected together, we proceeded to analyse it. The method followed is divided into three phases:

- Reduction of the data: This phase is about trying to obtain units of information which are at the same time comprehensible, relevant and significantly dense.
- Arrangement and transformation of the data: The final aim is to present the data in an operative way thus facilitating the examination and comprehension of the data, allowing us to reach conclusions. In this case, we used the SPAD N ® programme which allows us to obtain graphics which ease interpretation of the results.
- Interpretation and discussion of the results: In view of the graphics obtained, the factors which appear and their influence on the proposed sequence, of instruction are discussed.

Conclusions

The factorial methods are considered appropriate for a summative evaluation for the following reasons:

- The description of tables by observation is difficult when the dimension is big and this does not allow us to interpret them completely.
- The developments in information technology make them methods which are easily applicable and not very expensive.
- Multifarious methods consider all the relations between the elements in the table simultaneously. Educational phenomena are multifarious and it is necessary not only to realise a synthesis of the individual data, but also the relations have to be described and structures detected.
- In general, this type of analysis allows us to reduce the criteria and the factors, to select the most important ones, arrange them in order of importance, create groups and position them.
- They are descriptive or explanatory methods, they are not causal. They measure associations or interrelations, but they do not establish relations of causality, which have to be formulated by the analysts.
- In many cases, the results are graphical and this facilitates the work involved in a meticulous interpretation.

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The Mime That Screams: Where Is the Teacher In the Multimedia(ted) Classroom?

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Thesis

What is the role of the teacher in a multimedia teaching environment? The "title-question" intends to suggest the seldom-examined idea that perhaps all classroom instruction is multimediated; that what we think of as multimedia lies primarily in the interactivity between persons rather than between persons and machines; and that the role of "equipment" in the "multimedia environment" is simply control and delivery. Given this definition, there is the strong possibility that the success of this interactivity could be determined in large measure by how invisible the technology is. It is certainly clear in the case of technology that *doesn't* work that it becomes a hindrance to learning. In the case of programming that is so "slick" it is unnoticeable or has been made so natural to the circumstance that its use is simply intuited, it becomes like clean glass in a window. This presentation will illustrate the premise that "invisible" technology becomes another inter*media*ry between learning persons in a classroom environment.

Problem

The issue of media transparency is central to questions about the "appropriate use" of technology in support of classroom teaching. In the case of a student whose reading skills are inadequate, the text becomes a barrier to learning -- it gets in the way. As well, presenting an image or icon that has no relationship to the knowledge base of a student must likewise distract from learning. A teacher whose concern is that the projection system and presentation program work without flaw or whose entire preparation consists in the development of "pleasing visuals" may have allowed the machine to get in the way of teaching.[1] What the teacher does is being controlled by the machine which by that fact becomes the focal point of instruction. It is impossible to see beyond the hardware because it is in the way.

Technique

Using CD-ROM packaged digital video, this experimental presentation demonstrates one way of making technology more transparent. The strategy is to present and discuss the questions below by having a conversation between a real individual -- the teacher, live -- and a virtual individual -- the teacher, digitized. The questions were deliberately chosen as illustrations of controversial topics, but they also raise the point at issue -- that humans are the key to successful multimedia use because only they can orchestrate the technology and keep it from getting in the way. The objective of this demonstration is to invite audience participation in the conversation without giving a direct solicitation.

Questions

1) Can machines motivate? Isn't interaction with a machine actually interaction with the programmer who is absent and is therefore not able to respond except in his/her imagination? Most success stories about learning with technology seem to assume that the student is already motivated to learn. Is it possible for a tuned-in teacher[2] to queue the machine to create an interactive moment (like a conversation)? Is the stimulus of human interaction necessary for motivation?

2) Do I need *only* information or problem-solving models or must I learn to apply general knowledge to specific circumstances or to analyze complex interpersonal/interthing/interpersonthing puzzles? The goal of instruction is always discipline specific. Some areas of study are information intensive and some are more process oriented, some require analysis and some management skills. How does technology satisfy the needs of discipline-specific pedagogy unless directed by a person with a clear vision of the need?

3) Am I looking for "42"?[3]

4) How do I learn? By seeing? Listening? Touching? Imagining? Logically? Poetically? And who tells the machine how to present the material? Does it learn like I do?

5) How is it possible in the hypertext, non-linear environment of the computer to teach the linearity of logic and the discipline of analysis? Both of these skills are necessary in order to understand and create this technology. How is it possible for a person to contribute to the development of an intellectual project if he/she cannot present ideas in a disciplined and logical way?

6) Is technology "glitzy" and superficial? Books "require" a person to look at information on many different levels but the CRT seems to "require" passivity! Does it manage text in a way that is different from bound paper? Is it somewhere between the book and TV? What does that mean?

"I see a parallel between the goals of 'Sesame Street' and those of children's computing. Both are pervasive, expensive, and encourage children to sit still. Both display animated cartoons, gaudy numbers, and weird, random noises. Both encourage passive acceptance of a medium that will follow them for the rest of their lives. Both give the sensation that by merely watching a screen, you can acquire information without work and without discipline. And both shout the magical mantra: 'Here's the no-effort, fun way to learn!'"[4]

Consequences

There is clearly a middle place between the extremes of those who expect multimedia in the classroom to be the magic bullet and those who fear the glow of electronic display. While technology will never make a "bad" teacher into a "good" one it certainly has the potential to do the opposite. Good multimedia courseware will facilitate creative links between its parts; and the "parts" of any learning environment are always curious learners. If classroom technology is so opaque that it isolates students, it will not mediate learning.

In using multimedia in the classroom, the role of the modern teacher is like that of ancient mediums. They are the ones who read the spirits of their students and prescribe solutions for their curiosity. In this case -- sorry Marshal McLuhen -- the medium gives the message!

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[1] Teaching isn't good because it is novel, but because it entices student involvement with ideas and interaction with other minds. Teaching is "good" when it makes critical thinking attractive and when it raises a creative or inventive curiosity about questions.

[2] The characteristics of multimedia are the same as the characteristics of a good teacher: responsive, directed by needs, highlights content, versatile and adaptable, non-linear, interesting!

[3] Almost too complicated to explain, this refers to the passage in Douglas Adams, The More Than Complete Hitchhiker's Guide (Avenel, NJ: Prentice Hall, 1994), 118-120 where the world's second greatest computer gives its answer "To the great Question of Life, the Universe and Everything?" Because the humans were upset that the answer is "42", the computer points out that the question doesn't make much sense either!

[4] Clifford Stoll, Silicon Snake Oil (New York: Doubleday, 1995), 146.

The Effects Of Problem-Based Learning Software In Surgery Education

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Introduction

With the advances in computers and instructional technology many new teaching methods are available, however, there is minimal data to support that new methods are superior to existing techniques. A lot of the research in educational multimedia and instructional technology has focused on the effects this media has on children's education. The use of interactive multimedia has recent made its way into adult education, and is making a strong surge in the medical setting. Few studies have been performed and little analysis has determines the effects of multimedia in medical education, particularly in surgery education. This study helps bridge the gap and provides a foundation for the further use and development of interactive medical software.

Study Issues

This study is comprised of a two step process. The first stage involves the creation of a multimedia product appropriate for the education of medical students. Numerous design and development models were accessed as a means of creating the learning material which entails a student navigated, problem-based learning approach. The finished product will be used primarily as an aid in the instruction of third-year medical students whose focus is in the area of surgery. The second stage of the study involves using a post-test performance measure. The goal is to determine the extent to which the created problem-based learning software improves student performance.

Hypothesis

The hypothesis of the study is that the post-test performance of the students participating in a multimedia student-directed learning environment will be statistically significantly higher than the students in a faculty-directed group.

Brief Study Methodology

This study compares the post-test performance of two groups of medical students. Students will be assigned to one of two groups, either the experimental group or the control group. Each group will retain their current educational regiments as required by the medical school however one group has the additional aid of the multimedia software.

The experimental group has been defined as students who participate in the student-directed non-linear method of problem-based learning with a follow-up faculty review. This group will use a multimedia decision based learning product specifically designed and developed by the researchers for this purpose. The control group will be students who participate in only a faculty-directed linear problem-based learning method.

Product Design

The multimedia product allows students to pursue the course of patient management. Through the software students will provide care they believe most appropriate for their simulated patient(s). The software is designed to reflect the efficacy of students' diagnostic and therapeutic interventions and records treatment(s) and invention(s) suggested by the student. The application will provide various routes of interventions with no true "right" or "wrong" answer. Students will be free to choose among the given options without penalty, although patient outcomes will benefit or suffer accordingly.

Analysis

After completion of the program both the control group and the experimental group test scores will be quantitatively analyzed. Descriptive statistics are used to describe demographic information about the two groups. The student t-test is used to look at the differences between the two groups. A p-value < 0.05 is used to determine significance. Further information collected concerning the intervention or lack of intervention will be collect however is considered ancillary data and will not be used in addressing the studies hypothesis.

Visualization of Optimization Algorithms: The Downhill Simplex and Simulated Annealing Methods

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We present animated visualizations of algorithms for optimization. In particular, we show visualizations of the simplex algorithm [Press 1988a] and visualizations of the simulated annealing algorithm [Press 1988b] [McLaughlin 1989] [Carlson 1997] for a variety of optimization problems. These animations are useful in university courses in mathematics, applied mathematics, and computer science, especially wherever the topic of optimization is encountered.

The downhill simplex algorithm originated with [Nelder & Mead 1965]. Although it requires only evaluations of the function whose minimum is sought, and not derivatives of that function, it is not efficient in the number of function evaluations required. Nonetheless, it has a natural geometric treatment which makes it easy to describe and to learn, and it lends itself readily to visualization.

In the downhill simplex algorithm, a geometric figure, called the simplex, begins somewhere on a multidimensional surface, and, by a series of motions based on four rules, moves towards the minimum.

The animations we show begin with frame-by-frame sequences in two and three dimensions, showing the motion of the simplex down a surface which monotonically decreases.

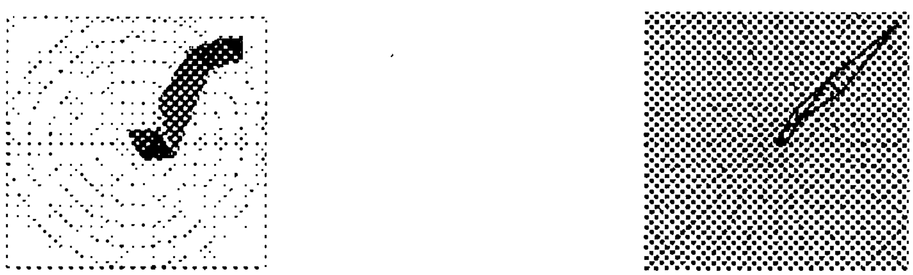

Figure 1: Motion of the downhill simplex in two (left) and three (right) dimensions.

The figure on the left shows the simplex in two dimensions; after nine steps it has come close to the bottom of the surface. The figure on the left shows the simplex in three dimensions. We progress towards QuickTime movies in three dimensions to show the motion of a simplex down surfaces with multiple local minima. The visualizations show the problem of becoming trapped in a local minimum and not escaping to reach a global minimum. The visualizations also show the utility of restarting the algorithm from a presumed minimum.

We show animations of simulated annealing algorithms applied to discrete and continuous problems, including the simplex method just discussed. The simulated annealing algorithm modifies greedy optimization algorithms by permitting an intermediate step which moves the system *away* from the minimum with a probability proportional to $\exp[(E_{old} - E_{new})/kT]$. The probability function resembles the Boltzmann distribution from thermodynamics, where the E's are energies, T is the absolute temperature, and k the Boltzmann constant. For optimization, E represents a score, or value of the function to be optimized, and kT is systematically reduced according to a "cooling schedule." It is helpful to follow the progress of simulated annealing graphically in order to choose a suitable cooling schedule.

Interesting applications of simulated annealing include the "Traveling Salesman" problem [Carlson 1997] and the problem of optimal placement of labels on maps [Christianson *et al.* 1995].

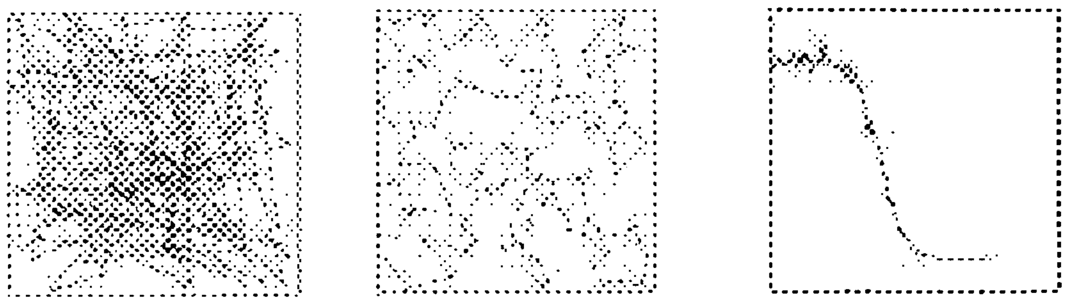

Figure 2: Itinerary of the "traveling salesman" before (left) and after(center) optimization; length of itinerary (right).

The figure on the left shows the initial attempt at a traveling salesman itinerary, and the figure on the right shows the final solution after approximately 200 iterations of the simulated annealing algorithm. A plot of itinerary length vs. iteration shows that, for some trials, the length of the itinerary actually increases, because of the "annealing" algorithm.

Similarly, here we show the initial and final states of the simulated annealing algorithm applied to finding the optimum placement of labels (in this case, names of towns) on a map [Anderson 1998].

Figure 3: Placement of names on map; before (left), after (right) using the simulated annealing algorithm.

Using animation, a simple greedy method can be compared to the simulated annealing method instructively. In addition, various "cooling curves" can be designed and tested empirically.

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RECEPTION AND EFFECTIVENESS OF AN EDUCATIONAL SOFTWARE PROGRAM OF LEARNING AND SELF-ASSESSMENT IN LAW HISTORY

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I. INTRODUCTION

What does the work of a lawyer consist of? It mainly comes down to finding solutions to legal problems by using three 'databases': first, the law; then, the jurisprudence which is also called case law, that is the way the law has already been applied; and finally, the doctrine which comments on the law as well as the jurisprudence. Students are expected to learn how to synthesize these three sources by making links between them. This is a particularly difficult task for first-year students whose most of their secondary courses is taught in linear mode. So as to take this into account, the course of Roman Law was right from the beginning split into three elements :

- the duplicated lecture notes which may be considered as the doctrine in actual law;
- the texts which include judicial precedents or jurisconsults' opinions over tricky cases;
- the vocabulary which contains basic notions in Roman Law and is similar to the law.

The computer could be used as a potentially very convenient tool to establish a network of links between numerous concepts as well as to ease students' initiation into the makings of their own conceptual network. During the design of this educational software, have been added some items of secondary importance. Finally, this educational software includes a stack of multiple choice questions (MCQs) on Roman Law, allowing students to assess their knowledge and improve it thanks to explanations given each time answers are wrong.

These four elements (lectures notes, texts, vocabulary, and MCQs) pursue two distinctive goals. On the one hand, the firs three elements aim at knowledge to be taken in by linking them to each other. On the other hand, the 400 MCQs enable students to check the accuracy of their knowledge.

II. RECEPTION AND EFFECTIVENESS

In spring 1994, when it was decided to build up a software program which would serve as a new medium for the teaching of Roman Law, Hypercard software made it quickly possible to build up a prototype which integrated most of the functional elements peculiar to the educational software into a proper architecture whose design features remained mainly unchanged until the ultimate stage of the project. The CD-ROM was obtainable from September 1996.

It seemed judicious to check, if not its profitability, at least its effectiveness in terms of harmful, neutral or beneficial effects on exam results. Exam results of May 1996 were therefore a very long time coming to us. Exams took the usual form of MCQs and were computerized to be marked. Comparisons with previous exam results showed a higher simple arithmetic mean computed over 577 data as well as a new statistical distribution of results (see Table 1).

Results	1989	1990	1993	1994	1995	**1996**	**1997**

<= 2	21	19	19	20	21	**12**	**10**
<= 4	43	41	38	47	39	**24**	**23**
<= 6	60	60	52	66	55	**38**	**34**
<= 8	72	74	66	80	71	**53**	**45**
<= 10	82	88	76	88	82	**67**	**57**
<= 12	91	95	85	95	93	**77**	**71**
<= 14	96	99	93	98	98	**90**	**84**
<= 16	99	99	99	99	99	**95**	**93**
<= 18	99	100	99	100	99	**99**	**99**
<= 20	100	100	100	100	100	**100**	**100**

Table 1: Frequency Distributions of results (Cumulative percentages)

It seemed putting it a bit strongly to conclude from this simple comparative analysis that the availability of the new medium was *the* explanation. So as to verify this relation of cause and effect from a scientific viewpoint, a survey was carried out in may 1996 over more than 500 first-year students in Law.

Some results are specially striking. For instance, when preparing for the exam, students used the educational software *more than* studying Roman Law by way of the lecture notes. It shows that advanced technology can quickly become integrated into such an educational environment as the field of social sciences, not mentioning Roman Law! In most cases, using advanced technology does not constitute an alternative teaching method to more traditional ones. Students who state spending some time in using the CD-ROM do go on reading the textbooks.

Figure 1 compares results from students using the software to those from students still sticking to traditional educational methods. The availability of advanced technology is shown to have some important effects on pass rates as well as on arithmetic means.

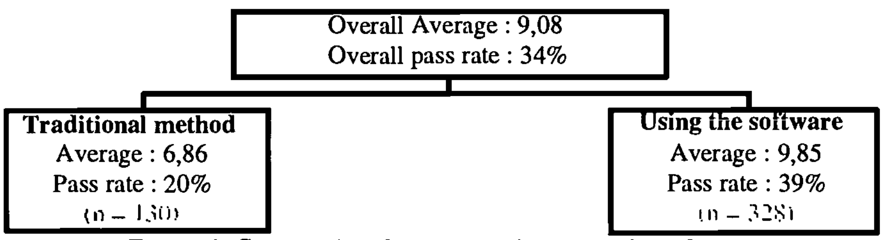

Figure 1: Compared performances using or not the software

When relating these figures to those on time spent in using the software, a clear relation between the two sets of data is pointed out, providing some time is simultaneously spent in using traditional educational methods. An upper limit to the time spent in using advanced technology is also shown to exist: beyond it, students do not succeed to improve their results anymore.

Data collected during this survey have made it possible to study the relationship between students'marks and different variables, such as:

- does the student attend lectures?
- does the student attend practical exercises?
- how much time is spent in studying lecture notes?
- how much time is spent in using the educational software?

The statistical model which is based on a linear method of regression gives very significant coefficients for the relation between the dependant variable (students' marks) and independent variables including the new interactive teaching method. Results are given in Table 2.

Basic mark	8.9
Student doesn't attend lectures in general	-1.8
Student doesn't attend several lectures	-1.5
Student doesn't attend practical exercises in general	-3.6
Student doesn't attend several exercises	-1.3
Student spent half of time in studying lectures notes	+1.1
Student spent time in using the software	+2.7

Table 2: Relationship between students' mark and factors measured

Training Disabled People to Do Gardening Tasks: A Pilot Study on The Effectiveness of a Multimedia Software.

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One of the most important goals of the Education of people with disabilities is to get them included in regular job places or, at least, to prepare them to do regular jobs. Gardening is a job that many mildly disabled individuals can do in both public and private organizations and companies. Nevertheless, training people with disabilities to do gardening tasks has a very high cost. Learning depends too much on the weather and the season. Disabled people usually need to see several times how to do every task, but it may be impossible to repeat some tasks in real settings. Furthermore many disabled individuals can not read, so that they can not learn the names of the plants or their characteristics from conventional gardening books . New technologies may be very helpful to overcome these difficulties. Specifically, multimedia software can be used to model how to do any task as well as to present text free information about plants, tools, and tasks. However, the effectivenes of such software is usually assumed but rarely tested. In this paper we test the effectiveness of a multimedia software to increase the subjects' knowledge about plants. Since the study was conducted in a natural environment we had not the level of control that an experimental study usually requires. Therefore the results must be considered cautiously.

Method

Subjects

The subjects in this study were six mildly disabled males, with a mean age of 23.66 years (SD=4.13) and a disability level from 33 to 66 per cent. All subjects are enrolled in a sheltered workshop in the Mallorcan Association for the Psychologically Disabled People (AMADIP).

Design

The experimental design had to be adapted to the conditions of the AMADIP environment. No other subjects could be used as controls because there were not more people waiting to learn gardening tasks. We used a repeated measures design with only one group.

Variables and instruments

The variables were: the names of the plants, their size (big, normal, small), their leaves (deciduous or not), their light/sun needs (much light, normal, few), their water needs (much water, normal, few), and their growing speed. We prepared an assessment software to be used to collect data before the subjects began to use the training software, and after training. Pictures of 45 plants in the assessment software were the same than in the training software. Pictures appeared in the computer's screen one at each time. The size of each picture was 320 x 240 pixels.

Procedure

Before using the training software, subjects were evaluated individually. The evaluator and the subject were seated in front of the computer.Using the assessment software, while the picture of the plant was on the screen, the evaluator asked the subject the name of the plant, its size, etc., and marked one of two possible categories for each variable: The subject know it or the subject does not know it. The same process was repeated for each one of the 45 plants.During the next months subjects worked with the training software with a gardener who knew the software and how to use it. The total amount of training time ranged from 4.5 hours (the subject who used the software the less) to 7.5 hours. The same procedure used to initially evaluate the subects' knowledge was used to carry out the final assessment but the evaluator was not the same. In the last case, a Psychology student who did not know the subjects at all assessed them after being trained with the assessment software during a short period of time.

Results

Only the names of six plants were known by all 6 subjects during the initial assessment. These more well known plants were typically mediterranean plants (palms, pines, orange trees). During the final evaluation the number of names of plants that all of the subjects knew increased to 10. To compare the data from the pre-training to the post-training, the SPSS t-test for paired samples was used. Table 1 shows the mean values found for each variable as well as the t values and the significance levels. Improvements can be seen in all the variables. Statistically significant differences were found for names (t=4,57, p=.006) and leaves (t=4,19, p=.009). As only six subjects participated in the study, an analysis of the individual improvement for each subject was made through charts. Figure 1 shows the number of names of plants that each subject knew before and after using the training software. We wish to underline the fact that all of them increased the number of plants' names they knew. The same can be said for the variable leaves, as shown in figure 2.

Table 1. Mean values pre- and post-training

	PRE		POST		
	M	SD	M	SD	t value
Names	20.66	7.06	26.50	6.80	-1.57
Size	21.16	7.38	21.33	2.80	.06 ns
Leaves	25.00	9.16	37.33	4.71	4.19 ***
Light	19.33	12.14	28.83	10.02	1.36 ns
Water	21.66	8.28	30.00	6.09	-1.72 ns
Growing	14.00	7.07	16.83	4.40	-1.87 ns

Figure 1: Knowledge about the plants' names

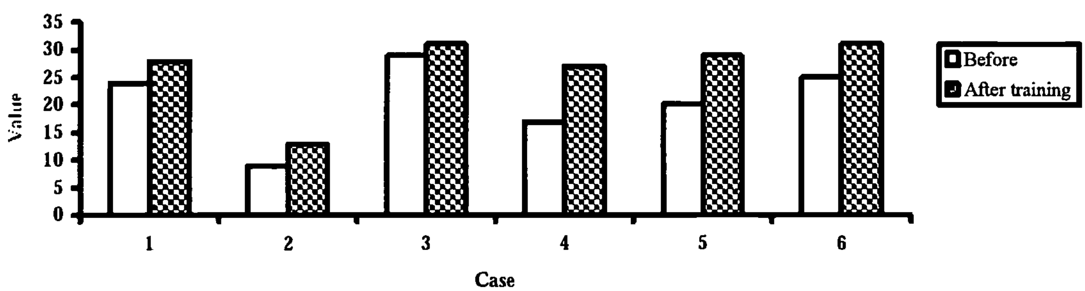
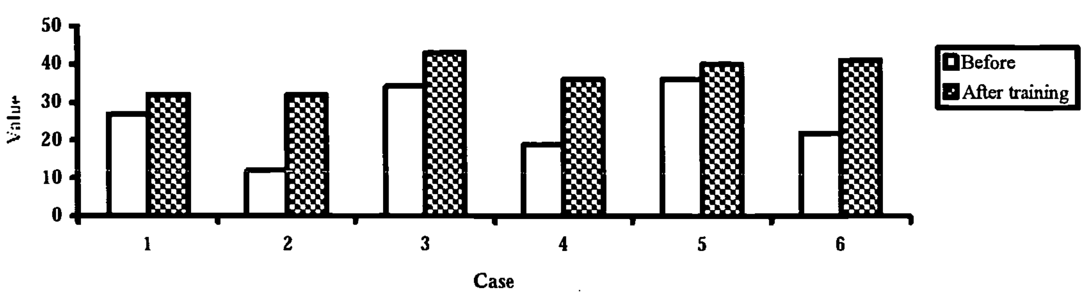


Figure 2: Knowledge about the plants' leaves



Discussion

It is necessary to repeat that our study is just a pilot research study to test the effectiveness of a multimedia gardening software that we have been developing during the last year. We are aware of the limitations of the study: the lack of a control group, the short and unscheduled training period, the fact that the subjects were doing gardening tasks in real settings during the period between the first and the final evaluation, etc. Nevertheless, we think that our results give support to the usefulness of the multimedia software to increase the knowledge that the mildly disabled subjects who participated in the study had about the plants. Hopefully the software will show its usefulness to improve the gardening skills of this people, but we know that a more controlled study is required to support this hypothesis. On the other hand, we wish to point out that some results are very useful in order to change specific features of our software. For example, we found that the subjects' knowledge about the size of the plants did not increase after training. This result could mean that the pictures we used were not as clear as they should be or that the icons showing the three possible sizes were not the appropriate ones.

MACS: A Flexible and Scalable Collaboration Environment

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1. Introduction

The aim in the development of MACS (Multicast based Advanced Collaboration System) is to provide a powerful and flexible framework for CSCW (Computer Supported Collaborative Work) applications. Key-features of MACS are the advanced session and floor control, the intuitive user interface (based on Virtual Reality) and its flexibility, scalability and portability (JAVA-based implementation). Due to the highly modular design new applications can be added.

2. MACS

Central components of MACS are the Control component and the Network glue. Each application is attached to these components (cf. [Fig. 1]). The Control component offers collaboration services, such as access to the user database, application database and token management. Attachment to the network services (e.g., LRMP) is through the Network glue. The Network glue provides an abstraction layer and, therefore, allows an easy incorporation of different protocols (currently LRMP, TCP/IP and CORBA are available).

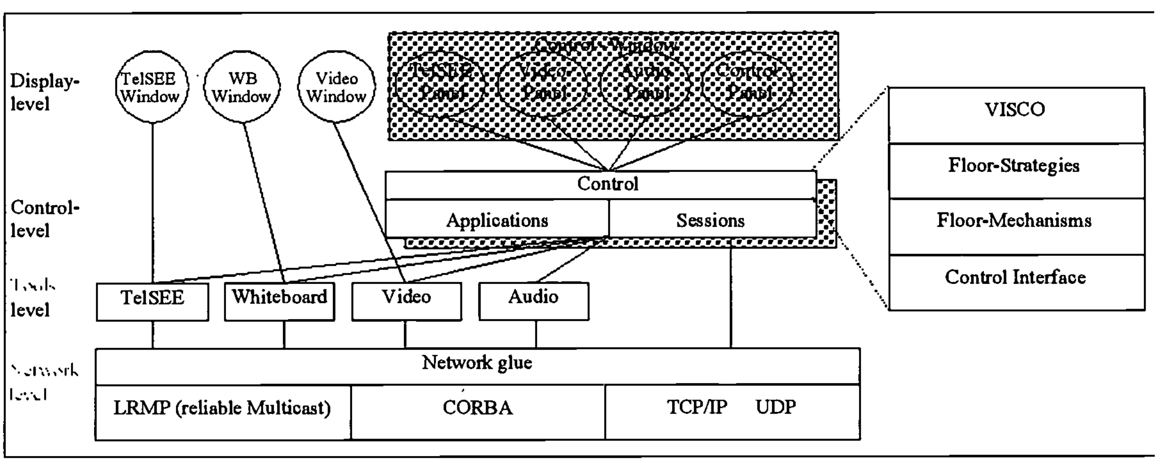

Figure 1: Structure of MACS

Basic compatibility to the MBone [Kumar 96] is provided. Advanced features will be implemented using partially non-compatible formats to circumvent shortcomings in the MBone protocols. Some aspects of the advanced conference control are influenced by the ITU-T.124 standard. The aim is to provide the mechanism known in tightly-coupled conferences while maintaining scalability. This is achieved through a hierarchical setup, that corresponds closely to the hierarchies found in "real-world" conferences. Especially in large conferences only a small number of participants is actively involved, the majority listens passively. It is not necessary to couple passive and active participants tightly. Obviously all active participants have to be tightly-

coupled. With this model the overall count of tightly-coupled participants will remain manageable even for large conferences.
The intuitive user interface is achieved by reducing the control elements to the essential ones. Advanced options are still accessible but will only be shown on request. Keeping the number of windows down by not using child/pop-up windows helps tremendously to improve the handling of the system. The visualization module VISCO (VIsual Session and floor COntrol) presents the conference control and floor passing in an intuitive and easy to use way.

3. Visualization of session and floor control

In commonly used conferencing systems like the MBone-Tools [Kumar 96] or JVTOS [Gehring and Guther 95], user interfaces for session and floor control provide an immense set of buttons, sliders and the like. This easily embarrasses users. Human perception issues are not addressed properly which significantly reduces the wide-spread acceptance of conferencing tools. In MACS, session and floor control is performed by VISCO (Visual Session and Floor Control). It performs session and floor control in a virtual meeting room, in which the participants of a conference are represented either by simple graphical symbols or by small images. Various state information about the corresponding users are represented within the symbols or images. The temporarily absence of a user from the conference, for example, is indicated by closed eyes in the symbol. The audio and video capabilities of the user's conference equipment are also represented in a graphical manner. If a user isn't capable of sending audio data, his symbol lacks a mouth; if he is able to send a video stream, a small camera icon will be displayed on top of his image.
Floor control can be performed within the virtual meeting room. A conference participant usually indicates a floor request by raising the arm (symbol view) or a "speaking bubble" (image view). This is recognized by the other participants and especially by the floor holder.
Hierarchical conference structures are supported by VISCO. If a user wants to conduct a private conversation, he can drag his symbol and move it through the meeting room to the symbol of the other user. This way, he can participate in both, the private as well as the public conversation.

4. Integrating applications into MACS

Due to the modular design of MACS, it is easy to integrate very different kinds of applications. An example is TelSEE (Tele Software Engineering Editor), a multi-user editor based on an enhancement of the MVC (Model View Controller) concept. TelSEE supports users distributed in time and/or space during cooperative project-work.
A JAVA-based Tele-Teaching Whiteboard is another example. It provides enhanced collaboration features, such as tele-pointer, highlighting as well as individual and independent handling of graphical objects.

5. Current status and ongoing work

Development of MACS is an ongoing process. A first demo release of the JAVA-based whiteboard is currently available. The whiteboard will be used in a lecture transmitted on the MBone between end of April and end of July. Other parts such as the virtual meeting room and TelSEE are available as prototypes. A first public release of MACS itself is scheduled for third quarter.

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Distance Study Program „Multimedia in Education“: Investigating The Internets’ Potential

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1. Introduction

The Tele-Akademie is the distance and continuing education unit of the University of Applied Sciences in Furtwangen, Germany. The location in the picturesque, but somewhat isolated Black Forest mountains, and the combination with a strong Computing Science and Media Department, provide an ideal background for distance education. One of the Tele-Akademies' main functions is to test the potential of the internet in training and re-training of professionals. The Tele-Akademie has been offering internet and video conference based continuing education for almost three years. The didactics of two main scenarios are being investigated here: *Tele-Teaching*, a multimedia-based, synchronous form of training, and tutored *Tele-Learning*, mainly based on asynchronous forms of internet communication. Since the internet has become widely available in Germany, the Tele-Akademie is mainly utilizing this technology for both communication with participants and cooperation among the students. A staff of about ten, joined by expert authors and a group of tutors, prepares didactically sound multimedia courses and supports distance education students. The Tele-Akademie staff is comprised of psychologists, adult educators, didactics and multimedia specialists.

2. Distance Study Program "Multimedia in Education"

Since 1997, the Tele-Akademie offers a one-year distance study program on "Multimedia in Education", jointly granted by the Federal Government of Germany and the State of Baden-Wuerttemberg. The course program, geared towards adult educators, teachers and other education professionals is, in its complexity, form of distribution and communication unique to the German continuing education field. The 100 participants in the 1997/98 course program are mainly based in Germany, but also some international students (e.g. from Turkey, South Africa or Russia) take advantage of the worldwide accessibility of study materials prepared in the Black Forest town of Furtwangen. The Tele-Akademies' concept of *collaborative distance learning* combines flexible and individualized learning with improved learner support and social involvement of the participants to fight low motivation and high drop-out rates often encountered in distance education scenarios.

2.1 Course Content, Schedule and Materials

The contents of this course program are derived from the practical needs of the target groups:

- educational hard- and software (media technology)
- learning theory and the design of learning environments (instructional design)
- the social impact of media use in education (media education)
- economic and management aspects of educational media (instructional management).

The course is organized in two semesters and based on five main elements:

1. *Study materials*: textual study materials, up-to-date supplemental information on the WWW, additional resources on CD-ROM
2. *Exercises*: independent study exercises, group work exercises
3. *On-site Seminars*: three 2-day sessions framing each course, designed to further enhance communication and allow networking among the participants. Discussions about technical problems, content related workshops, and participants' presentation of project work results are also part of these sessions.
4. *Project Phase*: during the second semester of the course program, participants are required to carry out a project that introduces the theoretical course information into their work-life.
5. *Final Tests/Certification*: essay on participants' projects or answering test items

2.2 Distribution of Study Materials

The written study materials are mailed out to participants bi-weekly as e-mail attachments in an *Adobe Acrobat Reader* format. Additional and up-to-date information, in-depth literature tips and interesting links are provided on the "Multimedia in Education" Web-Site (access restricted to participants, also updated bi-weekly). Resources, sample programs and software are provided to participants on several supplemental CD-ROMs, distributed to participants during the course of the program.

2.3 Communication and Cooperation

Participants of the Tele-Akademies' study program "Multimedia in Education" work and study in a different environment than, for example, students in a regular university setting. Accordingly, possibilities and strategies for communication and cooperation are quite different:

a) Communication

- participant → Tele-Akademie: via e-mail, internet chat, phone, fax, traditional mail
- participant → participant: via e-mail, internet chat
- participant → tutors: via e-mail, internet chat,

b) Cooperation

- study group of 6-8 participants → work-group newsgroup: designed for in depth discussion about exercises and questions arising from the written study material, supported by a tutor
- study group of 6-8 participants → internet chat: short discussions on specific topics, chats with 'experts'
- work group for all participants → "Plenary"-newsgroup: designed for posting results from the study groups visible to all participants, possibility for discussion of all program related questions

A group of 12 tutors assists the Tele-Akademie staff in supporting participants, answering questions and initiating discussion in the study groups and the plenary newsgroup.

2.4 Results

One objective of the distance study program is to instigate interpersonal communication and individual commitment through the use of internet technology. Several parameters indicate that it has been possible to reach this goal: the *posting per person*-ratio remained on a high level throughout the semester with a distribution typical for face-to-face seminars: 20% of the students initiate almost 80% of the communication, 60% participate moderately, 20% do not post any messages. The *drop-out-rate* after the first semester, typically high in distance education programs, was as low as 5%, indicating high participant commitment.

Providing students with electronic communication opportunities alone does not result in communication that can be classified as didactically meaningful. Study questions play an important role in initiating such a meaningful interpersonal communication in internet-based seminars. In the context of the internet, study questions must be even more to-the-point than in face-to-face situations. Furthermore the provision of "real" tutors is another factor that instigates interpersonal communication and the success of the program.

A Cognitive Model of Knowledge Exchange in Telematic Learning Groups

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Introduction

After two decades of research on computer-mediated communication the connection between cognitive science and media research is still rather unsatisfying. The general accounts of computer-mediated communication in organizational as well as educational contexts [McGrath & Hollingshead 1994], although being quite elaborate, do not deal with cognitive processes on a level where the manipulation, storage, and retrieval of knowledge structures come to bear. This neglect of cognitive processes can partly be attributed to the fact that until ten years ago cognitive science itself has neglected processes outside of the individual mind. During the last few years, and primarily advanced by research on human-computer interaction, this situation has changed rapidly. Several models and concepts now address cognitive processes within groups [Hinsz et al. 1997]. These approaches share the assumption that cognitive processes and mechanisms are not entirely localized within the individual mind, but are distributed over several representational spaces, thus forming a socio-technological single system which is comprised of several people and artifacts. The single system view claims that the internal representations of several individuals and the external representations being used by these individuals constitute both the frame of reference and the unit of analysis in related research. However, until now no account of cognitive processes in groups has explicitly referred to the use of computer-mediated communication.

Overview of the Model

This paper formulates a cognitive model of telematic learning that is inspired by the notions of distributed cognition [Hutchins 1995] and socially shared cognition [Resnick 1991]. I.e., it attempts to account for the rich interplay between the internal representations of several individuals and the external representations (media) in use. The model in its current form does not address the whole range of computer-mediated communication but is restricted to a prototypical instance of telematic settings, viz. the exchange of knowledge within peer groups via text-based, asynchronous computer conferencing technologies.

Using this model one should be able a) to generate hypotheses regarding the internal and externalized cognitive processes involved in the acquisition and conveyance of knowledge; and b) to test these hypotheses under laboratory experimental conditions. If the hypotheses derived by this model can be validated empirically future extensions will involve the group structure (e.g. by including moderators or instructors), and the media being used (e.g. synchronous video-conferencing).

One of the central assumptions of our model holds that the transition from a state of distributed cognition to a state of shared cognition is involved in knowledge exchange. In other words, knowledge exchange will only prove useful if the relevant knowledge is initially distributed over the group members. The goal state of the interaction would be achieved if all group members share the same knowledge (equalization).

The model regards knowledge exchange as a complex interplay between internal and external processes embedded within a socio-technological single system comprised of three parts. One part is the external representation of the information that is available within a computer conference at a given time. The other two parts model learners engaged in one of two basic activities, viz. acquisition of knowledge and conveyance of

knowledge. Note that during the course of interaction learners often switch their roles between acquisition and conveyance.
Both acquisition and conveyance are characterized by activities that involve the reception of a given message in a computer conference and activities that involve the production of a message. The receptive process of knowledge acquisition can be divided into several subprocesses. To acquire knowledge learners have to select information from a given message. This internal process of selection is reflected by externally observable activities. Firstly, learners select (or don't select) a given message in a conference folder by judging the subjective relevance of the message. The relevance can be assessed by using message attributes like sender, date, the status of the message as being read or unread, and the subject line. Secondly, subjectively relevant messages will yield higher relative reading times than irrelevant ones. Both relevance assignments (reflected by the number of times a given message was opened, or by deleting a message) and reading times can be traced back by analyzing log-file protocols.

At the same time message contents must be internally organized by the learners. Internal organization is reflected by the order in which messages are being read. In asynchronous computer conferences topics are often discussed in parallel, thus raising the probability that chronologically subsequent messages are thematically incoherent. Experienced learners will use the subject lines of messages (especially if messages are connected via the reply function) to establish coherence between successively processed messages. In other words, meaningful organization processes are reflected by deviating from a strictly chronological processing order.

To emphasize the constructive nature of knowledge exchange the model includes a productive component of knowledge acquisition as well. While searching the internal knowledge structure and/or the external conference a learner might experience some kind of knowledge deficit. This will lead to the production of a new message containing a request for information.

Similar to the acquisition processes, conveyance of knowledge is characterized by receptive and productive components. The receptive part involves diagnosing a knowledge deficit of a peer learner, e.g. by reading a message that requests for further information. This will lead to internal search processes. If the requested information can be retrieved from the internal knowledge structures this might lead to the productive part of conveyance, viz. creating a new message that contains new knowledge elements.

To summarize, our model constitutes a cognitive cycle of knowledge exchange that is comprised of four parts. Learners acquire knowledge from a conference, formulate requests regarding their knowledge deficits which in turn are received by other peers who might provide an answer to the request. This cognitive cycle within the socio-technological system can be started or finished at any of these four steps.

Knowledge Distribution and Knowledge Exchange

According to our model the initial distribution of knowledge over the group members is crucial for knowledge exchange. We are currently conducting a series of experimental studies based on [Stasser et al. 1995]. They found that facors like the availability of meta-knowledge (knowing who knows what) and group heterogeneity may lead to the efficient transition from distributed to shared knowledge in face-to-face groups. Our model comes to similar conclusions. Meta-knowledge will support selection processes and lead to a better deficit diagnosis; group heterogeneity will decrease the number of parallel discussion threads, thus supporting organizational processes.

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Developing and Using Interactive Software Templates for Learning Modern Languages

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The impetus to develop interactive software templates camefrom the desire to move away from more traditional oral testing, which hadtypically consisted of questions read to a class which they answered inwriting, to a more truly oral test that did not require putting thestudent in the often stressful situation of having a one-on-one interviewwith the instructor and did not involve the problems connected withscheduling such interviews. To solve this problem, our computer supportspecialist, Jacqueline Kaminski, and I developed a simple *HyperCard*template, which we call *Listen and Respond*, to allow students tohear a set of oral questions in the Macintosh laboratory and to recordtheir responses to those questions on our server.

Before using the template for examination purposes, the studentswere, of course, required to use it at least twice for listening andspeaking practice. These trials were very successful and encouraged us tocontinue using and refining the template, for when using the template thestudents became very interested in improving the quality of their oralresponses. They also preferred testing done with the template to thetraditional method.

When using *Listen and Respond* the student first signs in on the *HyperCard* stack and then works with a single card in the stack for eachquestion and response. On each of these consecutively numbered cards,there are instructions on using the *HyperCard Audio Palette* torecord and save responses and a button with the number of the question thatallows the student to play the question as often as time allows. If desireda field can be added for the student to respond in writing as well asorally. This is particularly useful to determine with precision if studentshave mastered certain endings that are impossible or difficult to test onlyorally, for example the difference between *je parle* and *tuparles* and the German article and adjective endings that are not alwaysdistinct when spoken since they do not fall in stressed syllables.Navigation through the cards is done with the standard arrow buttons.After completing and saving his responses, the student can, on the finalcard, hear each of the questions and each of his responses again andrerecord responses as desired. For the instructor there is a single cardfor recording questions. This card contains instructions on using the *Audio Palette* to record each question and a separate button to check eachquestion. The evaluation card, which is accessed by pressing an invisiblebutton, allows the instructor to hear each question and the student'sresponse, which is particularly useful when the questions have beenscrambled to avoid having all the students responding to the same questionsimultaneously. On the evaluation card the instructor can also assign ascore to each response, total these by pressing the total button, andrecord comments orally and in writing. The evaluation card also has a printbutton that will print the card with the student's name and allscores and comments.

Having used the basic template for both oral practice andtesting using only instructors' questions and students' responses, wewanted to extend the use of the templates to include external audio andultimately video sources. The first step in this direction was made inFrench instruction. Jacqueline Kaminski and I created a template fromwhich the student could link to a newscast from *Radio FranceInternationale*, listen to the newscast, and then respond orally to theinstructor's digitally recorded questions on the newscast. Shortly afterthat we followed an analogous process to have the students watch a videosegment and respond to prerecorded questions on it. For this we used asegment from a video that accompanied one of our textbooks that we wereallowed to digitize for educational purpose under the fair use guidelines.

Other members of my department have augmented the templates inother ways. For particularly difficult texts such as a formal speech, onecan provide on the template the text of what the students hear to give themsupport they often need to cope with complicated material. One can addglossaries and links to web sites to the template to further assist thestudents in comprehending such material. In addition one can add a slowerand more carefully articulated digitized recording of such material inorder to bring the students to an understanding of the original.

Jacqueline Kaminski and I have begun to create various versions ofthe template in Authorware. We have done versions entirely in the targetlanguage and have created versions for faculty members with differentlevels of sophistication as computer users. In my department, faculty havealso been working at integrating these templates, and other technology aswell, into our teaching.

Conclusion

Both faculty and students can use *Listen and Respond* withease. It has proven to be an effective approach for improving and testinglistening comprehension and oral responses. Moreover, it is a templatethat can be modified and augmented to fit the needs of students at variouslevels and the particular pedagogical needs of various target languages.

But is it *interactive* and does it *work*?
A review of some CALL English pronunciation CD-ROMs

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1. Suggested Guidelines for the Research and Development of Pronunciation CD-ROMs

But is it interactive? Does it really work? Teachers who examine educational CD-ROM products usually ask these two elementary questions. How many product developers can honestly say *yes* to both questions? An impressionistic examination of 23 English pronunciation products has revealed that in a majority of the products, an obvious lack of research into content and/or pedagogy has led to the development of products that are at worst misleading or inaccurate in terms of content, and pedagogically naive. The fundamental flaw of the products is related to the breadth of the market that they have attempted to reach. Producers of all of the CD-ROMs reviewed have attempted to tailor a product that targets all nationalities of English language learners who are in need of pronunciation modification. This is untenable because each first language has its own unique phonological inventory that interferes in a different manner with the English phonological system. Because of this variation in the learners' needs it is critical that a thorough contrastive phonological analysis of the first (L1) and second language (L2) is carried out and a *needs analysis* approach is taken in the methodology. The contrastive phonological analysis should form the basis of the needs analysis. The products reviewed have overlooked this and instead have taken a didactic *"this is how we say it in English"* approach to pronunciation modification without regard for the L1 phonological inventories of individual nationalities. Therefore, a deductive, task based model should be implemented in the design of multi-media whenever possible. This is what gives the product interactivity. The limited interactivity in the reviewed products was a result of the tendency for developers to adopt an inductive model. An example of a model that is inductive (and didactic) is this visual display (figure1) from the ELLIS pronunciation tutor. The learner is given a complicated phonological explanation of the place and manner of articulation of American English consonants. This may be a valid approach if the learner is an undergraduate linguistics student but can not help to develop the pronunciation skills of an L2 learner. The student can't possibly emulate the tongue position in the model just by looking at the diagram because they can't see inside their heads to compare. The articulatory adjustments required to imitate the model speaker are of such refinement that visual cues of this type can not possibly aid the process.

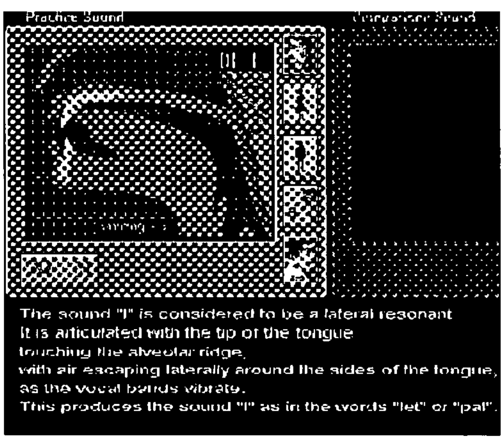

Figure 1: Ellis visual display of [l] articulation

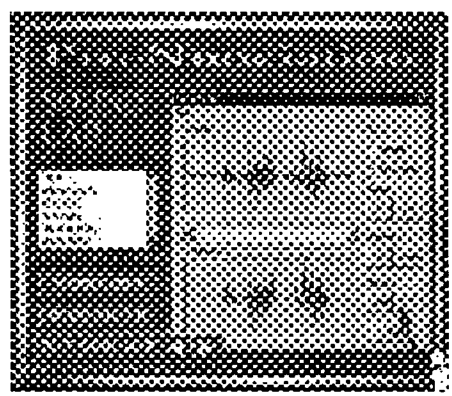

Figure 2: Waveform display from Pro-Nunciation

Another visual cue used by many of the products is a waveform and/or spectra of the target phoneme, word or utterance (figure 2) which can also be generated from the learner's utterance and (supposedly) compared with the model. This display may look impressive to those untrained in acoustic phonology, but unless you are trained you will not realise that this series of wiggly lines can not even be matched exactly by the original model speaker. Spectra and waveforms are an individual's unique voiceprint, however unlike a fingerprint, the variables involved in replication result in a different waveform every time. Such a misguided application of technology is similar to the rain machines of the Wild West, it looks impressive but can have no more than a placebo effect on the student's pronunciation ability. The visual displays that were reviewed serve as both practise activities for skills development and as an assessment of the student's ability. The assessment component of the products must be able to accurately analyse and give comprehensive feedback to the learner. The products reviewed did not do this. Most products left the assessment of performance to the student to gauge by listening and comparing their production to the native model. The computer has untapped potential to assess production much more accurately than the student can because it can isolate the important L2 acoustic cues that the learner filters through their first language and deems insignificant. With further research, the computer may be able to substitute for the ears of the student and assess their production quantitatively.

An aspect of content which the author takes issue with is the inclusion of tongue twisters as a drill for minimal pairs. Minimal pair drills assume that the speaker cannot distinguish minimally distinctive sounds such as the vowels in *ship* and *sheep* because these distinctions do not occur in their L1. This may be true for some L1's, but in certain languages such as Korean, there is a distinction, similar sounds exist in the L1, but at a phonetic level not a phonemic level. In a nutshell this means that they can't see the point in making a distinction. So the method of instruction should not only be skill based (eg. minimal pair drills leading on to contextualised practise) but also knowledge based (explaining the phonetic/phonemic contrast) to rectify this error. Many of the worst pronunciation tutors featured minimal pairs and/or tongue twisters exclusively. Tongue twisters are pedagogically unsound because they drill sequences of discourse with frequencies of phonemes that do not occur in natural speech. Besides this the difficulty of the exercise is de-motivating. It is even too difficult for a native speaker to say *red lorry, yellow lorry* ad infinitum at a rapid pace.

Most of the products only dealt with the segmental level of speech (individual sounds) and isolated words. This is only one component of pronunciation. Supra-segmentals, otherwise known as prosody, the components of which are stress, rhythm and intonation, are recognised by some practitioners as more salient errors in L2 speech than segmentals. To say prosody is more salient is however a generalisation. While prosody is important, the interlanguage significance of prosody varies across L1's depending on the extent to which they use prosody in the L1 and how the use of it contrasts with the L2. Prosody is the most complex aspect of pronunciation, causing many difficulties for linguists who have tried to develop a description of its structure and function. However, if a first language-specific approach to the development of a product is taken, it is possible to identify the needs of the L2 learner via a contrastive analysis and to then develop an interactive visual feedback model which can address some of the learner's needs. Pioneering work done in the past has shown that it is possible in theory to teach intonation by means of a fundamental frequency[1] (F_0) pitch trace. See [de Bot 1983] for an introduction to this idea and also [Molholt 1990] for visual feedback of segmentals. However, certain difficult system engineering refinements are necessary to make such a model workable.

This paper has raised criticisms that cut to the heart of educational multimedia development. If there is to be a future in developing multimedia products there needs to be the same amount of energy expended in the research of content and pedagogy for multimedia that has been spent on traditional pedagogy. Unfortunately, at least in the area of pronunciation software development, there is still a lot of room for improvement. The best way forward is for developers to ignore the economic imperative to get the product on the shelf, do the research required and make a product which is interactive and does work.

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[1] The measurable acoustic correlate of pitch is fundamental frequency (F_0), which is the number of times per second that the vocal folds complete a cycle of vibration.

The Effectiveness of Interactive Computer Simulations on Teaching Circular Motion

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Abstract: A series of computer simulation activities were developed at The Ohio State University to support the introductory physics laboratory. Based on our development experience, a instructional design model is proposed to integrate instructional technology, content needs, and pedagogy for technology-based material development. In this paper, the circular motion is used to illustrate this model.

1. Introduction

At The Ohio State University, a series of computer simulations were developed as a supplement to support the existing introductory physics laboratory activities. After the designing and implementing experiences, a technology-based instructional design model, the general Chain Model, involving educational technology, pedagogy, and content domain is proposed for effective use of computers in learning. In this model, a pedagogy is selected based on the content domain needs for achieving the expected learning outcome. Educational technologies are used to both facilitate the use of selected pedagogy and provide the content needs with special features which may not be available from other media. All three elements link with and support each other to effectively help students to learn.

2. CAL Design Model

In this study, computer simulations, constructivist and Vygotskian perspectives, and circular motion were the three elements of the specific Chain Model, see [Fig. 1]. Research on misconceptions shows that students usually have their own ideas about the world before taking science courses [Osborne & Freyberg, 1985]. Therefore, the goal of science courses is not just introducing new ideas to students, but also to help students remove the inconsistent ideas and rebuild new knowledge. To achieve this goal, the strategies of using conceptual conflicts suggested by constructivists [Jones, 1990] and using language to internalize specific tasks into mental functions suggested by [Vygotsky, 1978] were included to challenge student preconceptions and to help them internalize the physics principles. The instructional materials include computer simulations and accompanying worksheets that guide students to work through the entire learning activity. The animated images from computer simulations can also be used to describe the dynamic processes involved in the circular motion so to reduce the complexity and possible miscommunications resulted from verbal explanations.

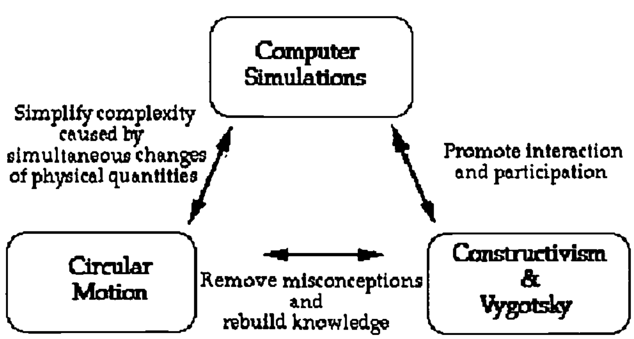

Figure 1: A specific Chain Model for integrating computer simulation and constructivist and Vygotskian perspectives in circular motion

3. Learning Activity Development

Newton's second law, **F** = m**a**, implies that the net force and the acceleration always have the same direction. In the preliminary study, it was found that after practicing the formula for weeks students still considered the force and acceleration as two independent factors when asked by qualitative questions about circular motion. A series of learning activities were then developed to help students learn circular motion by reconsidering the already learned equation **F**= m**a**. In the circular motion module, students are to determine the directions of accelerations at various points and to compare the tension of the rope and the weight of the pendulum bob at the lowest point. With accompanying worksheets, students go through the following steps to study a pendulum:

1. *For each problem, students are asked to predict the answer first.*

   This step helps students examine their current understanding of the accelerations and forces in a pendulum motion before they go through the learning activity.
2. *Students explain the reasons of their predictions.*

   This procedure helps students reorganize their knowledge and facilitate translating these physics principle into meaningful language.
3. *Explicit instructions are given to suggest students use some simple techniques which help solve the problem. The computer simulations provide a visualized dynamic process for each problem solving procedure.*

   Questions in this step are usually very simple and straightforward. In circular motion, students are asked to use vector subtraction to determine the acceleration direction, and to draw a force diagram.
4. *Students use physics principles to analyze and synthesize the answers obtained from the previous questions to determine the answers of the problems asked at the very beginning.*

   In circular motion, students use Newton's second law, **F**=m**a**, to analyze the acceleration direction and the force diagram obtained from the previous questions to determine whether the tension of the rope is greater than, equal to, or smaller than the weight of the pendulum bob.
5. *At last, students run the simulations to check the result and compare the answers predicted at the very beginning and after analyzing the motion with previously learned physics principles.*

After analyzing different physics properties at various points (the highest and middle points), student see the entire swinging process with vectors which represent different physics quantities.

4. Result and Discussion

The effectiveness of the instructional material on student learning is evaluated. Student conceptual understanding was tested by problems which either do not require mathematical equations or provide very limited information that deters students from manipulating the numerical variables to obtain an answer. The problem solving ability was tested in the midterm examination which includes a process of abstracting the physics properties from a description of an event, identifying appropriate physics principles and formulas, and then finding the numerical unknowns. All the needed formulas were given in the test so students do not need to memorize the formulas. Two hundred and thirteen students science and engineering students took the introductory physics course in the winter quarter, 1997. Due to the fact that different data were collected at different times and places, the data were analyzed with preliminary and follow-up analyses by the analysis of variance (ANOVA). The results of problem solving activities show that students using computer simulations had significantly higher scores than students not using computer simulations. On the pretest of the conceptual understanding, students in the non-computer group scored significantly higher students in the computer group. On the posttest, there was no significant difference between the two groups.

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Design, Development and Pilot Test of a Distributed Collaborative Science Learning Laboratory

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Introduction

One of the challenges facing distance education courses in science is the question of labs, considered an essential element in most science courses. However, science labs have proved difficult to integrate into a distance context, and most institutions either mail out lab kits or have students go to traditional sites for the lab component of a course. Another major challenge to all distance education activities is that of overcoming student isolation and low motivation. For these reasons, the decision was taken to explore the feasibility of creating a distributed collaborative science learning laboratory (DCSLL) using the Internet for delivery and communication. In a project of the TeleLearning Network of Centres of Excellence (Canadian government) and the Fonds de l'autoroute de l'information (Quebec government), researchers from the Centre Collégial de Formation à Distance (a post-secondary distance education institution) and the Université de Montréal have been working to develop a workable prototype of such a system.

Conceptual framework

The concept of DCSLL draws on four contributing areas: collaborative learning, science laboratories, information and communication technologies, and distance education. After reviewing the literature in cooperative/collaborative learning [Johnson & Johnson 76 ; Salomon 92 ; Slavin 86], we have adopted the approach of Salomon, who defines collaborative learning as requiring interdependencies among learners and with the learning environment on four levels: knowledge, competencies, resources, and infrastructure.

As a learning environment and an instructional strategy, the science laboratory [Collette & Chiappetta 94; Gallagher 87; Lazarowitz & Tamir 94 ; Soloway, Krajcik & Finkel 95] includes practical work within planned learning experiences taking place in a purposely assigned environment. The important aspect of a science learning lab is the controlled nature of the actions and the environment which permits generalization by the students beyond the specific instance under study. The term distributed is used to refer to different kinds of distribution : physical, temporal, and cognitive. Distribution across time and space are defining characteristics of the distance learning context [Bourdeau & Bates 96] we are addressing. Cognitive distribution, however, means that team cognition is distributed among its members, with team learning dependent on the characteristics of this distribution. The concept of distributed cognition has implications, therefore, not only for the way in which a group will work, but the results of that work. The role of information and communication technologies is defined as providing common space and communication channels for teamwork.

Design

The lab was developed in the context of a post-secondary course offering an Introduction to the Scientific Method for non-specialised students. The lab is a series of three experiments to be completed by a team of 3-4 individuals. The experiments were designed to be a progression along four continua: *communication*, from simple (voice only) to complex (whiteboard with screen capture, annotation tools, voice, chat, etc.); *collaboration* requiring less interdependence (joint data interpretation and conclusion-drawing only) to more interdependence (team planning, completion, analysis, interpretation and conclusion-drawing); *concrete activities* (manipulating real objects) to abstract, symbolic representations and manipulations; and *data analysis* beginning with qualitative and moving to quantitative data. The first experiment is a qualitative exploration of simple electric circuits. It involves the manipulation of real objects (batteries, bulbs, wires, etc.), qualitative observations, individual analysis of the data, and collaboration for the interpretation and conclusion phase. The second experiment deals with Ohm's Law. Students conduct experiments and analyse data individually using a computer simulation, and use the common work space to discuss the results and draw conclusions. The third experiment deals with Kirchhoff's Laws and requires collaboration from the beginning, with planning the work to be done the responsibility of the students. All phases of the experiment are done collaboratively.

The pilot test

The pilot test had several objectives. The first was to verify the feasibility of creating a DCSLL. The second was to collect data to suggest modifications to the prototype for the development of detailed design specifications. The third was to examine the results of merging the four contributing areas in one learning environment. It took place over two days with three "pseudo-students" participating. The participants worked in three rooms, each with a computer with Internet access and a telephone. They each had a copy of NetMeeting, and access via Internet to the simulation software. Data were gathered from group interviews, productions, and participant observation.

Results

The ideas taken from the four contributing areas combined in the Simulateur Electrique to produce a DCSLL that functioned largely as expected. Results of particular interest are presented briefly below.

It is extremely important to start with individual work, and provide the student with on-going access to personal workspace to respect individual cognitive and affective profiles.

The progression from qualitative observations to quantitative data to graphics to formal representations with equations allowed the students to integrate the different representational modes and develop a more complete understanding of the scientific principles under study. This progression must be designed into the activities.

The need for individual and common work space must be balanced; in our case the simulation was limited to individual use while results could be shared in the common space.

Audio communication was used successfully to substitute face-to-face interaction and supported the creation of positive interdependence among team members.

Conclusion

The results demonstrated the feasibility of a DSCLL. The data gathered were used to create detailed design specifications; an improved version of the lab is currently under development. The new version will be used to explore certain questions that emerged from the pilot phase; the most salient are listed below.

Should productive errors be encouraged.or introduced in order to provoke discussion of certain concepts?

How should the distant tutor act and interact with students to motivate and enable them to follow an approach based on cognitive conflict?

Under what conditions is asynchronous communication useful and what form should it take?

What is the impact on the tutor's role of the increased student-student interactions?

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An Expanding View of Literacy: Hypermedia in the Middle School

Pat Clifford, Sharon Friesen, D. Michele Jacobsen

"So, what have you guys got your kids on anyway?"
It was an early morning meeting in the provincial capital. Teachers from across Alberta, brought together to work on technology integration, were talking about the software packages they used in their schools.
"Well, Office 97 *as the basic suite."*
"No, you don't understand my question. I don't mean what do you *guys use. I mean, what software do you give the kids?"*
"Like I said, Office 97. *That's what we use for ourselves most of the time. That's what the kids use, too."*
The group was incredulous. "I thought you said you were in elementary. What grades do you teach, then?"
"Well, we used it with Grade Two last year. This year we teach Grade Six. Same deal. It's what we've got on our network."
"But you haven't got all kids on it, have you? Like, I can see how it might really stretch some of them for enrichment. But what about the rest? You must *have something more suitable for them."*
"Nope. Everybody uses the same."
"But it's far too difficult for children. For heaven's sake, teachers *go nuts trying to figure out how to use all the applications. How could you ever get kids doing it? You'd have to spend too much time even getting them to understand how to use* Word *let alone the rest of the stuff. And what about the learning disabled guys? You can't mean you just throw them to the wolves. I have to say I really disagree with you on this one."*

It was one of those conversations that has stayed with us for a long time—not because it was so unusual, and not because it's about the particular merits or flaws in one commercial software package, but because it holds, in microcosm, so many of the issues of technology integration that we wrestle with daily. Kids, it is thought, cannot bear the full weight of adult technology tools. Students require, such teachers tell us, developmentally appropriate versions of software applications because the real thing is too difficult for them to master. Children, the story goes, require direct instruction in the simulated use of applications before they take on real tasks. Teachers, most are certain, must control and direct the scope and sequence of skill mastery if anything useful is to happen. Learning with computers, say the cautious, requires labs with locked doors, strictly rationed access, and a designated technology teacher. Otherwise all hell can break loose.

These are the kinds of assumptions many educators accept without question as right and necessary for all students, let alone for children with identified learning problems, for whom such orthodoxy becomes true in spades. In school, these children's encounter with computer technology most often involves carefully sequenced courseware, remedial applications and computer assisted instruction. Applications guide such students through carefully monitored, controlled and measured steps. Learning tasks proceed in small, incremental stages. Walk before you try to run, the thinking seems to go.

Sometimes these applications are sold to the educational community on the promise of on-going reinforcement and immediate feedback. Mirroring teacher-directed lessons, they frequently provide as low a level of interactivity and as high a degree of control as traditional worksheets. Clever marketers now package them as edutainment: supposedly more palatable to children, books become "living" software packages; skill drills are tarted up with co-opted cartoon characters, and math facts get blasted with hyperactive graphics and manic sound bytes.

"We may not like who is is following us down the slopes, but they're gaining on us" (Rushkoff p.38).

Douglas Rushkoff calls them Screenagers. They are children "born into a culture mediated by the televison and the computer" (p 3). They are deeply at home in exactly the environment that schools try to tame and control: the rapid-fire, non-linear, chaotic, multisensory world of the computer. It is a commonplace that children know more about computers than adults, that they are better and faster than their parents and teachers. It is commonplace because it is true. But that is not the main point of interest. What is even more interesting, harder to grasp, and ultimately more compelling is that Screenagers use computers in ways that adults do not anticipate and frequently misunderstand. What we assume they require of us--careful instruction, step-by-step activities, computer curricula developed with a close eye to scope-and-sequence--is often exactly what gets in their way.

It is helpful to think of the difference between teachers' images of computing and children's experiences by comparing skiers and snowboarders. Rushkoff describes what happens when Screenagers hit the slopes. Scorning carefully groomed runs, snowboarders seek out precisely the gaps and obstacles that frustrate skiiers. "Unlike parallel skiing, snowboarding is a sport designed to give its participants the opportunity to test their reactions to gaps of many kinds" (p.38). The action in snowboarding happens in the spaces-in-between. "Getting air" means confronting discontinuity. It is improvisational and instinctual, an "intentional exercise of relaxing into chaos" (p.38) in which gaps, openings and obstacles define the sport. The precision and control required of skiiers gets in the way. For snowboarders, more is better. It is "usually always better" (p.38) to overshoot a jump than fall short; better to push your limits than pull back; better to overestimate than chicken out. *Usually always*: an ambiguous phrase that frustrates the precise and exactly portrays the improvisational skill of the breed. When they grab a mouse, they already know that it's *usually always* better to jump right in, to explore, to test the waters, to see what happens when you paste this graphic, import that sound or create a link right

Whether students confront the conceptual gaps and opportunities that computers offer, or jump "the physical gaps between mounds of snow, the coping strategy is the same: usually always overshoot and definitely always relax and have a good time" (p.38).

It is hard for schools and teachers to accept that the culture of screenagers and the attitudes of snowboarders embody skills and strategies that almost always work better with technology than our own carefully groomed, carefully planned, carefully schooled approaches. Unable to see any recognizable, underlying order in their apparently chaotic behavior, we tend to see only random energy and danger. Well intentioned on behalf of what we understand learning to be, we want, somehow, to prepare them, to direct them, to shape and control their encounters with computers. Nervous in the face of their obvious comfort and skill in an area that unsettles many of us, our deepest instinct as unseated experts is often to rein them in.

The Question

Shortly after hypermedia tools became readily available to educators, Marchionini (1988) predicted that hypermedia authoring tools had the potential to alter teacher and student roles and the transactions between them by allowing students to construct their own interpretations of information as well as share their interpretations with their teachers and other learners in unique ways. Marchionni points our attention in an important direction: hypermedia authoring tools have the power to change, forever, the power structures of the classroom. Exploring snowboarding as a fundamental metaphor for children's use of emerging technologies, we have already suggested something of the nature of that change. What follows puts meat on those theoretical bones. It is an account of what happened in a Grade Six classroom when one student, academically marginalized by his unsuccessful struggles to read and write in conventional ways, grabbed some air when he and his teacher stumbled upon Power Point.

Act One

Bryce was mad. He had to write a report on bears as part of his science unit on Forest Ecosystems, and he had *had* it. Years of failure with pencil and paper welled up inside him, and he crawled under his desk, arms shielding his head and knees drawn up to protect his heart. Entries to come out and just try failed. Suggestions about where he could find help failed, too. Demands that he at least sit up and think about what to do next actually broke the log jam. He crawled out, shook himself and walked out of the room. At his locker, hands shaking, he pulled out his jacket and boots.

"I'm out of here," he said. "I'm going home. You can't make me. You can't stop me."

And he was right. We couldn't make him and we couldn't stop him. But we could listen, and we could help. Half an hour later, he had calmed down enough to accept an offer to sit with him and open up a word processing document so that he could get something started. We promised to go down to the library and search for books with him. We said we would read them with him and type out anything he wanted to say.

"Okay, I guess you can do that," he agreed, tears still close to the surface.

Bryce had never opened a Word document before, so one of us sat with him and talked him through the initial steps: click on Start, go to New Document, choose Blank Document. One, two, three easy steps. Hands still unsteady on the mouse, Bryce accidentally opened Power Point instead of Word.

"Oops," he said. "How do I get out?"

His teacher sat for a second. "Do you really want to get out, or can I show you something?"

"What?"

She pulled up a template. "Look at this. If you want to make a bunch of slides about bears, you could do something like this." Working as quickly as she could to keep his attention, she made four quick slides, importing graphics, playing with layouts, showing him how to use bullets for point form.

"Nothing says you can't do your report like this. What do you say?"

Bryce said nothing. He just grabbed the mouse and started to play.

Act Two

Two days later, Bryce (now working with his friend Mac, an equally reluctant writer) had finished six slides.

"Hey, guys, can we show the rest of the class what you've been up to?"

"Why?"

"Well, it's really neat. And besides, they might get some ideas for their own stuff. What do you say?"

Unused to being cast as role models, Mac and Bryce shifted from foot to foot, looked at one another and agreed. "Well, okay, if you really want."

We grabbed the projector, hooked it up to the computer and called the class together for a quick meeting. Bryce and Mac stood beside the screen and walked us through their slide show. In the space of two days, all by themselves, they had figured out how to import graphics, create transitions with dissolves and sound effects, and design builds with bulleted text that flew in from left to right, right to left, top to bottom. A buzz ran through the class

"Hey, cool you guys. How'd you do it? Where'd you get those pictures from? I want to do that. How do I do that?"

The teacher gave a quick demo so that everyone who was interested could open up the program. Singly and in pairs, students returned to their terminals. Some continued with their Word documents, but many went straight to Power Point. Clustered in pods of three and four machines, they compared notes, made suggestions, experimented. Bryce and Mac hung around for a bit making suggestions, then returned to their own work.

Act Three

A month later, the bear reports were all done. Some were handwritten, with cut-out pictures from *National Geographic* and pressed leaves and specimens from the forest floor. Others were word processed, pages neatly stapled and bound. But many of the reports were saved to disk as Power Point presentations, and we were ready to watch.

Students gathered together around the projector. They were all curious to see what others had accomplished, and they were in a celebratory mood. They were *hot*, and they knew it.

--critqued their design: annoying sound effects, silly color choices,

--fought about spelling and how dorky it was to have a hugely projected slide with stupid spelling

--recognized that slide after slide of text didn't work. Janeve asking for advice from the "worst" students

--ability to talk to the points that they had captured on their slide. Presentation both in terms of the slides and in terms of their human presence to explain the concepts that lie behind the glosses they had chosen to present in bulleted form.

--eagerness to go back and fix up the mistakes they could now see in their work, and refine their work, try other things, experiment. Work wasn't over at all--it truly was theirs, and they wanted to keep going.

How do hypermedia authoring environments challenge conventional conceptions of literacy development?

Conventional approaches to teaching writing are built on pervasive assumptions about the nature of text and of literacy :

- Text organization is linear (i.e. beginning, middle and end)
- Text production proceeds in a linear fashion. (i.e. . the "Monday to Friday" writing process sequence of pre-writing, draft, revise, proof-read, publish)
- Text means the written word and recorded symbols
- A report is one long stream of uninterrupted text
- Reading and writing are solitary endeavors

The present investigation examines the merger of a constructivist approach to writing that regards the student as knowledge creator and the use of hypermedia authoring as the publishing and presentation medium for student work.

Review of Literature

Shortly after hypermedia tools became readily available to educators, Marchionini (1988) predicted that hypermedia authoring tools had the potential to alter teacher and student roles and the transactions between them by allowing students to construct their own interpretations of information as well as share their interpretations with their teachers and other learners. Turner and Dipinto (1992) have recently demonstrated that the capability for students to create their own interpretations includes the ability to author individual HyperCard documents that are shared with other students. Turner and Dipinto (1992) suggest that in order for students to become hypermedia authors, they must learn not only the content they will present in the hypermedia document but also the tool skills they need to use the hypermedia software. Carver, Lehrer, Connell, and Erickson (1992) emphasize the importance of master teachers who have a thorough understanding of design skills and can embed explicit discussion and practice of the whole process of design into daily classroom activity. Thus, hypermedia becomes an object of instruction as well as a medium for teaching and learning (Turner & Dipinto, 1992).

Project Description

In this study, sixth-grade students used PowerPoint to create multimedia research reports about bears as part of a cross-curricular investigation. Each student conducted research on bears using both physical and digital reference sources, such as books and encyclopedia, CD-ROM reference materials, and by searching for information about bears on the World Wide Web. Students digitized images of bears using optical scanners, created charts in Microsoft Excel, and downloaded images and sounds from the Internet. Students then determined what information to include in their research report, organized it into slide-by-slide chunks, re-organized these slides using the slidetray in a meaningful way, and presented their PowerPoint presentations, which were true hypermedia documents that incorporated text, links, graphics, charts, and sounds, to their classmates and teachers. During the presentation of the PowerPoint projects, students offered thoughtful and well-considered feedback to their peers on content, screen design, and media issues.

Purpose

Through an examination of the role of hypermedia technology as a medium for students to actively construct knowledge, our purpose is to explore alternatives to conventional conceptions of the development and nature of literacy.

Methodology

Our students are a heterogeneous, grade 6 classroom with 60 students in a rural community close to a major urban center. They range in ability from those who represent the "traditional" struggling writer to those who represent the traditional conception of the expert, or successful, writer.

Our data was collected over the course of a two-week study that was part of a larger, integrated study of the local environment. Students were, as a group, inexperienced in using the computer. A few were confident in their use of word processing, and fewer of those had also spent time using the World Wide Web. None of the students had previously authored a multimedia document. Instruction in the use of appropriate software applications was part of the regular classroom emphasis on the integration of technology into curriculum, following the requirements of Alberta Education.

The skill and ease with which students mastered the technology, and the surprising outcome that students at the "lower" end of literacy skills and abilities as measured by conventional means, has drawn our research interest to a number of compelling issues:

- Conventional understandings of "ability" are constrained by traditional assumptions about the nature of literacy. When teachers change the publishing environment, a whole new set of competencies appear to emerge.
- The conventional social structure and communication patterns of the classroom were transformed when students generally seen by their peers and by their families as "less able" produced the most interesting and exciting work.
- Conventional understandings of text as linear and uninterrupted gave way to an experience of knowledge construction that was multi-faceted, iterative, and malleable.

Discussion

--Interesting that the class did not become PowerPoint junkies, instead PowerPoint seemed to be a springboard into other applications and tools, ways to write, communicate.

Our discussion will focus on how hypermedia authoring provides and also demands alternatives to conventional conceptions of the development and nature of literacy. Results of the hypermedia authoring project will be discussed in light of the differential development and production of "lower" and "higher" ability students.

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Development and Implementation of a CAL Package on Plant Anatomy: Rationale, Preliminary Analyses and Student Response.

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Introduction

Context: Where and When Used

A hypermedia package entitled "Constructa Plant" is being developed for use in a course on "Plant Development, Structure and Function" in the second year of the Biological Sciences curriculum in the College of Science at the University of the Witwatersrand. The College of Science is a two-year foundation programme developed to address the educational imbalances of the past in South Africa, especially in science and engineering (Rutherford 1997). Students who pass the programme proceed into the second year mainstream. The students in the programme are admitted with lower than traditionally accepted school leaving qualifications, but have been selected on potential. The majority of our students are therefore educationally and often socially "disadvantaged", but are highly motivated and talented, though lacking in many basic skills.

The *Constructa Plant* package aims to provide a foundation for the recognition of plant cell and tissue types, but also to enhance understanding of the 3D structure of cells and relate this to their functions and positions in organs, as well as to give students the opportunity of practising answering questions (Cron *et al.* 1997).

Rationale: Why Develop It?

The package has been and will be used to assist self-study of basic plant tissues in preparation for the introductory practical of the course, in which students examine plant cells as whole structures and in transverse and longitudinal sections. The students do not receive formal lectures on this section of the course, and prior to the development of the package, used their textbook to research and summarise the main features of these cell types during a tutorial session. In 1997, they were able to use a prototype of the 'Background Knowledge' section of the package in conjunction with the textbook for this purpose.

The package has also been designed in response to observations of difficulties experienced by students over a number of years of teaching plant anatomy. Most of the students come from schools which lack practical facilities and have little experience in microscopy or interpreting sections of tissue. At a more basic level, some students have difficulty in conceptualising cells in three dimensions, as functional entities connected to other cells. They then produce drawings of cells with thickened walls (e.g. epidermis, collenchyma and sclerenchyma) as disconnected entities, reflecting their lack of perception of the cell wall and middle lamella.

Rationale: Why CAL?

We chose to use a computer package as the medium of instruction and as the intervention mode because of the many advantages associated with CAL. These include the following: (i) It is, if so designed, highly interactive and thus promotes active learning (as opposed to the passive rote-learning at which these students are especially good); (ii) it allows for learning to be directed or guided by the way in which the information is presented, and specific problems can be addressed; (iii) the learner can learn at his or her own pace, which is very important for the very diverse group of students in our programme; and (iv) it is a very non-intimidatory medium in the sense that no one "sees" the mistakes and students feel free to attempt to answer questions without fear of peer or teacher criticism.

Computer Design Features

The package is being programmed using Visual Basic 5 to allow for maximum flexibility in design. The Windows environment is being used, but no previous computer experience is assumed for the users. Simple screen layout is used and instructions for each screen are given at the bottom. A "Help" menu also provides information regarding text colours and navigation. A concerted attempt has been made to use relatively simple language with E_2 language learners in mind. A sans serif font has been adopted as research has shown that it is the most easily readable kind of font (Dekkers *et al.* 1993).

Instructional Design Features
The instructional design of the package is based on educationally sound principles as discussed by Alessi & Trollip (1991) and Peté (1997). Features worthy of note are the following:

Navigation: Students can select from the Main Menu which sections they which to visit and a colour change indicates where they have been. There is maximum control available to the learner, who can move forward (Next button) or backwards (Back button) as desired, thereby repeating screens, and can quit at any time.

Leanness (or "chunking" information): "Leanness" embodies the principle of not giving the learner too much information at once. This is achieved in two ways: firstly, through time lapse in revealing information and/or activities, although this has disadvantages as reading speeds and computer speeds differ, and secondly, through hypertext, to provide more information or explanations (usually of terminology), or more illustrations.

Interactivity: This is achieved in a number of ways by involving the learner in activities such as clicking for labels, answering questions: multiple choice and open-ended types, matching and search activities.

Feedback: The students receive the correct answer after a maximum of three tries for any attempt at answering a question. The feedback includes confirming or correcting information as well as indicating the correctness of the answer. Open-ended questions allow for variety in answers by letting students check their own answers from a "model" answer or list of possibilities.

Self-testing: The **QUIZ** is designed to give students the opportunity to test themselves and gain practise in answering questions. Students may select specific sections on which to test themselves, and note their score afterwards. They are also offered the option to see the screens they answered incorrectly and then given direct feedback as to whether their second-attempt answers are correct or not.

Method of Preliminary Analysis

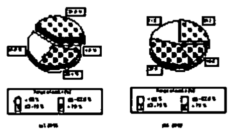
In evaluating the effectiveness of the package in its initial usage, we analysed the scores of two groups of students when answering an exam/test question. The question was given in the June 1996 examination to students who had *not* used the package, and then in a test in March 1997 to students who *had* used the 'Background Knowledge' section of the package. The question required the students to identify three different plant tissues and their constituent cells, to note their functions, identify structural features which enable them to perform their functions and where they occur (see Cron *et al.* 1997, Fig. 1). Differences between the scores of the two groups were then tested using a one-tailed two-sample t-test, assuming equal variance.

Correlation analyses of student performance in the test question with performance in practicals during the course and the practical exam were also carried out to see how effective a tool the test question was in assessing knowledge and understanding which could then be applied in these new situations. Pearson's coefficient of correlation was used.

In a more qualitative approach to assessing the impact of the package, students were asked to fill in a questionnaire at the end of the tutorial during which they had used the *Constructa Plant* package. They were asked for feedback on whether or not they had enjoyed using the package, what they had liked/disliked, whether they felt they had gained new information and understanding from using it, and questions regarding specific items such as quality of illustrations, clarity of explanations, etc. Students were also invited to make suggestions for improving the package, as it was made clear that they were the "prototype testers" and that their input was valued.

Results

Analysis of the scores of the two student groups for the exam/test question revealed that in 1996 (Figure 1a), 39.5 % of students failed the question overall, 25.5 % obtained between 50 - 62.5 % and 30.4 % between 63 -79 %. Only 4.5 % of the students got 80% or more for their answers. In comparison, in 1997 (Figure 1b), the number of students failing is markedly reduced to 25 % and a larger percentage (15.6 %) of students got more 80 % or more. Using a one-tailed t-test (two sample and assuming equal variance), the improvement is significant at the 2.5 % level: P (T<=t) one-tail = 0.024476; t (Critical) one-tail = 1.6669144 at 72 degrees of freedom.



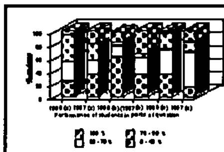


Figure 1. Overall performance of students in the exam/test question in (a) 1996 (N=43) and (b) 1997 (N=32).

In analysing the scores for the three different parts of the question (Figure 2), it can be seen that the number of students failing the specific section decreased for parts (b) and (c) in 1997 compared to 1996, although not for part (a) of the question. There is, however, a substantial increase in the percentage of students getting 100 % for the all of the sections in 1997. Each part of the question relates to a different tissue type.

Figure 2. Comparison of performance of students in parts (a), (b), and (c) of the question in 1996 and 1997.

Correlations of Performance in Test Question with Performance in Practicals and Practical Exam
Pearson's correlation coefficients for the test/exam question, assessment of performance during practicals in the plant structure, development and function course, and for the Practical component of the June exam in 1996 and in 1997 are presented in Table 1.

Although the correlation coefficients on the whole are low (Tab. 1), most of them indicate a significant correlation between the variables for the population from which they are sampled (as indicated by *p*). An exception is the very low correlation between the exam question and the practical assessment in 1996 (r=0.1976) and its lack of significance. Another exception is the high correlation value (r=0.6774) between the exam question and the Practical exam in 1996, and its high significance. It should be noted that the test/exam question did *not* form part of the practical component of the June examination, but was part of the so-called "theory" part of that exam. The exam is divided into two parts, involving the use of microscopes and experimental equipment in the "practical" part, although the work done throughout all components of course is integrated and tested in both parts of the exam.

Table 1. Pearson's correlation coefficients and assessment of their significance for two groups of students.

Variables being Correlated	Correlation Coefficient (r)	Test of Significance of Correlation (*p*)	*Significance (NS = not significant, * = significant, *** = highly significant)*
1996 (N = 44):			
Test/exam question and Practical assessment	*0.1976*	*0.1985*	*NS*
Test/exam question and Practical exam	*0.6774*	*0.0000*	***
Practical assessment and Practical exam	*0.3452*	*0.0217*	*
1997 (N = 32):			
Test/exam question and Practical assessment	*0.3775*	*0.0343*	*
Test/exam question and Practical exam	*0.3992*	*0.0236*	*

Practical assessment and Practical exam	***0.3515***	***0.0485***	*

Student Response to the Questionnaire
The students were overwhelmingly positive in their response to the package and requested that more, similar packages be developed for other topics. The following are a selection of their responses from the questionnaires completed at the end of the tutorial:

Q. What did you like MOST about the package?

"Every aspect is accompanied by a drawing."
"The way information is being highlighted."
"Being asked the question and then given the correct answer to compare with the one I gave."
"Explanation of cells and tissues, especially their microscopic structures."
"The whole of it, I was so impressed by the way the information was written, you know beautifully and most understandable."

Additional Comments:

"I wish that there can be more of this kind of package for every topic as it is easy to understand, and you know what, it's most enjoyable."
"It is easy to understand things 'cos everything is done at our own pace. It'll be useful if more programmes on other topics are developed."

Discussion and Conclusions

A major assumption in the underlying theory of the two-sample t-test is that both samples come at random from normal populations with equal variances (Zar 1984). Although this cannot be known, it is hoped that the influence of the selection procedure in establishing entry to the course may assist here. "The t-test is nevertheless robust enough to withstand considerable departures from its theoretical assumptions" (Zar 1984: 130), although the samples in this analysis were not equal in size, nor were they very large. Nevertheless, the difference between the groups tested is significant at the 2.5 % level, which reflects a considerable level of improvement.

Although there are other factors which have possibly contributed to the significant improvement in the group of students who used the CAL package, the results indicate that it has been an effective mode of assisting learning in a foundation tutorial for plant anatomy. The most important of these contributing "other" factors is possibly the fact that the 1997 group were tested nearer to the time of learning the content. Another factor might be the different levels of anxiety associated with a test (in 1997) as opposed to an exam (in 1996). Different time pressures may exist in a test and an exam, although we propose that the test may be more pressurised in that there is an overall lesser time period and therefore less flexibility. This last factor would therefore not have enhanced the test scores in 1997.

Students also did not answer *all* aspects of some parts of the question, and this may reflect bad test technique, rather than lack of knowledge. It cannot be known whether the students would have supplied the correct answer if they had answered a question in its entirety. Similarly, poor exam performance could be a factor contributing to the poor correlation between practical assessment during the course and the practical exam (Tab. 1), as many students do not achieve as well during exams as they do during the term.

The lack of correlation of the scores for the exam question and the assessment for the practical component of the course in 1996 (Tab. 1) may be explained by the fact that a considerable proportion of the marks for practicals is awarded for drawings/diagrams. Although a good understanding of cell structure and the ability to recognise cells would assist in producing a good, well-labelled drawing, drawing ability is not directly being measured in the test question as it is in the practical mark. It should also be noted that the Practical component of the June exam (2½ of 5 hours) includes work and skills from the *both* the first and second blocks of the semester, thus including additional skills and topics not correlated with an understanding plant anatomy.

The enthusiastic response of our students to using a computer package to assist learning is similar to that of the students in Blackmore & Britt's (1993) study. Most of our students had had limited exposure to computers before using this package, and the only aspect with which they experienced difficulty was in "dragging and dropping" arrows in some of the on-screen activities, reflecting inexperience with use of a mouse.

In our opinion, the three main reasons why the computer package did significantly positively affect learning is due to (i) the more directed nature of the learning, (ii) the more simple and more visual presentation of information, and (iii) the fact that fundamental concepts are emphasised.

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Neurology Interactive
An Interactive CD-ROM to Supplement Clinical Experience

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What is the program 'Neurology Interactive' about?

We are faced with the facts, that educational resources have become progressively scarcer, clinical teachers have less time for teaching and patients with classical presentations are not available, when the curriculum calls for them. As medical student, I received my information from lecture and books, then I converted the information to knowledge at the bedside and in the labaratory. It is this latter activity which is threatened most by the resource shortage.
With the computer-aided-instruction-tool ("CAI") 'Neurology Interactive', we intend to soften the adverse effect of this processes to the education of medical students in the field of clinical Neurology. While I do not propose that CAI can replace the actual clinical experience, I propose that appropriately designed programs can supplement reduced clinical exposure.
Our approach is a case based interactive computer simulation of the neurological examination of ten prototypical patients - including the essential clinical and paraclinical features. A concise theoretical framework of the different diseases and their investigation is provided.

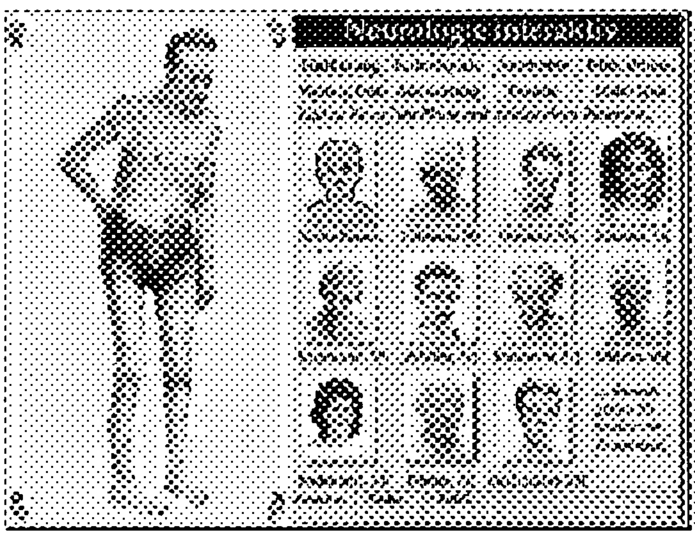

Figure 1: User interaction is provided by an intuitive graphical interface.

The Simulated Clinical Examination

In analogy to normal clinical practice, students are first presented with a case history.
When the student proceeds to the clinical examination part, the patients face and history are already known to him - elements that are important to invoke empathy.
Then, the student is confrontated with a pictural representation of a patient. Each patient is representated by four pictures: the frontview, the rightsideview, the leftsideview and the backview. This allows the student to 'turn-around' the simulated patient and so to reach any point of interest.

The interactive graphic interface is based on a set of implicite maps of the body surface representing the trigger-areas for various neurological signs. The application of neurological tools (reflex hammer, ophthalmoscope etc) to the appropriate location causes the program to provide realistic verbal and visual responses.

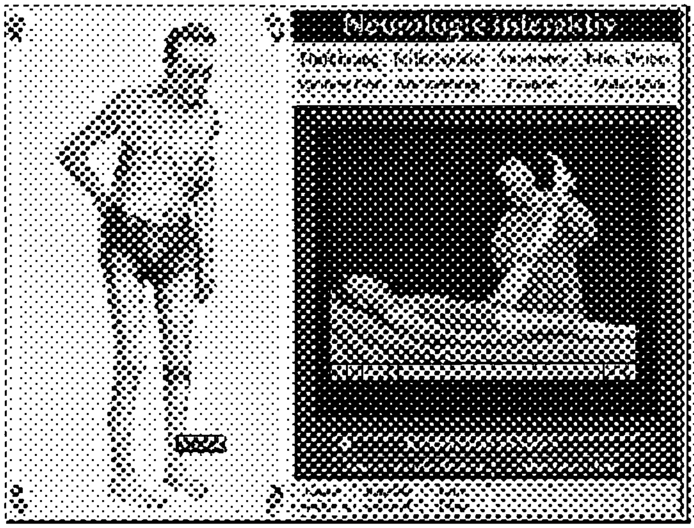

Figure 2: The application of the tool "hand" to the leg of this patient causes the program to provide the user with a digital video in which he can analyze the reaction of the patient to a specific examination.

Indicating the Appropriate Locations for Each Examination Tool

Each examination-tool is represented by two different cursors: One represents the active tool, the other one the inactive one. While moving the cursor over the simulated patient, the appropriate locations are indicated by switching the cursor into its active form.

Providing a Help-System for Case-Based-Learning

The case-based learning environment demands for a help-system that doesn't destroy the student's curiosity while protecting him against losing itself on a wrong track.
We provided a simulated tutor who advices the student the way he should handle things. A user can anytime demand for assistnace. Then a little QuickTime®-Movie is presented to him in which an experienced tutor recommend an examination not jet performed but of importance for the making of the diagnosis.
Here's an example:
Examine the sinsibility for touch on the legs - compare sides and regions of both legs. For this purpose, you take the tool "feather" and put it against the regions you intend to examine!

Feed-Back

For a computer-based program, it is possible to track the users' actions. This offers the opportunity to give either immediate or summative feed-back. In 'Neurology Interactive', three different summative feed-backs are provided.
There is first a tracking of the users actions for each case, then second a reminder of "what is to do" and third an assessment of the reactions caused by the users' actions.

Adaptive Learning Model for Workplace Environmental Training

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1. Environmental Management Training: international issues with specific individual training needs

Taking environmental issues into consideration is an ever evolving endeavor—one in which Environment Managing Standards (EMS) appropriately step in to assist willing industrial and commercial enterprises of all sizes, at national and international levels, to harmonize their activities in view of respecting the environment. The challenge is to provide adequate personnel training for all the enterprises that want to apply these standards and wish to obtain accreditation [Boutin et al., 1996].

This type of training which targets a potentially large and diversified clientele, must be flexible, adaptable and transferable, context-wise, as well as with respect to the appropriate methodological approach and pedagogical activities. This is especially desirable when the learners are adults from different walks of life, each one of whom has objectives, some level of education and professional expertise. It is also well known that, in the same learning environment, each adult has his/her own cognitive style and could resort to different strategies to assess what is needed to construct knowledge and attain the required learning objectives.

With the stack of such needs, the World-Wide Web and Hypertext hold a lot of promise as teletraining media, to the extent that an adaptive Learning Environment (LE) can become a relevant solution. Put together, these technologies can help not only improve access to training but also come up with a constructivist approach for designing an individualized, user-centered, authentic-task and cognitively flexible model for adult learners.

A Web/Hypertext training project is more than just an information base or an electronic book. It must provide the type of LE in which elements of the content, the pedagogic approach, learning activities as well as help and support tools are expressly made available. With professional training in mind, such an LE must be flexible, adaptable and transferable, context-wise, as well as with respect to the methodological approach and pedagogical activities which are best suited to adult learning.

Within educational circles, the Hypertext has commonly been seen as a valuable, new constructivist tool—one usually associated with nonlinear properties which, by extension, give the learner more control in the LE and its content—; it allows for different levels of prior knowledge, encourages exploration, and allows the learner to adapt material to his/her own learning needs [Stanton and Stammers, 1990]. But in reality, we have to recognize that these virtues do not all come from the hypertext properties alone, but mostly from the decisions made by it's author-designer such as his/her own view of the learner, his/her conception of learning and of what learners could or should do in an LE. The design of a hypertext for training should therefor be based on these considerations.

Hypertext can be defined simply in terms of text organized into chunks, units, or "nodes" linked together. So, a hypertext software can be linear or non-linear and access to the hypertext's contents is mainly defined by the organization of the links provided by the author/designer. The type of interaction permitted in a hypertext is essentially provided by its link structure type (e.g.: linear, hierarchical, associative, random linking, etc. and combinations of these types). Also, because of the implication of the content's organization over learning, decisions about the linking structure provided for hypertext searches should take into account the cognitive styles of use [Chi-Hui and Davidson-Shivers, 1996].

In fact, depending on knowledge levels (expert or novice), goals and learning styles, learners can have different strategies and choose different paths in a hypertext LE. Cognitive style has been demonstrated to be a significant component of individual behaviors and strategies within computer-based LEs and hypertext environments [Ellis et al., 1993]. Depending on their learning styles, for example, be they field independent/dependent or holistic/serialist, a learner can adopt a surface processing of symbols or a deep or strategic analysis of the meaning that underlies the symbols. They can also prefer certain teaching methods or styles—behaviorism, mastery learning, apprenticeship, constructivism and free discovery [Mendelson ,1996]— which can have a significant impact on their achievement [Conti and Welborn, 1986] .

2. The Hypertext Learning Environment For Adult Training : Toward Adaptive Model

Many authors have thus suggested that an LE offering "cognitive flexibility" [Spiro *et al.* 1992], should be designed to support a variety of teaching and learning styles [Collin, 1993; Powell and Okey, 1996] by regulating the locus of control between student and system, and accommodating task-based methods and providing feedback to help the learner control explorations, investigations and problem-solving, and by allowing trainees more routing choices and access strategies to cater for their preferred learning styles and trainers more flexibility in tailoring the design of the LE to organizational and trainee needs [Ellis et al.,1993].

This perspective corroborates the learner-centered conception of the constructivist movement which acknowledges the importance of adult training outcomes such as problem-solving and applications by proposing a transition to the problem-based or case approach from the traditional linear and content reproductive one. From this point of view, an LE using hypertext as a delivery technology should: engage learners in authentic, context-sensitive or case-based learning tasks; facilitate problem identification, definition and solving; emphasize knowledge construction, rather than reproduction; present multiple perspectives, and provide alternative means for reflecting on personally constructed meaning [Jonassen, 1993]. It should be designed to allow the interactive manipulation of information based on the models of the "problem exploration systems" and the "systems for structured reading/ browsing/ reference".

Guided by a constructivist conception of learning and focusing on the characteristics and differences of the clientele in the environmental teletraining context —by taking into consideration and combining different variables such as: a) adult learning styles and strategies; b) teaching methods and styles; c) organizing and linking hypertext structures—, we look forward to designing a cognitively adaptive teletraining model which, with its diagnostic and prescriptive modules, will offer the user-learner alternative avenues, scenarios and learning paths, based on the problem-solving and authentic-tasks approach. It will also provide a trace mechanism, guidance tools and the necessary pedagogical support. In all, this polymorphic training model should offer each student a customized learning environment tailored to his/her needs, and which equally allows for transferability of training products and services to various contexts and countries. This model will be tested and put in place as an ISO 14000 training prototype in industrial settings.

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Hands-On Distance Education Opportunities in Science Education: Maintaining Excellence While Extending Frontiers

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An award-winning elementary science program provided a foundation for this project. In the early 1980s, cooperative efforts between College of Education and College of Science faculty and administration resulted in program changes that met National Science Teachers Association (NSTA) standards for preparing elementary grade level teachers. The outcome was an Award of Excellence in 1985, as one of seven universities nationally meeting NSTA standards. A large part of this recognition was based on a hands-on approach to teaching elementary grade level science. In 1985, the author initiated science methods course offerings via distance education. In the time interval 1985-1996, these offerings have included audio conferencing, slow scan video, live video both directions, public television, and on-site facilitators. Student populations have ranged in size from a few persons at up to 10 sites to over 2,000 people enrolled for a single offering. These experiences have formed a foundation for the current project, which utilizes the World Wide Web, accompanying CDROMs, hands-on labs, and e-mail interactions. Utah State University offers courses and degree programs at sites throughout the state as part of Land Grant University extension role. Typically students at ten to twelve sites will enroll in the science methods course annually. To offer ten courses with a few students and a live instructor would be economically unsound and would be physically impossible with available faculty. The obstacles of distance, numbers of students, and faculty availability are alleviated by electronic delivery. One of the basic challenges for the project was how to best incorporate the very important hands-on lab experiences into a course delivered on the web. The issue was dealt with by designing instruction at three different levels. First, students are presented with text material which explains the nature of basic science process skills: e.g., observation, inference, classifying, hypothesis testing. Students are then provided with materials and instructions for doing these types of activities. In some instances, their results are self-evaluated using website information. In other cases, their results are e-mailed for instructor analysis and response. At the second level, students are required to view video files in which children perform tasks similar to those experiences in first level student hands-on labs. Students analyze the children's activities using provided analysis strategies. They then report their analyses to the instructor or to colleges for comment. These interactions are in the form of linear discussions, thread discussions, or group discussions (see website for examples). At the third level, students are provided content and procedures in the form of a CDROM and are then required to plan, carry out, evaluate, and report on an electronic-based practicum experience with children. Another challenge was the issue of how to maintain a feeling of instructor presence. This was also done at three levels. First, text materials were tied to the instructor's philosophy early in the course, with the student admonition to view all text as the instructor's perspectives, which could be different from student perspectives and should be viewed as one way to look at course content and procedures. Student reflections were built-in to encourage a feeling of interaction with the instructor via e-mail and 1-800 number conversations. At the second level, students observe video files of the instructor as an information provider and an elementary classroom role model. These episodes are open to electronic discussion and reflections challenges. Students are required to respond to specific items and the instructor provides comments. At the third level, students are asked to model what they have experienced in the course in an electronically-driven practicum and then are asked to share their experience with the instructor. The purpose of these interactions is not primarily to assign a grade, but more importantly, to identify with a person (the instructor) and a process (the course philosophy). Two supplements accompany the website text file. One is designed to provide immediate reinforcement of information in the text file. It contains video of instructor and classroom episodes directly related to the text. Viewing episodes are followed by optional or required reflections. The other, a CDROM, is designed as a model of what could be used as an electronically-driven science unit for upper elementary grade level students. The topic covered is "Earthquake Preparedness." This unit was designed to model various aspects of Science, Technology, and Society literacy (STS) and exemplary electronic delivery design. The STS aspects include use of science process skills in which the user is required to conduct laboratory exercises using provided equipment and materials, and then reporting on them. After providing a written report, the user is allowed to view a video of the lab as a verification of their works. Video access and graphics are also provided as enhancements to basic concepts and procedures. These enhancements are particularly valuable for expanding various aspects of technology. Societal ties are interwoven throughout the curriculum and culminate with applications for personal earthquake preparedness. The Earthquake Preparedness CDROM is designed to be highly interactive and user- friendly and can be used in a variety of ways by a teacher. Students registered for the science methods course must use the Earthquake CDROM in some way for a practicum. These uses include using the CDROM as a resource file for information for the teacher, as a station study for small groups, as enrichment for independent study, or as a whole class organizer for a unit on earthquakes. The electronic practicum requirement forces the student to use some of the same technology around which the website course was developed. As such, it provides an opportunity to use educationally sound, electronically-driven technology as part of their learning experience. Thus we have designed a course that rests on a foundation of proven science education techniques and also places the student in a situation where frontier principles of learning are modeled. The course described above is a required course for all people in the elementary education degree program. Preliminary results indicate that about 1/3 of the students react very well to the delivery system, 1/3 are neutral, and 1/3 are very negative. The 1/3 that are enthusiastic evaluate the course at about the same high level that they would with a live instructor (5.7 on a six point scale). The 1/3 who do not relate well to the technology or who feel primary responsibility for learning rests with the instructor, evaluate the course much lower (3.0 on a six point scale). The net result is a significantly lower course evaluation for the distant education course. The course can be viewed at http://www.awbl.com/classes/education/eled4000.

New Media, Proven Method: Results of the Beta Test of the First TeleWEBcourse℠

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Proven Model

In the early 1980's telecourses became a way for colleges to pool their resources to economically reach new audiences through the new medium of television. The courses were designed to serve national audiences and to meet the curricular requirements of many institutions, using national advisory committees to define the content, select the texts, and consult on the development of the video programs, the student study guide, and the faculty manual. This model has led to the creation of more than 100 high-quality telecourses designed for undergraduate education

Increased access to technologies in the past 15 years have prompted changes in the way students are learning with telecourses, gaining flexibility of time and place as they moved from viewing one-time broadcasts, to multiple cable castings, and then to videotape. Today's broad availability of the Internet allows students to interact asynchronously with their instructors and their classmates, further enhancing their learning.

The quality, flexibility, and economy of telecourses have led to their wide acceptance by colleges launching distance learning programs. Faculty develop the syllabus and requirements for the students who receive credit from their institution and serve as the learning facilitators for their students and determine the grades. The institution pays a license fee to the telecourse distributor (typically $500 per term) and can enroll as many students as they wish in the course, with a small additional per-student cost. Some, like the University of Maryland, are offering telecourses internationally.

New Media

Since today colleges are turning to the Web as a way to reach distant students, teleWEBcourses are being developed that retain the instructional components of telecourses and fuse them with the interactive capabilities of the Web. The first such course, "Internet Literacy," was piloted in fall of 1997 with two colleges, is being beta tested in spring 1998 with 34 colleges, and will premiere worldwide in fall 1998. "Internet Literacy" is a one-term integrated multimedia learning package that uses the Internet to teach Internet literacy. Institutions are offering the course for either undergraduate or graduate credit, or as non-credit classes. By completing the course, students become Internet literate in three ways: understanding the Internet, doing the Internet, and creating a personal presence on the Internet.

The multiple components of "Internet Literacy" include:

- a textbook published by McGraw-Hill and first available in January 1998;
- a Website that links to all of the materials and activities covered in the text;
- an "Internet Literacy" CD-ROM; with more than 200 "show me" videos

- a Student Jumpstart Pamphlet; and
- an Instructor's Guide with sample syllabi and other tools

Students must have an Internet account with access to e-mail and the Web.

Objectives of Beta Test

The beta test was designed to test the scalability, transportability and implementation of the teleWEBcourse Internet Literacy. Research questions related to

1. Identification of key decision makers and their roles in the adoption and implementation of externally produced Web-based courses
2. Identification of distance learning personnel and their training needs
3. Ease of implementation and operation for both college faculty and administrators
4. Evaluation of SERF, the course-management platform
5. Evaluation and acceptance of the course content by faculty and learners as licensing institutions
6. Evaluation of the course design and its effectiveness in instruction
7. Evaluation of the instructional effectiveness of the course
8. Identification of performance objectives which may differ from institution to institution
9. Identification of the range of options for the academic department and level of the course.

Results of Beta Test

As of this writing, results from seventeen of the 34 colleges responding to a preliminary survey have helped us begin to formulate answers to these key questions. The beta test currently reveals the following:

1. The department in which this course resides varies dramatically from the math department to learning resources; 8 reported offering it in computer sciences. The course is being taught as a non-credit class (6) and as a credit course at both the graduate (1) and undergraduate levels (7).
2. Thirteen institutions responding already have an on-line program in place, with 11 offering a full degree at a distance.
3. All of the faculty rating the book (9) gave it excellent marks; similarly the CD-Rom was ranked very high, with only a few usage-related problems.
4. Six of the reporting beta sites have modified the course to fit specific institutional needs.
5. Six of the reporting beta sites show a direct involvement by the college president in the assessment of the course, with one institution reporting that the president is enrolled as a learner.
6. Overwhelmingly the concerns of the students have come to the forefront with comments such as "need faster server time," "need a place where students can put pictures of themselves on a class roster."
7. Ten of the institutions reporting do not now offer courses internationally but 7 of those plan to.

More complete results will be presented at the conference and will be available at <www.pbs.org/als/> after May 25, 1998.

Next Steps

As educational resources burgeon on the Internet and the Web, one of the challenges to higher education is recognizing the barriers to education created by these new distance learning methods. In the coming months additional surveys will be developed and collected, leading to a more complete evaluation of the course. This will be the basis for recommendations for course improvements, including a plan for technical training, improved faculty orientation, and technical support.

Key to the success of any distance learning courseware is effectiveness. Understanding the Web's strengths and weaknesses in the delivery of Internet Literacy will provide us with the foundation for fostering self-directed learning using this medium.

The Language Net Project and the Finnish National Strategy of Education, Training and Research in the Information Society

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The Language Net Project and the Intranet Pilot Project

The Language Net project was begun in October 1996 with a deadline set for completion in September, 1997. The purpose was to plan and construct a net-based hypermedia program for the remedial and complementary teaching of English and Swedish at university level. Funding for the project was made by the Finnish Ministry of Education together with the project partners, the language centres of four major universities in Finland (the Universities of Turku, Helsinki, Tampere and the Helsinki School of Economics). Programming and visual planning were taken care of by the Multimedia Laboratory of the University of Tampere. The overall goal of the project was to create and put on the World Wide Web such material that can be used for self study and the traditional teaching of English and Swedish. The implementation of the program began in the autumn of 1997 with a group of about 20 students in the Language Centre of the University of Turku. At this stage of the project, data concerning the implementation process was collected in the form of student portfolios and interviews. On the basis of this information a pilot study was made in order to prepare for a wider study on the online culture which would develop around the program. The results of the study are expected to be of importance because it deals with the first generation to learn second or foreign languages via the World Wide Web, instead of by way of more traditional teaching methods. The results of the Language Net Project gave rise to another project, the final goal of which is to build a common Intranet for the university language centres of Finland. Both projects follow the guidelines given by the Ministry of Education in 1994. On 13 September 1994, The Finnish Ministry of Education set up an Expert Committee to prepare a strategy for education, training and research in the information society. The deadline for this work was 31 January 1995. The work of the Committee resulted in a strategy document containing both the Committee's opinions and proposals for methods of utilizing information technology to raise the levels of education and research, thus improving the opportunities available to obtain and use information. The Finnish Ministry of Education emphasized the following points:

1. Basic information society skills for all.
2. Development of information products and services.
3. Transition from on-off training to lifelong learning.
4. Evaluation of education and training.

Basic Information--Social Skills for All

> The task of the comprehensive school is to give every girl and boy the multifaceted basic skills and competencies required to find and manage information and to communicate. These are basic requirements in the information society and are essential for further education. All levels of the educational system should support the continuous updating of these skills. Adults must have the opportunity to learn the basic skills of obtaining and managing information, communicating and understanding information technology. They must have the opportunity to improve these skills continuously. [Ministry of Education 1995]

The Internet, or its successor, will eventually become an indispensable element of cross-cultural and international understanding in the new European Union, in America, in Asia, and around the world and an important tool for language teachers. Other tools, such as those of applied linguistics and critical discourse analysis, can be used to develop a coherent understanding of the future relationship between public discourse and the new information technologies as they emerge during the first half of the 21st century.

The traditional "one way street" of language classroom information flow, typical of today's public schools, is rapidly becoming "New Media discourse" through information language-learning interactivity. Language learners are now experiencing, because of the newer computer-assisted communications software, the toppling of information control in the classroom. The increased complexity of the computer-aided language-learning experience becomes a positive experience, but a more difficult task for the teacher/facilitator to control. The teacher's role is by no means supplanted by the cyber environment. However, the teacher's absolute authority is replaced by the existence of a multi-authoritative world of knowledge available only on the Web. In New Media communication, such as the computerized language lab of today, students learn to deal with what author Mitchell Resnick calls "decentralized systems." In decentralized systems, "...orderly patterns can arise without centralized control... But many people continue to resist these ideas, assuming centralized control where none exists--for example, assuming (incorrectly) that bird flocks have leaders." Educators and researchers need to develop "new ways of thinking about and understanding decentralized systems."

Focus on Teachers

> In the implementation of lifelong learning, teachers' professional skills are absolutely essential. ...Teachers should have the ability to use the media necessary for open and flexible learning and be able to modify and develop material in ways which make it suitable for them to use. [Ministry of Education 1995]

Teacher and classroom autonomy is essential for successful language learning at Finnish universities. The development of teacher and student native speaker contacts is a traditional part of foreign language teaching which is considerably enhanced by the new computer laboratory and server technologies.

All this calls for enhanced and life-long teacher education, too. The new technology is developing so rapidly that it can often be difficult to arrange suitable courses for the teachers. A common Intranet would be a perfect forum for this kind of on-line education. We long for more interaction between the language centre teachers from different universities.

Research

The university language centre offers a plentitude of opportunities for language researchers. Using modern Net-supported methods enhances the collection and interchange of data. The implementation of the Language Net Program is being studied by Ilkka Norri. His dissertation on this subject will be evaluative in intent (research focused on a particular program, product or method in applied setting, for the purpose of describing the culture around the program, improving it and estimating its effectiveness and worth) and it will employ qualitative methodology (electronic and/or traditional diaries and portfolios, observation, case-studies, interviews, and other methods that ordinarily involve the collection of qualitative data, and its analysis using theoretical and ethnographic approaches).

Evaluation of Education and Training

These new tools will have an increasing role in the evaluation of teaching and learning. We can now easily design tests, exercises, surveys and questionnaires on the World Wide Web which consist of multiple choice and fill-in-the-blank questions. A good way of evaluating are virtual student and the portfolios. Both teachers and students are made to monitor their teaching and learning. The necessary forms for tests and portfolios are designed and put into a Web server. The users then access the form and do the filling out of the form and then click the "Submit" key inside the form. These files can in the future be automatically imported into a spreadsheet and the imported file will become a matrix with each column holding answers to one question and each row a student's or a teacher's record. In the future, this kind of system could be dealt with within the Intranet and it will be quite beneficial in team teaching, distance learning, and research situations where it is necessary to test or question students and teachers who are spread out over different geographical locations.

Conclusion

In the 21st century all educators will begin assuming their own unique role as an interactive component of a globalized electronic public information distribution system, one which will function far more effectively than all previous systems of communication and offer enormous advantages to users. This emerging "new information order," say the many optimists who argue in favor of an interactive "cyberdemocracy," will change the concept of individual liberty. A genuinely pluralistic media could be available to all citizens by means of a global system of interconnected computer networks which could guarantee an uncensored give and take of information.

Literature & programs

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Animation Elements: An Approach for Authoring and Presenting 3D Animation in Internet Based Learning Environments

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Introduction

3D animation is not as commonly used as video, graphics or audio in World Wide Web (WWW) based learning environments. This is not because 3D animation is any less valuable for educational purposes. It is due to the fact that animation authoring requires much more effort in terms of time and cost, not to mention expert skills. In order to cope with these obstacles preventing a broader use of 3D animation, we present an element-based approach as a new paradigm for 3D animation authoring and propose implementation strategies using the Virtual Reality Modeling Language (VRML) and Java.

3D Animation Authoring

In the traditional 3D animation authoring process, animations are created for building unique scenes where each scene represents one monolithic piece of work. This makes animations difficult to reuse. When compared to the authoring of graphics, an important difference can be observed: reusability may be achieved in graphics authoring by the use of Clipart. Since Clipart can be provided by professional designers in the form of Clipart collections, non-experts are able to create complex graphics of good quality in a short amount of time. However, Clipart in itself is not sufficient for 3D animation generation since behavior, and not just geometry alone, is required. Therefore, we propose enhancing 3D models of objects with object-specific functionality to obtain so-called animation elements. For instance, an animation element "forklift truck" may not only consist of its geometry, but also provide methods like "move forward", "lower fork" or "take palette". If considered an object in the sense of the programming paradigm of object-orientation, each animation element in a scene is an individual instance of its class and is capable of managing its state. In our example, a scene - with two forklift trucks stemming from the same animation element "forklift truck" - can be built where each truck controls its visualization according to its state (loaded or not, malfunction or not). An animation element's methods can be used not only during the authoring of a 3D scene but when presenting the animated scene to a learner, as well. In this interactive animation, the learner can manipulate each object in a scene using the predefined methods.

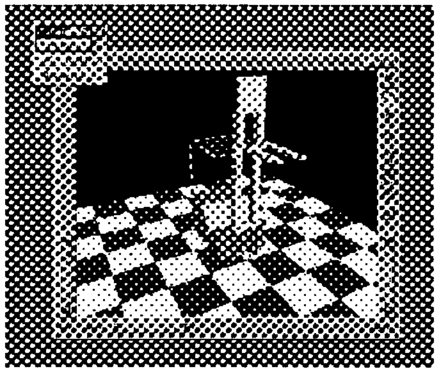 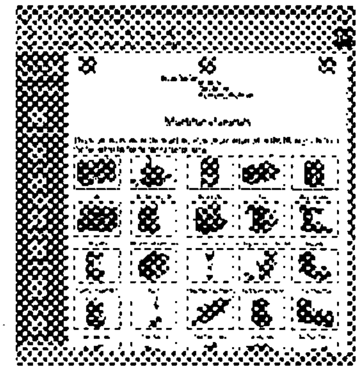

Figure 1: Animation element "forklift" and an animation element catalogue

Implementation Issues

In order to put the concept of animation elements into practice, a suitable technological platform is needed. We propose the use of VRML, a language that can be used to specify animated and interactive 3D worlds and can be considered a de facto standard in the WWW. Using the external authoring interface or the Java API interface of VRML, the behavior of an animation element can be defined using Java programs. VRML can also be used to combine the animation elements into a scene, since VRML implements a hierarchical structure; the VRML scene graph and the animation elements are the basic parts of this hierarchy. Since VRML descriptions, as well as Java programs, can be distributed via WWW, this is a way to implement the concept of animation elements for tele-learning environments. If we assume that the animation author is familiar with VRML and Java programming, she can directly apply our approach, build up a library of animation elements and reuse them for her scenes. However, since this degree of familiarity is not the norm, animation elements have to be provided by a third party and dedicated authoring tools are needed. One tool is the animation element library, a multimedia database that allows the user to browse for required elements, showing the methods they provide. Another tool is a scene editor that allows scene composition using animation elements graphic-interactively. Helpful tools include a conversion tool for format conversion (e.g. VRML to a video format) or a translator that translates sensor data or simulator output in method invocations of animation elements, thereby automatically generating an animated 3D visualization. Most important is the VRML browsing system, usually a plug-in of an Internet browser, such as Netscape or Internet Explorer, that interprets the VRML scene description and then renders it.

Prototypes of the tools mentioned in the last paragraph have been implemented in the context of the CASUS System project. Our VRML browser CASUS Presenter has been built upon Open GL, allowing the use of dedicated hardware and the presentation of VRML scenes with high performance and interaction with low latency, especially on the PC platform. Additionally, it offers special features for presenting the VRML scenes using not only desktop, but also immersive VR. Thus, the scenes can not only be shown on a computer monitor, but also in stereo mode on dedicated virtual reality devices.

Applications

While applying our system, we concentrated on a well-defined application field, since we aimed to achieve a high degree of completeness regarding the animation elements offered for this field. We chose vocational training in the areas of industrial production and logistics. Here, 3D animations can be used to serve communicative goals, explaining processes or showing the function of expensive, unavailable machinery. 3D animation is also especially suited for the visualization of simulation results. The learner is able to manipulate simulation parameters and gain insight into logistic processes. With the help of the presented concept, the amount of effort needed for authoring the scenes can be minimized by reusing animation elements. An additional benefit is that the instructor, as well as the learner, although not being animation experts themselves, are able to modify the animations. An advantage of using VRML as the basic technology is that it is scaleable. A learner can interact with a VRML scene using special devices in a VR laboratory at an industrial training center. At home, she can continue practicing or reflecting on her experiences on her own PC either alone or together with other learners using the same VRML scene. This also demonstrates a possible realization of laboratories at a virtual university.

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Designing a Design Tool for Web Instruction - Project Marigold

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Abstract

Project Marigold is building a software tool that assists educators in designing effective web sites for learning. Its aim to incorporate in the tool a distillation of current instructional design expertise faces the continuing challenge of being responsive to the diverse needs of educators coming from different theoretical perspectives. This presentation highlights the design decisions that were made to accommodate this recurring difficulty in the field. After presenting the features and distinguishing characteristics of Marigold, we discuss the prospects for tools of this kind to influence the field of multi-media distance education.

The paper is at http://www.nova.edu/~duchaste/marigold/marigold.html. The project itself is at http://www.fcae.nova.edu/~duchaste/marigold/eco.htm.

A Phased Approach to Developing a Set of Requirements for the Use of Virtual Actors in Shared Virtual Learning Environments

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1. Introduction

The main aim of this project is to develop a set of requirements and design principles for the use of virtual actors in Shared Virtual Learning Environments (SVLEs). This set of requirements will address issues of pedagogy and interaction (e.g. how can actors be used to structure a learning session in virtual environments) rather than underlying technological concerns (e.g. what computer graphics techniques best suit the generation of the actors). There are three main problems facing the development of such a set of requirements.

Firstly, a large range of variables is involved in the construction of SVLEs. This makes it difficult to isolate which design decisions are responsible for the overall effectiveness of the environment. It is also difficult to identify the inter-play between various factors (e.g. the effects that usability issues have on pedagogic issues). Secondly, there are not many examples of research on the use of "real-world" SVLEs. Thirdly, the current immaturity of the technology underlying SVLEs means that the full potential of the SVLE medium cannot be exploited (e.g. the range of interaction and image quality is often limited).

A possible solution to the first problem is to follow a phased, iterative approach [Boyle 1997]. This will involve the construction of a SVLE in a series of distinct, manageable phases. Such an approach will allow the variables involved in design to be isolated and will also help to identify the effect each has on the effectiveness of the environment. This in turn will simplify the derivation of design principles based on these variables. Comparisons will also be made between the environments constructed during each phase of the project.

To address the second problem it was decided to make use of a complex "real-world" case study. One such exemplar is provided by the work of Manchester Museum's Education Service [Mitchell 1997]. The primary emphasis of a school's visit to the Museum is to enable children to study and work with real artefacts. One particular strength of the Museum is its collection of ancient Egyptian artefacts from the pyramid builders town of Kahun. This collection plays a major part in the Education Service's teaching. It is proposed that the example SLVE be based around this collection.

To cope with the third problem it was decided to initially develop prototypes using a more mature technology (two dimensional (2D) multi-media). This would allow certain requirements of a SVLE to be studied without the overheads of constructing a full system. Later in the project these requirements will be used to construct a prototype using SVLE technology. The evaluation of this SVLE prototype will allow the validity of the requirements to be tested.

2. Project Phases

The project has been divided into three main phases. Each phase will involve the implementation and evaluation of a prototype SVLE. The phases will differ in terms of the degree to which the environments are populated by virtual actors. In addition, the phases will differ as to whether the interaction is external to the environment (i.e. between the users in the real world) or internal to the environment (i.e. between virtual actors within the environment).

In the first phase an environment is being developed which is "non-populated". This contains individual objects that the user can interact with but do not contain any virtual actors. Thus the interaction between users (e.g. a discussion between a student and a teacher about an object) will be external to the environment.

In the second phase there is a transition from a "non-populated" to a "semi-populated" virtual learning environment. The second phase will examine the use of virtual actors in the virtual learning environment. These virtual actors will adopt the role of a knowledgeable participant (e.g. a teacher or museum guide). These actors will either represent a real person (avatar) or an automated guide (agent). The virtual actors will be extra elements added to the environment constructed in the first phase. There is also a transition in terms of the interactions taking place from external to internal.

In the third phase a virtual actor representing the student user will be added to the environment from the second phase. This environment can be seen as being a "fully-populated" shared environment. It will contain virtual actors representing the student, other students, as well as knowledgeable participant. This will allow collaboration and interaction which can be seen as internal to the virtual environment.

An iterative process of formative evaluation will be followed throughout the project. This will indicate refinements that have to be made to the environment, as well as to the set of requirements that have to be followed for the construction of a SVLE. Observation of students and teachers using the environment will be conducted to identify patterns of interaction between users and distinguish the learning situations that occur. In addition the usability (e.g. how easy is it for the users to operate in the environment?) and pedagogic effectiveness (e.g. can the teachers use the environment effectively to accomplish their tasks and do the students learn?) of the environment will be studied.

3. Current Work

The SVLE is based around artefacts from the Kahun collection at Manchester Museum. A set of criteria has been developed for selecting artefacts from the collection for inclusion in the virtual environment. These have been based on a variety of sources including: National Curriculum requirements; English Heritage guidelines for the use of objects for learning; and interviews with Egyptologists, teachers and children. Finally, artefacts were chosen that would allow a range of interaction and learning situations to be studied. The five artefacts selected for inclusion in the SVLE are: *senet* (a board game for two players); *shaduf* (a device used for raising water from the river); the *mould* (used for creating mud bricks); *weights* and *measures* (cubit); and a *mirror* [David 1986].

A prototype senet environment has been constructed using 2D multimedia technology (Micromedia Director). This allows two users to move pieces on the board and access instructions on how to play the game. A pilot evaluation with the general public has been carried out over four days during Manchester Museum's activity week. Observations have been carried out of interaction patterns between pairs of children. These initial findings are being used in the design of experiments under more controllable conditions. Samples of the work can be accessed at: http://www.doc.mmu.ac.uk/RESEARCH/Kahun

4. Conclusion

A phased, iterative approach has been proposed for studying requirements of SVLEs. The phases differ in terms of the degree to which environments are populated by virtual actors and also the degree to which interaction takes place external to or internal to the environment. This approach allows:

- isolation of the range of variables involved in virtual learning environments into phases
- implementation and evaluation of the environment in small manageable phases
- analysis of the outcomes of the evaluations and linkage to requirements for subsequent phases.

The final outcome will be a set of requirements and suggestions for the development of multi-populated VLEs. The phased approach allows these principles to be studied in a systematic manner from the baseline case (the traditional school visit) right through to a fully populated virtual environment.

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Problem Based Learning in Medical Education: Designing and Evaluating a Multi-User Application for the German Curriculum

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Introduction

*P*roblem-*O*riented-*L*earning Groups (*POL*-Groups) have become part of the optional curriculum at several German Universities. *POL*-Groups let students learn in a problem and case-based way within small tutor guided groups. The benefits of the *POL*-format are to foster active student inquiry and independent learning with focus on clinical problems.

This article describes an approach to put the German *POL*-format into the web-based application "*Kasus Online*" which allows a group of students and a tutor an asynchronous computer supported information exchange on a case-workup. "*Kasus Online*" bases on parts of concept and screendesign of the developed stand-alone application "*Kasus interaktiv*" [Elsner 1998]. The application is implemented using HTML-Code, Java-Servlets and CGI-Scripting. A platform-independent and universal access via the Internet is therefore possible.

Attempts to incorporate computer based training into problem based learning have already been made with good results [Schor 1995] [Coulehan 1995] and are just in progress [Nuthalapathy 1998].

Application Description

To use "*Kasus Online*" 3 students and 1 tutor form a group working on a case. The students' identities are kept confidential via an alias. Depending on difficulty and complexity a case is divided into several sessions. Each student and the tutor can login to a case session independently and as often he/she wants. Group communication is achieved by a built-in messaging system. A new session will be entered if all students and the case tutor agree on proceeding with the case.

After the login to "*Kasus Online*" a student first reviews the information provided in a session independently. By brainstorming he/she will then comment the given information/clinical findings for his/her peers. All given comments will be displayed in a kind of newsgroup next to the case information it refers to. To discuss certain topics and peers' opinions further messages can be added to every item of this newsgroup.

Basing on the subjects of this discussion each student will try to extract relevant information and formulate in two seperate datasheets:

- A differential diagnostic workup for the case.
- Specific learning issues/problem questions for the case.

This input is then compiled for a "case learning center" that can be reviewed by the other users and the tutor at a subsequent login. In the "case learning center" every student can review and comment all compiled information sheets. If the group decides to proceed to the next case session, all "case learning center" information will be saved for a review at the end of the case.

As the case progresses and new case information is given, the students will have to set up new statements and discuss findings for their differential diagnostic workup. Students also get the chance to print a list of all piled up problem questions. They can then review their books and study material to answer the questions during the next login for their peers.

The role of the case tutor is to guide the students during their case-workup and forward them to the next case session if they have finished analyzing the given information satisfactory. He/she gives feedback to single students or the group and helps to get the right learning issues and an adequate differential diagnostic case-workup. For this task a "Gold Standard" of the case-workup will be provided for the tutor.

At the end of a case the students will have the chance to compare their lists in each session with the "Gold Standard" and value their findings in the single sessions of the case.

For the application's screendesign the guidelines developed from evaluating the stand-alone application "*Kasus interaktiv*" are used. The analysis of n=248 questionaires provided information on user-friendly and functional Screendesign for a case-based educational application.

Evaluation Description

In contrast to normal *POL*-Groups the potential benefits of the "*Kasus Online*" application lie in its time-independent and universal accessibility. Further the e-mail based messaging system has the potential to take back group dynamics and therefore improve the written self-expression of the *POL* members [Coulehan 1995].

In contrast to stand-alone CBT-Tools "*Kasus Online*" adds the dimension of group discussion and participant identified learning issues and therefore can encourage students' accountability and independent thinking.

To get objective objective study data on the advantages a *POL*-Group can take out of Web-based *POL*-Learning a cross-over study designed for the evaluation of CBT applications will be used [Auhuber 1997]: at the University of Leipzig 24 *POL*-experienced students and 4 case-tutors will evaluate "*Kasus Online*" versus normal *POL*-Group Session learning.

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The Use Of Interactive Multi-Media CD-ROM To Facilitate Health Behavior Change

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Background

Current technological improvements in the area of computer assisted instruction (CAI) and declining production costs allow health professionals to consider new options for innovative health education/health promotion interventions. The advantages of CAI over more traditional interventions, such as didactic lectures or informational brochures, include immediate feedback, increased interaction between user and the instructional material, user control which allows random access to the instructional sequences, presentation of multiple real life simulations, and a learning atmosphere of anonymity and confidentiality, which is especially important for topics related to human sexuality. However, CAI remains underutilized in health education at a time when health education programs require not only cost-effectiveness but also behavior change as an end outcome.

Screening and early treatment of abnormal cells can reduce the incidence of cervical cancer by more than 90%. In the US, considerable gains have been made toward mass screening, although many women continue to avoid screening or do not follow-through with treatment. Traditional health education programs which focus upon written materials have had limited success in increasing screening adherence in this population. Our goal for this study was to develop and evaluate a theory-driven program targeting behavioral change. The purpose of this paper is to illustrate an example of the transfer of theory to practice using CAI, or CD-ROM in this case, describing project development strategies and issues from the field.

Project Description and Development

"*Taking care of Business: An Inside Look at the Pap Smear*" is a theory-based multi-media educational CD-ROM that was developed to increase young women's regular Pap smear screening behavior. Through the use of short story scripts, role models, and demonstration (both animated and video-taped procedures), young women learn about the importance of regular Pap smear screenings, personal risks for developing cervical cancer, the meaning of abnormal Pap smear results, dealing with abnormal results, communication with doctors and nurses, and sexual practices that impact the transmission of human papillomavirus (HPV), the virus which is causally-related to about 90% of all cervical cancer cases.

The CD-ROM is divided into six sections, each of which provides scenarios that can be understood independently: Scheduling your Pap Smear, Doctor-Patient Communication, Life Cycle of a Cancer Cell, Anatomy of a Pap Smear, Understanding your Test Results, and Risk Factors for Cervical Cancer. This format allows the user to review only the sections she believes to be personally relevant, and to choose the order in which she views the different 15-20 minute sections. To ensure validity within the program, much of the content and all of the video vignettes included in the CD-ROM were obtained through individual interviews and focus groups with women from a variety of ages, ethnic groups, and educational backgrounds.

The story script was developed within the framework of Social Cognition Theory, with particular attention to cognitive processes that impact affective responses. Moreover, a strong emphasis was placed upon strategies for empowerment and skill building specific to this health issue. Social Cognition Theory is a theory of interpersonal health behavior that addresses the cognitive, emotional, and behavioral dynamics that influence health behavior change and provides implications for intervention. Some of the constructs of this theory include environment, situation, behavioral capability, expectations, expectancies, self-control, observational learning, self-efficacy, reinforcements, emotional coping responses, and reciprocal determinism [Baranowski, Perry, & Parcel 1997].

A plethora of research exists about cervical cancer and theories of compliance to screening. We synthesized information both from the literature and from interviews with women. Our original intent was to gather women's stories to illustrate educational features in the CD-ROM, but it became clear to us that experiences surrounding cervical cancer screening are emotionally charged, that large gaps in women's knowledge exist, even among women considered "compliant", and that women rarely share these experiences with one another.

We were faced with the problem of educating women about many facets of the experience – terminology, assertiveness, scheduling, interpretation of a wide range of results, etc. Moreover, a major component of our work became learning how to address the risk factors, particularly a sexually transmitted disease for which most women have not considered themselves at risk. We chose a variety of tactics – humor, interviews that included positive and negative experiences, role models, animation, and a physician and nurse interviews providing guidance. .

Lessons from the field

The lessons from the field included common CD-ROM logistical challenges such as length and interface issues, but the more interesting features involved the cognitive-affective components of the content. We conducted focus groups following the first iteration of the CD-ROM. The focus groups made the implicit obvious; we were dealing with the great taboos of death and sexuality, and more specifically, sexually transmitted diseases.

The narratives and interviews contained within the CD-ROM accomplished one objective, which was to access the viewer's emotions and memories, but the intensity of the women's response was unexpected. The scripts accessed the women's own memories and meanings, which had not been necessarily positive nor previously supported. Gender issues were pertinent, and they extended beyond the balance of represented role models in the CD-ROM.

We learned that we underestimated the interest levels of our audience. Our initial efforts sought to entertain women to hold their interest and "soften the blow" surrounding the nature of the risk factors. An overarching goal-based scenario tied the components together. Many told us that they did not need to be entertained on this subject, and that the content itself could be intriguing. Feedback to us also confirmed the importance of actual women's experiences to support the information. Professional actors were not necessary. More important, we learned that new and complicated information carrying an emotional charge needs to be carefully positioned to facilitate motivation and allay frustration.

Further evaluations include continued process evaluations and testing of theory with impact evaluation. In addition, the focus group experience suggested to us that the women valued the opportunity to discuss their reactions and debate and integrate the new knowledge. This observation will also be addressed in the evaluation.

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Video Teletraining: Improving the Effectiveness in a Civilian and Active Duty Learning Environment.

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Introduction

Over the last decade, new technology has been rapidly changing the way individuals are trained. This is especially evident in the United States Military where budget problems continue to plague the Department of Defense. As a result, new instructional delivery methods are being implemented to reduce the millions of dollars spent on airfare, lodging, and food associated with training military and civil service employees [Belcher 1997]. Several studies have attempted to evaluate the use of Video Teletraining (VTT) systems consisting of sites linked with two-way audio/video communication in the lecture-based classroom [Belcher, 1997; Rupinski, 1991; Rupinski & Stoloff, 1990; Simpson et al. 1991; Wetzel et al. 1994]. The findings of previous studies were that student attitudes and performance on examinations were comparable in the originating and remote classrooms [Wetzel et al. 1994; Worley 1991]. However, most of the research involved low cognitive level classes containing limited case studies and group activities [Bramble & Martin, 1995; Wetzel et al. 1994. The amount and type of interaction and learner feedback has been found to be instrumental in determining the effectiveness of distance learning [Moore & Kearsley 1996]. The live interactive nature of VTT requires that instructors encourage the participation of remote-site students and attend to their needs to obtain help and resolve questions [Simpson, 1993]. Students perform best when their instructors inspire them to take an active role in their learning process [Rosenshine & Stevens 1986; Sullivan & Higgins 1983].

The Naval Facilities Contracts Training Center (NFCTC) is undergoing several course conversions to include remote sites by means of VTT technology. Every course taught at NFCTC requires active student participation in case studies, workshops, and macro exercises. This paper focuses on improving the interaction and instructor effectiveness when VTT is used as an instructional medium for the specialty course, Facilities Support Contracts. Research question: What are the skills and techniques needed by instructors to be effective in interacting with learners in the VTT learning environment?

Methodology

A multidimensional triangulation approach was used in developing an instructional paradigm for ensuring effective learner interaction for the VTT learning environment [Patton, 1993]. The sample size (total n = 94, VTT students = 47) had an average of 7.32 years experience in the acquisition workforce with sixty-four percent having a Bachelor's degree and twenty percent had completed a Master's degree. The class was 59% male with an average GS grade of 10.69/15. The following techniques were used to asses the instructor's skills and techniques in optimizing student interaction: student and faculty interviews, observational recordings of interaction, end of course questionnaires (4 point Likert Scale), VTT questionnaire, and daily feedback forms. Both questionnaires had a 99 % response rate. Four different course offerings were compared, two VTT and two traditional. Each of the course offerings had the same experienced instructor.

Findings

Contrary to the literature, the traditional classroom offerings had a higher overall student satisfaction rating than the VTT offerings, (3.75, 3.33 respectively with $p < .05$). Although, analysis of the final exam grades shows that the students attending the VTT offerings had slightly higher scores than students in the traditional classroom (VTT = 89%, Traditional = 87%). When looking at the final exam grades for the VTT offerings, there was a significant difference ($p < .05$) in the means between originating and remote sites (94% vs. 87.5% respectively). There was also substantially more student-instruction interaction in the originating

VTT site than in the remote sites 7.45 vs. 4.38 ($p < .05$). Regression analysis showed that location was a significant ($p< .01$) predictor of the dependent variable, exam grade, when the target audience was controlled. Other predictors that entered at the $p < .01$ level were the following: VTT technical ratings, cumulative instructor performance and skill ratings, "Did being randomly called on in the classroom help your learning needs?" and usefulness of Picture in Picture technology in meeting student's learning needs.

Table 1: Group Statistics For VTT Offerings

VTT Questionnaire Variables	Offering	N	Mean	Std. Deviation
Overall Satisfaction	1st	23	6.0435	2.0277
	2nd	27	6.9074	1.9711
Recommend to coworker	1st	25	2.8400	.8505
	2nd	28	3.2143	.7868
Exam grade	1st	32	88.0000	8.9009
	2nd	23	90.0870	9.8254
Random Quest. helped	1st	25	2.8000	.8660
stay attentive**	2nd	28	3.3929	.5669
Random Quest. helped Learning*	1st	25	2.7600	.7789
	2nd	28	3.2500	.7005
SCHEDULE**	1st	25	2.9200	.7024
	2nd	28	3.5000	.6383

** ($p < .01$) *($p < .05$)

Interviews with the students and instructor from the first VTT offering produced several beneficial action items for the second VTT offering. A majority of the students felt that the interaction was minimal, even though there was forced interaction by the instructor randomly calling on the students. When the students from the first VTT offering were asked if they could remember anyone else's name at another site, only one student out of thirty-two could recall another student's name. The student said she could remember him because "he was called on more than most." In the first VTT offering no icebreaker was used. The students only stated their name and current job position. In order to rely less on forced interaction and foster more personal connections, an extensive icebreaker was utilized for the second offering. Forty-five minutes were dedicated out of the 2nd VTT offering for everyone to share their four "C"s of their personality. The instructor noticed a considerable increase in the amount of natural interaction between the remote sites in the second VTT offering. The students in the second VTT offering on average rated feeling comfortable using the VTT equipment one day earlier ($p < .05$). Their acclamation and comfort level may have given rise to the increase in student interaction. In fact, the only incidence of negative written/verbal comments from the second offering came from the inability of being recognized to speak quicker. A majority of the students from both VTT offerings came in with low expectation levels and somewhat negative attitudes. When the students were asked on the VTT end of course questionnaire, "If given a choice would you choose a VTT classroom setting over a traditional setting?" fifty percent of the students indicated a favorable response (3 or 4).

Conclusions and Implications

Even though the overall satisfaction averages were lower for VTT than the traditional classroom offerings, the student interviews supported a positive response to the VTT learning milieu. The VTT questionnaires indicated that 78% of the students had favorable responses to the question, "Did being randomly called on in the classroom help your learning?" The student interviews concurred with all of the students saying that they recognized the value of the instructor's technique. Detailed icebreakers may take a long time to do in the VTT learning environment, but it should be helpful in promoting natural interaction in the classroom. Table 1 shows a trend that the icebreaker may have increased student feedback ratings for all variables. Ostensibly, the comfort and preparedness level of the instructor will have an impact on the effectiveness of the VTT learning environment. The instructor noticed that her VTT preparation efforts and modifications in the second offering contributed to her feeling that she was teaching in a traditional classroom setting. Continued research should be completed to explore how the learner interactions in the VTT learning environment are different than in the traditional classroom setting. A similar study with a larger sample size may lead to more variables in Table 1 being statistically significant.

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Using Interactive Multimedia for Assessment

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Abstract

This paper makes a case for the use of Interactive Multimedia (IMM) product in assessment in schools. By drawing upon the ability of this media to simulate environments and to accept many different kinds of input from the user, it is proposed that IMM can perform valid assessment of classroom learning. Further, through careful design, it can provide valuable insight into the reasoning processes of students.

Assessment is still an important issue in education and in this paper I explore the potential of IMM to provide valid and authentic assessment, using assessment in science as an example. All of the useful functions of assessment (monitoring outcomes, making teaching more effective...) are based on the assumption that the assessment methodologies used are valid. Assessment in science has usually been teacher developed dealing with the taught curriculum, backed with occasional externally developed assessments at exit points from the system.

Traditionally this assessment usually involves pen and paper tests, mostly involving multiple choice questions, which focus on atomistic knowledge - that is, knowledge portrayed in parts, out of context and unrelated to the body of knowledge as a whole. "Decomposition of important knowledge and skill into disconnected bits and the decontextualisation from meaningful situations...virtually ensure their inability to validly assess complex activities" (Resnick, 1994, p523). This method of assessment is widely considered to have low validity when it comes to determining what students know about the topic being assessed. Students usually know much more than can be measured this way and multiple choice science tests do not determine factual knowledge particularly well. In science more valid assessment methodologies should provide opportunity for assessing science skills, be carried out over time, include problems with missing information to allow students to critique the problem and allow students to make up their own questions (Raizen, Baron, Champagne, Haertel, Mullis & Oakes, 1989, p63).

In general, to become more valid, assessment needs to be changed from traditional multiple choice methods (which focus on recognition, recall, are quick, atomistic, measure surface learning, are based on course objectives, and are conducted out of context) to assessment focussed on students' own conceptions, which is holistic, measuring deep learning and long lasting knowledge, is linked to learning theories, is conducted in context, allows students to express interpretations and is authentic. Interactive multimedia assessment scenarios would have authenticity due to the ability to portray relevant contexts and to provide test items requiring a variety of types of student responses.

The potential to improve assessment by using the computer's interactive and multimedia capabilities to the maximum can lead to the use of many creative testing strategies. For example, constructed response items based on simulation techniques which offer students tasks which are more realistic and closer to those they encounter in everyday life and in education and work settings are likely to be more authentic and valid. It seems certain that the face validity of such items is greater; that is, the perception among subject-matter experts and test-takers that such test items are better measures of the test objectives than corresponding paper-based multiple choice items. Although such items may measure different skills than their multiple-choice counterparts (Ward, Frederiksen & Carlson, 1980), they offer a "window" into the processes used to solve particular problems (Birenbaum & Tatsuoka, 1987) and they may better predict some aspects of educational performance (Frederiksen & Ward, 1978).

The demonstrated product is a work-in-progress. In its present state it simulates a jarrah forest located in the south-west of Western Australia. Dealing with the topic ecology it allow students to interact with the program and, through a series of graded scenarios, allows them to express their understandings in this topic area. A teacher in a classroom could allow a student to interact with the program with the program recording a variety of responses which would allow the teacher to gather a good portrayal of the student's understanding. Such portrayal is likely to enhance classroom practice and have relevance beyond a particular classroom.

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Designing a Classroom Management Learning Environment: Case Exploration and Performance Support Tools

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Abstract: This paper discusses new features in hypermedia case studies that are designed to improve the transfer of knowledge and skills to actual job situations for teachers. The case studies embed problem solving activities into authentic case situtations and provide opportunities to build multiple perspectives. Prompts are inserted into the program to support reflection and to provide expert models for evaluating decisions. Performance support tools are included to facilitate learning and performance within the hypermedia environment and for later use in actual job situations. The research design is described for determining the use and effectiveness of these new design features as well as the actual impact on children when the tools are implemented by teachers.

1 The Problem

Teacher education involves the development of knowledge and skills and their application to actual classroom settings. The weakest link in preservice teacher education is the translation of knowledge and skills taught in methods classes to performance skills in the classroom (Rule & Salzberg, 1988). Reform efforts in teacher education have recently focused on expanding opportunities for preservice teachers to gain experience in classrooms via increased field placement and involvement in multimedia simulations based on authentic classroom scenarios.

Hypermedia case studies are simulations that provide complete information, expert modeling, and challenges to be solved by the user which mirror those to be faced in teaching roles. Hypermedia case studies go beyond traditional simulation models by allowing learners to take control and responsibility for their own learning through nonlinear access to information, problem generation, and problem solution. Hypermedia cases are active learning environments in which users explore case scenarios through video and audio, gather contextual information, access foundational information, listen to commentaries by experts, define contextualized problems, and revise solutions based on prompts and scaffolds.

Empirical data has recently emerged on the effectiveness of learning through hypermedia cases has been documented. Despite differences in class rank, prior experience with computers, prior teaching experiences, or different learning styles, learning outcomes have been significant and equivalent across users (Fitzgerald & Semrau, 1998; Fitzgerald, Semrau, & Deasy, 1997; Kraus, Reed, & Fitzgerald, 1997). Findings demonstrate that users with differing learning styles utilize hypermedia case environments in different ways, yet overall engagement time and outcomes are equivalent. Based on analyses of user records and on-line products, two concerns must be addressed in improving learning from hypermedia case studies: 1) engaging users in reflecting on their solutions, and 2) supporting users in transferring knowledge and skills to actual job situations (Fitzgerald & Semrau, 1998).

2 Instructional Design of Program

Instruction and Management in Behavioral Disorders is the third title in an interactive training series for use in teacher education programs. Three of the programs utilize a hypermedia case study format, and the other two programs provide skill training in classroom observation.

The program is based on case study scenarios in which the user takes the role of a teacher in planning for three different youngsters with significant behavioral and emotional problems in classrooms. Figure 1 displays the main menu screen for the case study program *Martelle*. Each program has the same overall structure and learning activities.

Figure 1. Main Menu Screen of Program

The computer program contains computerized background information on the youngster and school policies, a resource information base related to behavior interventions, a series of problem solving activities based on job responsibilities, scaffolds for the user related to the activities, and 35 template tools for creating plans for the youngsters. Material on an accompanying Level III videodisc includes videos to observe the youngsters in authentic settings, audio interviews with adults with information about the children, mini-presentations on specialized curriculum, and commentary by experts in the field. The resources and template tools are designed as stand-alone applications for users to have following successful completion of the case study activities. Thus, a direct bridge is provided to support the application of knowledge and skills to real-world use.

Cognitive Flexibility Theory and Multiple Perspectives

The overall design for the hypermedia case studies is based on *Cognitive Flexibility Theory*, one of the constructivist theories which emphasizes the real-world complexity and ill-structuredness of knowledge. Ill-structured problems are complex and require cognitive flexibility for understanding and decision making (Spiro, Coulson, Feltovich, and Anderson, 1988). A person demonstrates cognitive flexibility when able to selectively use knowledge to adaptively fit the needs of an ill-structured situation. The computer-mediated activities provided through these materials strive to stimulate cognitive flexibility to enable the learner to construct his or her own knowledge based on analyses of complex and irregular situations, to view situations from multiple perspectives, and subsequently utilize that knowledge in problem solving activities. See Fitzgerald, Wilson, and Semrau (1997) for a detailed explanation of hypermedia design based on principles of cognitive flexibility theory.

Performance Support Tools

The nature of preparing workers to perform and/or understand work tasks is changing dramatically. Given the vast amount of information available to workers, it is increasingly important to provide people efficient and effective ways of receiving new information. Through performance support tools and resource databases, workers can have constant access to crucial information and guidance while they are performing tasks. This information may be accessed in different ways, depending on the needs of the worker, creating a cycle of continuous improvement and training (Laffey; 1995; Barker, 1997). Based on the axiom "right time, right place, right form," this program incorporates two new features for hypermedia design— access to on-line resource information and performance support tools for present and future use.

3 Illustration of Key Interactive Features

Problem Solving Activities

Prior to creating plans for the child, the user explores the case study for information, observes the child, gets input from others, assesses the child's setting, and goes through a behavioral consultation interview to define problems.

In this Plan Intervention component of the program, users develop instructional and management plans for the identified problems. Plans are entered into a template form andsaved for later retrieval.

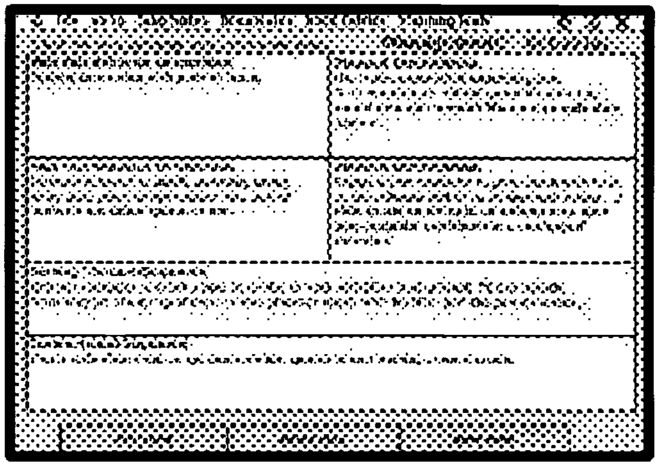

Figure 2. Management Planning Template

Reflective Prompts

Prior to reflection and revision of previously completed plans, the user listens to experts discuss intervention programs from multiple perspectives to encourage the user to broaden plans to settings beyond the classroom.

In this Evaluate Plans component of the program, users can view previous plans at the top of the screen and enter personal reflections into a notepad at the bottom of the screen. These entries are attached to the original plans during this revision step.

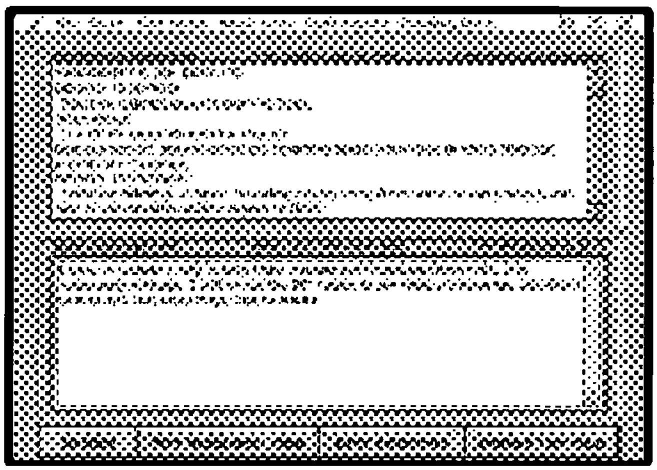

Figure 3. Notepad for Entering Reflections

A series of four prompts are provided for management plans and four prompts are provided for instructional plans. An example prompt is: *Have you involved this child in self-management?* Users must evaluate whether their plans meet these criteria by responding "yes" or "no."

If the user enters "no," the notepad at the bottom of the screen opens up and requests the user make adjustments. These adjustments are added to the original plans and personal reflections for documentation.

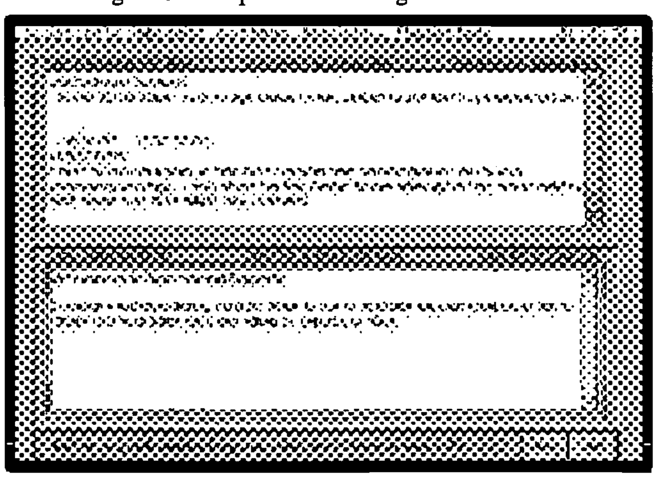

Figure 4. Notepad for Entering Adjustments

Performance Support Tools

The resource information base provided in the program contains information on intervention procedures covering a wide variety of techniques offered in 15 categories, ranging from self-monitoring plans to classroom rules to conflict resolution.
Each category provides procedural information, examples of plans, tips for implementation, and references.

Users can search for information using the Find tool or by navigating the structured database. The Resources are linked to 35 template Tools on the pull-down menu bar.

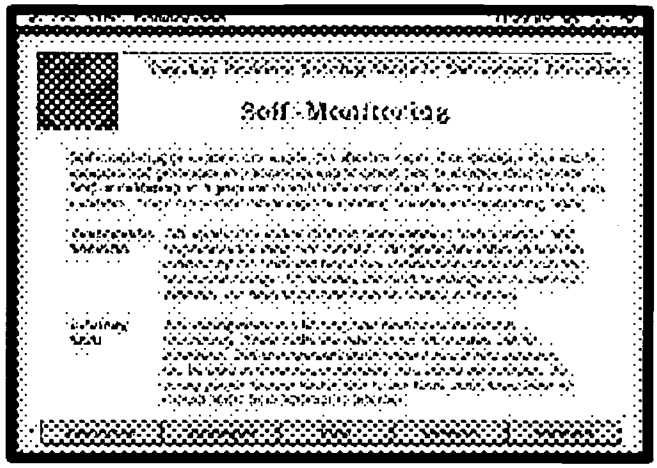

Figure 5. Sample of Resource Information Page

Each intervention category offers 1-5 templates for preparing instructional and management intervention materials. The templates are designed for generic use and adaptable for children of different ages and ability levels. Templates for younger children allow the user to select graphics from a graphic library and create very simple forms.

Each of the templates is illustrated in the resource information base to provide models. The 35 template Tools are linked to the Resources on the pull-down menu bar.

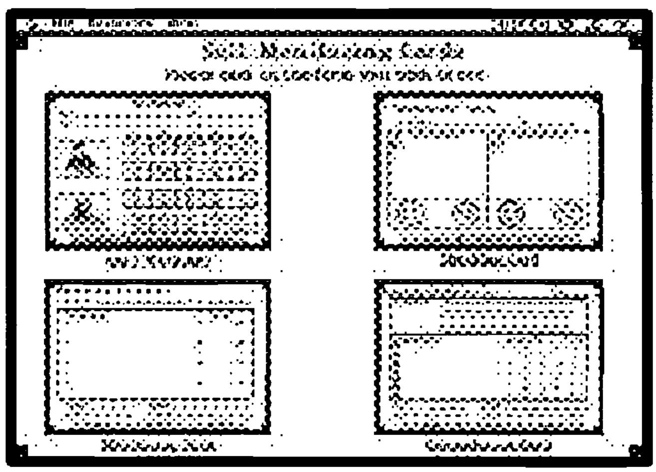

Figure 6. Self-Monitoring Template Choices

To create materials, users simply click on "hot" words or entry lines and input their plans. The template allows the teacher (or capable student) to create personalized intervention materials to support the child in successful behavioral change.

From the template screen, plans can be stored to disk and printed. The user records maintain a cumulative file of entries, time stamp each entry, and log the user's name and time spent in the Resources and Tools.

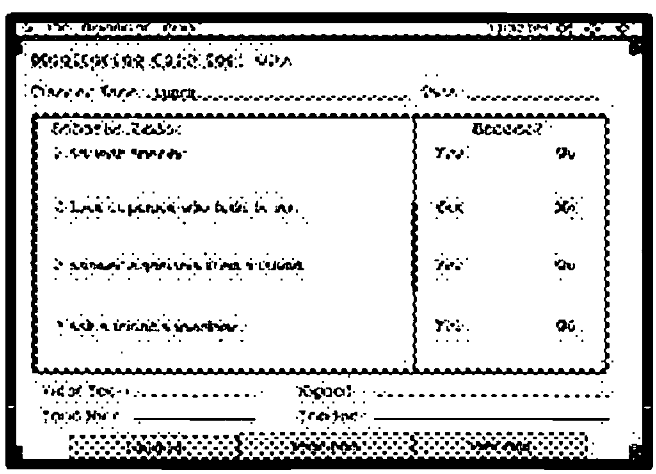

Figure 7. Sample of Completed Monitoring Card

Audit Trails and User Records

The program time stamps the options in the sequence selected by the user. By computing the differences, it is possible to determine the how long the user engages in each section of the program. This information allows the researchers to evaluate the use of an on-line resource component in a performance support tool.

The program also saves to disk all content the user enters into a template which provides a record for the user.

Open Tools	12:29:50 PM
Open Resources	12:31:19 PM
Self-Monitoring	12:30:26 PM
Open Tools	12:40:02 PM
Monitoring Card for:	Mike
Class or Time:	Lunch
Date:	October 5
Behavior 1:	Sit with friends.
Behavior 2:	Look at person who talks to me.
Behavior 3:	Answer a question from a friend.
Behavior 4:	Ask a friend a question.
Tara Teacher 9/21/97	End Tools Session 12:45:40 PM

Figure 8. Audit Trail and User Records

4 Research Design

The program is being implemented in three sites during the 1997/98 year to determine its effectiveness as a personal productivity program for teachers. In each site, information on users will be gathered for use as independent variables to enable comparisons of usage and effectiveness across users with different levels of prior computer experience, prior teaching experience, computer anxiety, and ease of access to computer work stations. Audit trail records will be compiled to determine the engagement time of users within each work session and across time, the frequency and duration of accessing resource information within the process of preparing intervention plans through the templates, and user pathways through the materials. The effectiveness of the program will be measured by holistic scoring of the quality of intervention plans created for children within each type of procedure and across time, as well as measuring change in knowledge via a pre-and posttest. A user satisfaction questionnaire will be administered to compile feedback and assist in determining how different users value the various features and tools within the program. Impact on children will be determined by looking at change in children's behavior correlated with implementation of plans by teachers.

Sample Group	Preservice Teachers	Practicing Teachers	Preservice Teachers
Implementation Variables	Resources and Tools	Resources and Tools	Resources and Tools and Case Studies
Comparisons			
• Engagement Time	x	x	x
• Utilization Patterns	x	x	x
• Knowledge Change	x	x	x
• Quality of Plans	x	x	x
• Case Study Utilization			x
• Quality of Plans for Case Students			x
• User Pathways in Hypermedia Case Studies			x
Individual User Case Studies of Implementation		x	

and Behavior Change Impact on Children			
Satisfaction Feedback	x	x	x

5 Summary and Implications

The design of this hypermedia program based on cognitive flexibility theory builds knowledge and skills that go beyond performance within the hypermedia learning environment. Instead of relying on feedback delivered through the program or instructor discussion of the case studies, a series of reflective prompts are placed within the program activities. These prompts support metacognitive reflection and provide expert models to learn to evaluate one's own decisions.

Increasingly, software in the work environment is becoming task-focused to support learning and performance through electronic performance support tools, including on-line references for instant access to information, tools to carry out specific tasks, and help functions to enable the user to carry out a task at the moment of need. Instead of learning to do a task within a piece of software and later using a different software program for a job task, this hypermedia program is designed for integration into actual job settings, supplying the resources as well as the tools.

In that professional practice involves judgment and wise action in complex, unique, and oftentimes uncertain situations, learning to pose and solve problems is central to the role of educators. While research outcomes with the other hypermedia case studies included in this series have been extremely positive, no studies to date have looked at transfer of knowledge and skills to actual job situations and impact on children, the ultimate measure of value. It is hoped that the combination of features of the program—the case study format, a design based on cognitive flexibility theory, embedded prompts and tools, and ongoing access to resources will help bridge the gap between preservice teacher education and performance of teachers in the classroom.

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Course Management and the New Technologies

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Introduction

As a member of the teaching faculty at Mount Royal College (MRC) I have been involved in the educational uses of computers for almost twenty years and have experienced the various waves of expectations that each computer enhancement has brought, along with the attendant disappointments. Andrews [Andrews, 1997] has outlined two models of teaching/learning: (1) the traditional teacher centered (sage on a stage), and (2) the learner centered, teacher as mentor (guide at the side) model. Model 2 in Andrew's view requires greater use of technology. I have always approached teaching/learning from model 2, with or without technology, and I have viewed the computer simply as a tool, that, if used wisely could improve the productivity or reduce the costs (primarily in time) of performing the duties associated with this approach to teaching and learning. In this I have followed an evolutionary, not a revolutionary, path [see Ehrmann, 1995] to the integration of computers in course delivery. This paper will outline the progress of this approach at MRC using computer managed learning (CML).

The Problem

Facilitating student learning with the use of computers has been difficult for many faculty for a number of reasons well documented in the literature. With all that faculty already have to do, computer use became just one additional thing to learn. Yet there has been a wave of production of multimedia course curriculum materials by universities and colleges, private entrepreneurial firms, traditional publishers, and others. However, a problem that has become apparent is how can faculty implement these materials in a systematic and easily administered way within a course framework that makes it productive in accomplishing the goal of directed learning. In order to realize the full value of all of the interesting and useful curricula materials available they need to be placed in a logical ordering with appropriate student assessment in order to measure if learning is truly being facilitated. An appropriate CML environment or "shell" needs to be applied that can deliver various curricula in a properly structured, sequenced, and integrated course.

The Goal

The advent of computer managed learning (CML) created the possibility of structuring, directing, and assessing students in an orderly manner. The first generation of CML programs were very effective but limited in the type of material and its presentation that could be incorporated. Our current goal is: (1) to maintain the value that early CML added to computer uses in the delivery of course material, assessment of students' performance, and the record keeping for a large number of students; and (2) additionally provide the shell to incorporate all of the curriculum innovations of recent years. The ultimate program will do all of this in an easy to use package that reduces the time and effort of faculty.

Our Experience

Success in economics requires that students achieve the ability to solve a large variety of numerical problems. For students to have the learning opportunities to do this entailed considerable time and effort for instructors in creating and marking assignments in addition to regular exams.

In 1986 we introduced a CML component into the introductory university-transfer economics courses at MRC. The purpose of this innovation was to provide problem assignment opportunities while using the computer to automate the delivery, marking, and record keeping functions. Subsequently, CML was implemented in all of the department's economics classes serving over a 1000 students a term.

The CML software used was supplied by Computer Based Training Systems which was taken over by Campus America. Later versions of this software were titled the Learning Manager System (LMS). We developed courseware in order to implement this software including testbanks of questions, study guides, course maps, and manuals. The testbanks included standard multiple choice, true and false, matching, short answer, essay, and problem questions.

All of these types of questions (except essay) can be computer graded, and the students' records maintained. The most useful question type for our purposes is the problem type. A typical question would have a programmed function that generates similar but different problems for each student. For example, the students would receive an assignment with standard economic problems to solve through calculations. Each student, however, would be issued specific numerical data for their questions with unique correct answers. Thus, students are encouraged to collaborate on approaches to solving the questions but cannot use other student's answers. Although a very simple system of computer application, this CML system proved extremely valuable to our students and faculty for over a decade of use.

Current Developments

To meet the above goal we are currently implementing a software package called The Learning Manager (TLM) developed by Campus America (USA) in their Canadian office in Calgary. This software provides the "super glue" that incorporates computer generated curriculum material into a course structure and maintains all of our previously produced testbanks, course maps, and study guides. The value of this approach needs to be emphasized. First, all the curriculum material a student needs to use on a computer is integrated in one place---the course map. Second, computer based materials are placed in this course map in the sequence determined by the instructor (curriculum designer) for maximum usefulness.

TLM will allow the department to continue providing the benefits of the CML component of the courses in economics with the same curricular materials while incorporating much more feedback and guidance to students than the old LMS system could. Additionally, TLM provides the management shell for the easy integration of current multimedia resources and the implementation of future production of computer based instructional materials as new course materials are developed by various individuals and outside agencies. This feature will hinder piecemeal development of curriculum that may be used exclusively by one instructor, or that may even "sit on the shelf" unused after being developed because of the lack of its integration into a cohesive system.

The approach taken at MRC illustrates how CML can work as a solution to the problem posed. First we establish the modules of the course and the specific objectives within each module. We have found that the chapters in the assigned text are best considered the modules for CML and then specific objectives created for the chapters (modules). In Economics the publishers generally provide a testbank of multiple choice questions which is adequate for the basic module self tests we incorporate in the course flow. Each module includes a study guide as well as a self test. The study guides include any materials than can be delivered on a computer. For example, we use the interactive tutorials supplied with the textbook by the publishers. Our students have found these chapter tutorials to be very useful. Yet, when we had this type of computer curricula placed alone on computers, students very rarely took advantage of them. When integrated into the CML course map at appropriate points they do get used. We have found that close integration of the CML materials with the assigned textbook works best for students. The self tests are used to assist learning the material and therefore include all kinds of feedback to the student. Our random data problem sets built up over ten years are integrated in the course as assignments with all of the advantages outlined above maintained. Individual instructors are on release time to develop specific computed based teaching materials and we will integrate these easily into the courses to be used by all of the students taking economics. In this way over a long period of time we have a system that grows and improves in assisting our students while promoting collaborative efforts within the department where each instructor (as well as all of the students) obtains the benefits of their colleagues efforts.

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Joint Learning Across the Ocean

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Introduction

For decades, ink and paper and the postal service have done an excellent job in helping bridge the ocean and aid in bringing about cultural understanding as well as assist in the difficult task of language instruction. Often, initial pen-pal contacts led to student exchanges and influenced lives in unforeseen ways. Today, e-mail has replaced ink and paper. The telephone ("reach out and touch someone," as the AT & T commercial states) allows for easy communication. Chat rooms on the Web are the virtual coffee houses for tech aficionados to exchange ideas. Unfortunately, the Web has also aided the perception that speakers of English do not need to know a foreign language (especially do not need to know German) because the world (and especially Germany) speaks English. Yet, to gain a real understanding of a foreign culture (e.g., German) the knowledge of the language is necessary. Learning about other cultures via English, if that is the only approach we take, is the academic equivalent of colonialism. The same is true for any serious text-based research. To be able to read originals is essential; a translation is always an interpretation.

This intellectual awareness of the importance of learning foreign languages is not enough of an incentive to attract students. A more pragmatic approach is needed. Students have to see how the knowledge of a foreign language directly benefits their professional careers. The nation-wide initiative "Foreign Languages Across the Curriculum" sponsored by the American Council on Education is based on this realization. Unfortunately, most small colleges do not have the resources and faculty to staff such programs. The project "Joint Learning Across the Ocean" addresses this issue and builds on the desire of most students to work on concrete projects. "Learning is doing" remains the pedagogical approach underlying the project. Instead of practicing language skills on tasks unrelated to the actual interests of students, the project tries to find new learning strategies with the help of technology to come closer to the ideal of interest-centered learning.

While the pilot project in German Studies is geared to students with an intermediate level of proficiency in German, follow-up projects include higher levels of language proficiency, for which other courses are being developed, e.g., a "Living German Writer/ Artist Series," and a series based on working with alumni in different fields in different countries.

Pilot Project in German Studies

General Considerations

Students in Intermediate German are seldom of one mind in regard to their interests, and rarely is their language competency homogenous. Over the years, various textbook readers have taken these facts into account; instructors have devised different strategies to deal with this problem; the Web has offered new avenues for flexibility. Based on the many ideas found in these approaches, the project "Joint Learning Across the Ocean" attempted to create a learning environment marked by such features as (1) a variety of topics based on the input and interest of the learners; (2) multiple levels of exercises; (3) a combination of didacticized and authentic texts; (4) individualization of the learning process.

These goals were achieved by linking three courses: (1) Landeskunde und Fremdsprachenunterricht (German Studies and Foreign Language Instruction), H. Rössler, Freiburg; (2) Intermediate German, D. Hoffmann, Colgate; (3) Theory and Methodology of College German Teaching, C. Fraser, Indiana University. The Colgate students wanted to improve their proficiency in German and knowledge about Germany; the students in Freiburg needed practice in preparing teaching materials and designing teaching tasks; the students at IU gained first-hand experience in observing an on-going teaching experiment, as well as evaluating both this process and the use of technology.

The Individual Steps of the Project

At the beginning, the Colgate students introduced themselves via the Web and presented the Freiburg students with a wish-list of topics. This meant that all students were trained from the outset in basic HTML and the use of a Web processor (e.g., FrontPage). In today's world, such a training is more than justified and does not detract from the actual goal of learning German. Just the opposite is true; the later use of technology in the German-learning context more than makes up for the hour "lost" in the beginning. After the initial HTML training, both courses, the one at Colgate as well as the one in Freiburg, established course Web sites in German at their institution which contained links to (1) the syllabus, (2) the list of topics, (3) the class list with links to private pages. As experience has shown, most students are addicted to the use of e-mail and like to create personal Web-pages with self-portraits. Therefore, it seemed logical to give them the opportunity to follow their inclinations in German. Their first contacts with their new e-mail pen-pals contained the URL of their private pages as well as the course URL. A first learning contact had thus been established and was then intensified with a first multi-point teleconference. Personal introductions as well as a first presentation of works-in-progress filled the hour whereby this teleconference also provided an opportunity for gaining experience with the new technology using slides, videos, computer, and the camera projection unit.

The creation of the Web-projects was accompanied by a flow of e-mail communication between the participants. This way, German was used in live situations, not only as an abstract exercise. The instructors were always kept informed through electronic copies and could make suggestions for content as well as grammar structures if they deemed it pedagogically necessary. On-line dictionaries and on-line grammars were always available. The final products comprised topics ranging from "Politics in Germany" to "Wine making" and "Fasnacht" besides introducing the Colgate students to Freiburg which is the home for study group programs by Colgate and IU.

Most of the final products had (1) a basic text (with many illustrations)) linked to additional materials and to other authentic German Web sites related to the topic; (2) a glossary with definitions in English and/or German (sometimes illustrated); (3) structural and content-based exercises (graded according to level) for the texts prepared by the Freiburg students as well as German Web sites; (4) answer keys to allow for feedback and independent study; (5) author page. Students learned quickly how to work efficiently with these materials by placing text and glossaries and/or exercises in separate windows next to each other on the screen. One of the distinguishing features of all projects was their freshness and relevance. They clearly showed their authors' enthusiasm and knowledge of all current aspects of German culture. Links to commentary pages allowing any reader to send suggestions for improvements to the authors were an additional aid in keeping the projects updated.

Learning as well as teaching took place on all sides (at Colgate, at Freiburg, and at IU) and was enhanced (1) through postings of questions and comments by the instructors on an electronic discussion forum; (2) international chat sessions; (3) additional teleconferences with Colgate alumni whose field of work coincided with one of the projects under discussion; (4) a final teleconference to discuss and evaluate the project and the use of technology. While discussion forums have the advantage of being accessible to all participants at their convenience and to allow for a structured discussion by threading messages, chat sessions allow for immediate responses to individuals, groups, or all participants and are, therefore, highly stimulating. Finally, making use of alumni through teleconferences is one of the best motivational factors, especially if the alumni are relatively recent graduates. Students can identify easily with them and see how they could use their language skills in the near future.

A final teleconference between the participants served as a sounding board for suggestions on how to improve such joint learning ventures and gave the Colgate students the opportunity to display their improvement in the German language. A TelePrompTer helped to increase self-confidence and allowed participants to give a fluent presentation of a topic of their choice to their audience.

Comparing Student Performance in Independent Study Versus Traditional Lecture Sections

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The computer literacy course is taught every semester to over 600 students. Course capacity is always met and many students are refused entry. Students are drawn from many faculties, can be in any year of their program, and can be taking a full load of courses or only one course while working full-time. Because of student demand and the diversity of student characteristics, it was thought that an independent study without formal lectures and labs might give students more time flexibility, appeal to those with a self-directed learning style, and allow more students to complete the course without unduly increasing demand on existing departmental resources.

Course Delivery

Students in both the lecture and independent study sections had access to the text book and accompanying CD ROM, lab work-book, course outline, assignment descriptions, and a course Web site with postings of all written materials and links to related materials. The Web site was also used for facilitating group work on two assignments and E-mail was available for student and instructor communication. All students had access to a computer lab on a drop-in basis for 50 hours per week. Students could also access the Web site and E-mail from home via modem. Students in both sections completed six pass-fail assignments due on specified dates and wrote the same midterm and final exams. Students in the traditional lecture section had scheduled classes composed of three lecture hours and two lab hours per week.

One course section was offered as an independent study in the Winter semester 1997. A one-hour meeting was scheduled each week. About half the meetings were mandatory, and these were used to describe the course outline, hand out materials, introduce assignments, organize group projects, and administer the midterm and final exams. The course Web site was used to post announcements and notes from the mandatory meetings. The instructor attended all class meetings and communicated with individual students via office hours, telephone, and E-mail. One teaching assistant was assigned to the course, and he marked assignments, provided lab support six hours per week, and was available for consultation via office hours, telephone, and E-mail.

Method

Students from both sections of the course completed a survey that identified student characteristics, pre- and post-course computer usage patterns, and self-perceived pre- and post-course overall computer expertise and expertise with E-mail, World Wide Web, and Newsgroup functions. Student id number was used to match survey response with course grade. Students in the independent study section were also mailed an extensive qualitative feedback survey that explored their learning experience and perceptions of the course.

Results

Student Characteristics

Almost half the independent study students took the course as an optional course and/or were motivated to take it to acquire additional computer skills. Only two students took the independent study because the lectures were full - the rest were attracted by the flexibility and additional free-time provided by this format. Students in the independent study section were significantly older ($F=20.8$; $p<.001$) and had significantly more years of post-secondary education ($F=23.0$; $p<.001$). Their written comments indicated that almost all believed that their strong self-study skills and previous computer courses or computer experience were characteristics that would help them be successful in an independent study format. Prior to the start of the course, about 90% of students in both sections owned a computer, held an AIX account, and had used word-processing software. However, independent study students reported significantly higher levels of self-perceived overall computer expertise (F=5.5; p<.05), spent a significantly higher number of hours per week on the computer (F=4.5; p<.05), were more likely to have used E-mail (80% vs. 58% ; chi-square=3.5 ; p<.06), and were significantly more likely to regularly play games on their computer (70% vs. 42% ; chi-square=7.0; p<.01). There were no significant differences between sections in E-mail, the World Wide Web, or Newsgroup expertise.

Student Performance in Traditional Lecture vs. Independent Study

Following course completion, there were no significant differences between sections in the percentage of students who regularly used the computer to do word-processing, E-mail, library research, or "other" functions, but independent study students continued to spend a greater number of hours per week on the computer (F=3.6; p<.06) and were still significantly more likely to regularly play games on their computer (70% vs. 35%; chi-square=11.7; p<.001). Although the percentage of students who received a grade of "A" or "B" was similar across sections (39% vs. 38%), a significantly greater percentage of students in the lecture section obtained a grade of "C" (43% vs. 21%; chi-square = 7.6; p<.01) whereas a significantly greater percentage of students in the independent study section obtained a grade of "D" or "F" (41% vs. 18%; chi-square=9.0; p<.01). It may be that strong students are able to perform well with either format, but that struggling students need the lecture format to achieve a passing grade. However, independent study students were also unanimous in expressing concerns that inadequate information regarding exam and lab expectations and marking criteria had negatively affected their performance. A majority recommended that the weighting on the exams be reduced and that a higher weighting (and also percentage rather than pass-fail grading) be used for the assignments.

Qualitative Feedback from Independent Study Students

About one-half of the independent study students indicated that the course had met their goals and that they would recommend the course to other students. About one-half the students were "satisfied" with the amount of interaction they had with the instructor, teaching assistant, and/or other students - and the other half were equally divided between being "very satisfied" or "unsatisfied". E-mail, telephone, and office hours / lab time were the primary tools the students used to communicate with the instructor, teaching assistant, and other students. All students had used the text, workbook, course web site, E-mail, and World Wide Web as resources, one-third had regularly attended lectures in another course section, and less than one-third had used the text's CD-ROM and/or found it helpful. Over half the students indicated that some form of practice on-line testing would be helpful and about one-third believed the incorporation of interactive multimedia tutorials and/or required use of the text's CD- ROM would improve course delivery.

The major perceived benefit of the course was time flexibility and one-half the students believed that their most beneficial learning outcome was the development of marketable skills with the Office '95 spreadsheet and database applications (i.e., Microsoft Excel and Access). The major drawback was considered to be inadequate information and guidance regarding exams and assignments and one-half the students believed that more regular class-time with formal instruction and/or guidance could help address this problem. Overall, the students found the independent study format appealing and believed it had potential, but that felt that some changes (particularly in communication and evaluation issues related to the exam and lab assignments) would be needed to realize this potential. Future sections could place greater weighting on course assignments and use them as opportunities for students to develop practical and marketable computer skills and explore areas of personal interest.

Conclusion

An independent study format provides students with greater flexibility and more free time. The format is best suited to mature students who have strong self-study and time-organization skills, previous experience with independent learning, and/or good prerequisite computer skills. To be effective, the independent study format needs to address issues regarding communication, support for assignments, and evaluation criteria and procedures. An independent study can also allow students to explore projects and areas of interest that would not be possible in a traditional lecture format. A revised independent study is currently being delivered in the Winter 1998 semester which allows students to define and complete individual projects.

Web Supported Learning - A user evaluation of a Media Studies application

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With the publication of the "Dearing Report" on Higher Education in the Learning Society in 1997 in the UK, there is much pressure on academics to examine ways in which Communication and Information Technologies can be used to enhance the learning process to improve the "quality, flexibility and effectiveness of higher education" [Dearing 1997]. Providing flexible learning environments that can be used in a variety of ways to suit individual students is going to become increasingly important.

Many academics now feel confident to develop their own materials for publication on the Web but the extent to which students benefit from such resources, (particularly on courses which require little prior knowledge of computing) requires further investigation.

Integrated learning environments or on-line courses which *require* students to interact with each other or with their tutor through the computer have been investigated by several researchers (e.g. [Newman et al 1997]). However in many cases there is a significant learning curve for the students in relation to their interaction with the computer.

We believe there is a role for the provision of support materials on the Web for traditionally taught courses. This type of provision is less demanding of the student in terms of their ability to interact with the computer but nevertheless provides adjunct materials at a relatively low "learning cost" for the student. This may be a precursor to moving more material onto the Web in order to replace all or more likely some of the traditional delivery mechanisms. It is especially likely as an initial step where students are often not already familiar with the Web and in disciplines that are not the first to embrace new technologies.

The site under study was introduced in autumn 1997 to support a second year undergraduate degree module called Narrative and Genre (NAR). This module is taken primarily by students on the integrated Honours degree programme in Communication Studies at Queen Margaret College, Edinburgh. The NAR module introduces students to the economics of the film industry and to various theoretical approaches to the study of narrative and genre. The site was developed by 4th year students who had previously studies NAR, in collaboration with the course tutor. The Web site [http://jimmy.qmced.ac.uk/usr/cibutt/narrgen/] has as its core a small text based set of seven pages, most of which were written specially for the site. The pages are the menu (the home page with a weekly outline of the module), descriptor (the formal module description), staff (a link to the NAR lecturer's home page), readings parts 1 and 2 (additional reading texts for each week and weekly lecture overheads), links (a page of links to appropriate and checked external sites) and assignment (examples of previous essay questions).

The aim of the research is to assess the user's interaction and view of the site as a support mechanism for their study. Of particular interest was that the users of the site are not on a technology course and are not generally found to be technology enthusiasts.

A number of techniques for evaluating on-line and hypermedia courses were examined and it was decided to administer a questionnaire of mostly closed questions to elicit information about the users':-

- access and use of the site
- evaluation of key criteria (from criteria described by [Gillham et al 1996])
- general views about Web based education
- use of other computer facilities and feelings about computing
- demographic details.

The questionnaire was completed by 38 respondents which is 42% of the students registered for the course. The sample consists of 38% international students, mostly from Norway, and the gender make up is 60% female and 40% male. Eighty-one percent of the respondents are between 18 and 25 years old.

The NAR Web site was used by 90% of the respondents with only four admitting to not using it. The site was highly regarded overall by the users with a large majority stating that it is, essential (39%) or useful (52%), and every respondent stating that is had assisted with their study, either a little (46%) or a lot (54%). They all stated that they would like similar sites available for other modules. Most users accessed the site once every two weeks (31%) or once a month (34%). Access at less than once a month (25%) suggests a single visit. It may be expected that the site would be visited weekly to match the weekly pattern of classes on the course. However only about 9% did this. The information on the site was not added to during the semester, so it may be that students accessed information for several weeks' work in a single visit. They were asked a series of questions to see what balance between traditional teaching and Web based delivery they favoured [Fig. 1]. It is interesting to see a marked conservatism towards moving away from the traditional forms of tutor contact. All the respondents were of course in attendance at a lecture which may immediately bias the sample. Also, the questions stressed the aspect of tutor contact rather than flexibility in learning as would occur with more of a Web based programme and the popularity of the particular course tutor may be influential here.

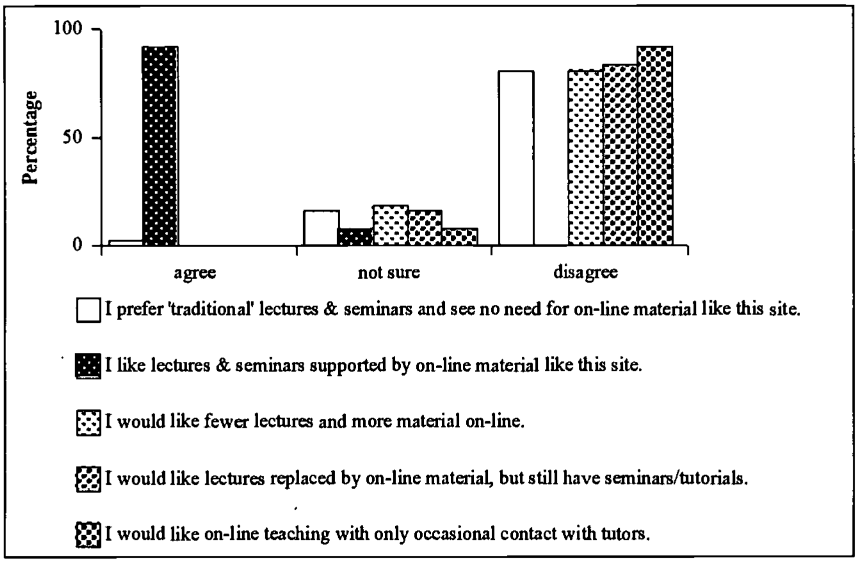

Figure 1. Views of students on various type of teaching approach.

It is clear that the students find the Web site a useful additional resource in their study of the NAR module. The site seems to be used by many as a rather static source of information with over half of the respondents accessing it only once a month or less. The material was not changed during the semester, so the batch approach of printing out material and presumably keeping it on file is appropriate. There is no 'latest news' area in the site, but given the weekly meeting of lecturer and students in the classes this may be considered unnecessary. Given that the site is not as dynamic as many Web sites it could be reasonably argued that the information could be satisfactorily provided on paper to the students. The only area giving real added value in having a Web site is the links to external sites. Indeed it is this facility that was used most frequently.

The site was highly successful in introducing potentially unenthusiastic students to Web based educational material. However with this application there has not been any 'trade off' in reducing traditional contact situations. The surveyed students seem resistant to moving further along the path to computer assisted learning; they appear content with what they are familiar.

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Teachers Assessing Student's Performance: a Proposal for Hypermedia Applications

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Introduction

The advantages of hypermedia software are often considered self-evident. They present a variety of information in multiple representations; They provide to student's a dynamic and individually way of constructing their knowledge, in a constructivistic learning perspective [Jonassen & Duffy 1991], [Spiro et al. 1991]. Those potentials will only guarantee an effective learning by the students, if there is a “step-by-step” integration of evaluation procedures, both into levels of development and actual use of this software. A great variety of approaches and evaluation methodologies can be found in the literature [Reiser & Kegelmann 1994].

Learning contexts are crucial to the success or failure in educational uses of this type of software. Assuming that each student has his own skills and learning style, the ways they access information and the difficulties they may experience can be tremendously different. Research about assessing student's performance in front of educational hypermedia applications has proposed relevant methods to access and analyse student's interactions with the software, [Crosby & Stelovsk, 1995]. Nevertheless, these studies focus essentially questions about design of hypermedia applications, in a formative evaluation perspective. It is also necessary that teachers, in real context learning, supervise student's activities, discuss their performance and advise them for future work.

The new trends in science learning highlight the need of improvement in assessment science learning. An effort has been made to propose alternative methods and techniques of assessment that emphasise the process and not only the content, such as concept mapping, tasks analyses or student's portfolios [Smith et al. 1993]. Developing computer-based assessment tasks in science is an issue that has yet to be fully resolved [Kumar 1996]. By drawing upon educational software evaluation and evaluation in science learning we believe that we can contribute to the improvement of both areas [Gomes 1996].

Model of Assessment

Although there is a great number of methods that analyse student's performance in front of hypermedia applications, tools designed for teachers should have features especially addressed to them. They should be kept simple: Methodologies of application should not be complex, should not demand manual processes and amount of time; Data visualisation must be simple, facilitating the analyses by the teacher; They should contemplate not only statistical approaches about de visited nodes, links types, time spent at each part of the programme, but also data visualisation that gives emphasis to the original version of student's performance; Analyses should not only focus on the objects of the interface and on the navigation styles but also on the concepts involved; They must emphasis the interrelations between concepts, media resources and applications strategies.

In order to gathered all the information that we can reach by student's interactions with hypermedia, that might be relevant to help teachers in evaluation processes, a categorisation model is proposed, see [Fig.1]. We assume that each interaction results in a specific event with certain types of media resources.

An Interaction			Causes an Event				With Media Resources	
Identification	Object Type	Action Type	Theme	Concept	Level	Strategies	Media	Media Types
-Specific for each object	*e.g.* -Icon -Hot Word -Window	*e.g.* -System navigation -Exploratory	-Global level of concept organisation	-Particular level of concept organisation	-Concept treatment	*e.g.* Information presentation -Simulation	-Sound -Images -Animations -Text	*e.g.* -Speak sound -Real image -Graphics

Fig 1: Classification Frame

The integration of this classification frame into the process of conception and software development will guarantee a very simple way to collect and analyse data of student's interactions with the hypermedia applications.

The Experiment and Results

We developed tests with nine first years students engaged in higher education. These tests consisted in video record of working sessions with a hypermedia application (*The Way Things Work*, a successfully Edutainment CD-ROM developed from a book by David Macaulay). Each session had the duration of 30 minutes, and students worked in groups of two or three. On the first session they worked freely with the software, to accommodate to software interface and structure. On the second session they had a specific task: "explore what is a computer and how it works". We codified all the interactions based on the categorisation model.

By classifying interactions and events in the hypermedia system a map was generated where hypermedia application structure, event strategies, and media resources are expressed. To deal with the conceptual level, we identified in hypermedia structure, the relevant events for students to achieve the proposed task the *key concepts*. We present some possible representations of the data collected in the second work sessions, the one that have involved a task, that emphasise:

-Student's preferences for the global themes of the software, by counting interactions percentages on each theme.

-Student's efficiency in accessing information, by counting interaction percentages in events related with key concepts, events related with other concepts and neutral interactions and by counting the number of interactions made until student's reach a key concept.

-Student's navigation style, by counting interaction percentage on theme navigation, system navigation, association idea navigation and exploratory navigation. We also considered the links student's have done between events.

Discussion

With the explosion of hypermedia applications and the growing interest in their use in education, it is important to reflect how can we help our students to take the best profit of them. Data generated by this experience emphasises the potential of evaluation tools especially addressed to teachers.

We found groups of students with great difficulties to accomplish the propose task. One group has visited so few events related to computers. Others, visited almost all the events identified as important, but they could had accessed information in a better way. Reflecting and discussing with students their own performances may help them to develop skills to deal with hypermedia software.

The categorisation frame we proposed allows for a great variety of perspective analyses and the results encourage the integration of this type of tools in hypermedia applications.

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The Way Things Work it's a product by Dorling Kindersley Multimedia

PROBLEM-BASED LEARNING AT THE UNIVERSITY OF COLORADO AT DENVER

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Abstract:
This paper provides a brief overview of Problem-Based Learning (PBL) as an instructional methodology. A master's program in information and learning technologies, designed for classroom teachers using PBL as its primary instructional strategy is then described. Information about program issues, problems, and successes is provided.
The ILT Master's Program

The ILT Program

The Information and Learning Technologies program in the Division of Technology and Special Services at the University of Colorado at Denver (UCD) offers a master's degree program for practicing teachers. The primary emphasis of this degree program is to help teachers learn to integrate information and learning technologies in student-centered ways in their classrooms. The main instructional strategy used was problem-based learning (PBL).

PBL AND LARGE GROUPS

Most PBL programs are conducted with small groups who meet frequently with tutors. We didn't have that luxury. There are 20 people in the program and one teacher/tutor. The tutor is critical in helping students reflect on their learning and to remain faithful to the PBL process, so we had to learn how to conduct that reflection and monitor the process either in our absence or with a single large group. Strategies that we tried include:

- Rather than meet with each group individually, we had the small teams prepare for reflection discussions by writing answers to reflection-based questions individually. Then we gave the teams time to discuss their individual responses together. Finally, we brought all the teams together to share their thoughts.
- Infrequently (when there were two of us on site) we met with individual teams, mostly in an effort to monitor the process. Teams tend to fall victim to "production bias." That is, teams tend to want to solve the problem, produce a product, or "win the race" and avoid things that get in the way of "producing" – things like taking time to reflect on their learning.
- Since the students met only once every two weeks, we gave up significant portions of class period to team meetings and team work. To compensate for missed class time, we used e-mail discussions focused on reflection questions during the times between classes.

- We gave reading assignments during class so that part of the class would have something meaningful to do while a team or individuals worked with a teacher.

Even though we strongly supported the PBL approach and were prepared to make changes, giving up class time for other activities was (is) one of the hardest things to learn to do. Learning comes from working on the problem and from reflecting. Even after two years, we are still learning and thinking about how to handle class time. The main issues that we learned to deal with include changing student and faculty roles, infrequent class meetings, the necessity to emphasize reflection, reducing student anxiety, and assessment.

Those of us who have used PBL know that there are critical changes in the roles of both students and faculty. Yet, "knowing" and "acting" are two different things. As our program progressed both the students and us became more comfortable in our roles.

Most PBL programs have several meetings per week. We met once every two weeks. To facilitate the PBL approach, we gave up significant amounts of class time for small group meetings. This continues to pose problems for us. The teams need to meet together more frequently and the distances several of the students had to travel made this difficult. E-mail is not always effective. Many of the students waited until the Thursday evening before the next class (Friday evening) to read and respond to the question of the week, leaving little time for thoughtful reflection and reaction from their peers. Some of the strategies we tried include:

- We created small groups based on geographic proximity. This enabled them to get together between class sessions. However, one group was composed of people in rural locations. They were not able to get together.
- We gave up class time for team meeting time.
- We worked on class norms for e-mail discussions (short, single-topic responses, earlier and more frequent reading of e-mail). In fact, we used this strategy a great deal. When we encountered problems in the class, we asked the students to verbalize those problems and then to develop solutions that they would all agree to follow.

One of the things that we as teacher-facilitators learned that probably had little effect on our students is the importance of reflection, whether students are working on a problem or a project. In general, a problem is more open-ended than a project, leaving almost all decisions about where to go with the problem to the students. A project is more narrowly defined and may specify the nature of the final product or solution.

Our notion of doing the program with intensive weeks in large blocks was appealing to our students. Yet, it took us, as teachers, half the program to figure out how to deal with it. It was difficult enough for us to organize 15 hours of class per weekend and then try to subdivide that into time for three separate projects and any other material we wanted to deal with. The students had the same organizational problem, not knowing how to divide their time away from class. They were always overwhelmed. They also tended to want to put in much more time than we wanted them to for each project.

Assessment and grading are continuous problems. As teachers, we constantly wrestle with the conundrum of not believing in grades, but since the university requires them we believe they should mean something. This becomes a greater problem in a problem/project environment based on small groups where everything is always in process and feedback is supportive rather than judgmental.

LESSONS LEARNED

- The courses for our next cohort will be arranged around single problems (contact the principle author for a description of the curriculum for the next cohort).
- Rather than traditional 3- or 6-hour courses, we will assign credit hours based on the needs of the problem – anywhere from one to four.
- We will shorten the length of the weekend meetings. By Sunday morning the students and us were exhausted. We had some fruitful Sundays, but not always. So, we will use Friday evenings and Saturdays for our meeting times.
- We will make a greater commitment to PBL. We will make sure that students understand that the bulk of their meeting times will be in small teams with a tutor. We won't try to mix traditional and PBL class times together.

- Target a student population that is closer to the university, making between-class meetings more practical.
- In the next cohort, we will be much more systematic regarding assessment and focus on:
    - knowledge in the problem domain;
    - reasoning and problem-solving skills;
    - self-directed learning skills;
    - group process (collaborative skills).

Establishment of a Virtual Consultancy

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Introduction

Recently there has been an increasing interest in the concept of virtual corporations. The virtual corporation is envisioned by many experts as the solution for a quick introduction of a variety of high quality products at a low cost. But there are still some open questions and problems to be solved.

In this paper the SERVICE project (SMEs pilot for business process design in order to establish a virtual international consultancy using electronic commerce) is presented. The project is partially funded by the ESPRIT programme Technologies for Business Processes (TBP) from the European Commission and aims to build up a virtual consultancy (VC). The VC consists of partners from Germany, England, Greece, Sweden and Finland.

Project Objectives and Approach

The overall objective is to facilitate the participation of small and medium-sized companies (SMEs) in the global market by pooling their resources and exploiting the opportunities offered by the development of electronic commerce. One specific objective is to transform the company-specific business processes into distributed processes, which cross the boundaries between the partner companies.

Accompanying activities in Human Resource Management are necessary for the effective transformation. HRM activities must consist of exchange-oriented, qualification-oriented, coach-oriented and support-oriented tasks. At the same time the suitability of current Information and Communication Technology enablers for the support of distributed business processes in SMEs has been checked.

As SMEs cannot afford to build up their own corporate networks, they depend on the availability of public networks. Public networks can be used by SMEs to establish a virtual private network. Effective sharing of data and collaboration between manufacturing organisations requires technologies that are cost effective, flexible and portable. During the implementation of the pilot, support training, coaching and qualification measures are taken to verify the VC's efficiency and effectiveness.

The first step was an "as-is" analysis of each partner's organisation and a clear definition and scope of the pilot. The process analysis provided the basis for the process design which was implemented (pilot implementation) and consequently will be evaluated and disseminated.

Pilots to Be Considered

After the first project phase (process analysis) the consortium agreed on three different pilot categories:

- *Pooling products:* user organisations select products already available and pool them together, so that other partners within the virtual consultancy can exploit them.
- *Glocalise products: a* discussion revealed that glocalisation as a strategy could be employed in cases where products are intended for different markets and need to be glocalised, as well as for multimedia products. The product/service is 'glocalised' by customising details of the product (e.g. language, dialogue, tastes, aesthetics, etc.) to match the preferences of local consumer groups within particular local markets (e.g. countries, language zones).
- *Creating new products/ services:* user organisations engage in a process whereby new products or services are developed.

The project itself provides for various, interesting items to be discussed. Following the baseline of the conference we will focus on the aspects of Human Resource Management within this paper.

Human Resource Management

Human Resource Management ensures that a company has the right number and type of people at the right place and time, who are capable of effectively and efficiently completing those tasks that will aid the organisation in achieving its overall objectives. Therefore, accompanying training and education activities are vital for the success of the virtual consultancy.

There are four key elements of a human resource management system, each of which can operate both as an outer control and an internal incentive to foster business goals. The four elements are:

- *selection* of people who are best able to perform the tasks defined by the organisation's business objectives,
- *appraisal* of performance to facilitate the equitable distribution of rewards
- *reward*, which motivates employees by linking rewards to high levels of performance
- *development* of employees to enhance current job-related performance, to keep them happy and motivated, and to prepare them for future business opportunities or positions they may hold within the organisation.

Selection, promotion and placement are all related to the internal movement of people across positions and projects, and to the external hiring of people into the organisation. The underlying consultancy process is that of matching available human resources to the projects undertaken within the organisation. This entails defining the skills required to complete the project to the client's satisfaction, and assessing the available people who represent the best fit.

Once the jobs are filled and the tasks are being performed, they employees should be rewarded both financially and emotionally for good performance. They also need to be further developed and supported in order to widen their range of skills, thus increasing the number of projects upon which they can work while at the same time increasing their own job satisfaction.

Ensuring that an organisation has an adequate supply of human resource talent and particular skills is by no means an easy task. One of the potential benefits of a virtual consultancy, such as Service, is the ability to draw from a large pool of people with skills and experience in the Human Factors/Ergonomics/Human-Computer Interaction domain.

In order to plan marketing activities and resource requirements, each of the Service partners needs an accurate inventory of the current Human Resource stock held by the other partners. This should include an up-to-date description of the skills and qualifications of each consultant, brief details of major projects upon which they have worked, their preferences and areas of interest, and their own wishes for future development and type of projects.

Any HRM system will contain certain underlying hypotheses about the type of people the organisation employs. For example, we view our consultants as highly self-motivated individuals who seek opportunities to learn, develop and apply their competencies. Management attempts to create a co-operative environment for them, while recognising that the world is an essentially competitive place. The nature of the psychological employment contract between the company and its consultants is "challenging, meaningful work in return for high rewards and loyal, committed service". The degree of participation in decision-making is relatively high, with management encouraging widespread participation in human resource activities. The HRM systems are geared towards a mixture of individual performance (through individual appraisal review/rewards), and collective, group-based performance (through collective bonuses, a matrix-based project team structure, and various company social activities).

Summary

The nature of the consultancy services offered at each user site is 'knowledge work' carried out by highly educated and professional members of staff. Knowledge workers tend to have a particular set of work standards, freed from the tedium of close supervision, and oriented to co-ordination, co-operation, organisation and planning.

The provision of high-quality consultancy services is dependent on the consultants who deliver them. The human resource management processes are thus at least as important as those of strategy, marketing and finance.

Internet-based Integrated Pre-clinical Education System

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1. Introduction

In the German speaking countries, general medical education can organizationally be divided into Pre-clinical Education (comparable to an Undergraduate Program), Clinical Education and The Practical Year. This is normally followed by several years of Internship. The Pre-clinical Education, although organized by the Medical Faculty, depends on the cooperation of other faculties. For example, introductory courses and lectures in Physics, Chemistry, Biochemistry and Biology must be imported from the Faculty of Life-Sciences.

It has long been known that lecturers ideally should present course material as interdisciplinary thematic blocks rather than as subjects organized along the line of their own disciplines. This applies to the life-sciences where courses should emphasize medical relevance and vice versa, where the fundamentals of medicine should be taught with consistent reference to their underlying scientific base. However, thematic coordination within related subjects and even more so across faculties is difficult to achieve and depends on individuals who are willing to sacrifice their time and efforts against their own interests.

Facing this situation, and in order to assist medical students to cope with the growing demands of their field that requires solid, scientifically-based knowledge of medicine and life-long learning, we have developed an Hypertext-based Integrated Pre-clinical Education System as a pilot project and part of the Virtual University of Ulm (VUU). This project is called in German *Integriertes Vorklinisches Ausbildungssystem* (Integrated Pre-clinical Educational System) or ***IVA (see Internet address: http://iva.uni-ulm.de).***

2. Principles

Many computer-based educational projects are presently available and a lot of hype has been associated with their purported usefulness. Most of this has never been evaluated by a procedure that would hold up to scientific principles. Furthermore, many if not most of these programs cannot easily be integrated into existing curricula and naturally suffer from lack of acceptance. Therefore, our first principle is to

- **Ensure compatibility with existing curricula.**

Design principles of computer-based projects in our experience lend themselves well to the initiated computer freak rather than to the uninitiated average user. This leads to frustration in a field that attracts students of little techno-mathematical background as in medicine. Therefore, our second principle is to

- **Make intuitive usage possible.**

Surfers of the Internet more often than not experience that behind a flamboyant facade, real content is lacking. We therefore

- **Focus efforts on providing content.**

Textbooks unlike hypertext-manuscripts are scrutinized by a professional editing and reviewing system. The customer, although unaware of the details, with respect to quality, relies on the brand-name of the publishing house when purchasing a textbook. The Internet, however, lends itself to anybody willing to provide information. No institutionalized quality assessment ensures the correctness of the information given (although quality seals may sometimes help). This has contributed a lot to the shady reputation for Internet-based educational endeavors. We therefore have developed a procedure to ensure that our

- **Contents have to pass through a university-level reviewing process.**

Self-representation must be assumed to be the primary goal of many an Internet-based project which does not only pertain to the abundance of homepages but also to many a manuscript which has been uploaded to a server not so much to serve the student as to impress in general. Our principle, however, is to

- **Provide the information as a *service* to the *reader*.**

Hypertext, in contrast to linearly arranged text, can ideally be read by following one's intuition rather than by following a prescribed path. This may lead to the infamous situation depicted as *lost in hyperspace*. Unfortunately, it has never conclusively been shown that hypertexts lead to a better understanding and/or more reliable recollection of contents. Rather than relying on anecdotal experience we have decided to

- **Develop hypertext-based curricula based on didactical evidence.**

3. Materials and Methods

3.1 Hard- and Software Requirements.

Judging from past experience, we have decided to set the minimum requirements for the participation in our project to the present-day industry-standard computer. Compatibility to exotic or outdated hardware is not cost-effective. As we provide true multimedia information, state-of-the-art sound cards, video-boards and network access are requested. A somewhat restricted version of our curriculum is also available on CD-ROM for isolated sites, until it has been replaced by the more capacious DVD-ROM. Servers run under NT (presently V.4.0). Software to develop hypertexts is left to the individual author's liking. Clients are requested to employ the latest version of popular browser software (Netscape ore Internet Explorer). To accommodate special features, Java applets are uploaded to clients as necessary.

3.2 Generation of Hypertexts and Quality Control.

Hypertexts are written by a group of authors specially trained and qualified to take into account the fallacies listed above. Subjects are chosen with respect to the curriculum. Authors provide and submit their work in HTML-Format to a non-public server via FTP. Their material is previewed on a bi-weekly conference where recommendations are given to improve the material and to make it compliant with the style of the IVA-project. The material is then submitted to an independent reviewer with special experience in the field. Finally the material is re-reviewed by the project supervisor and transferred to the public server. Feedback from users is used to improve the material further.

3.3 Special Features.

The user-interface of the IVA-Project is based on a frame-set, featuring one frame with the main information and an accompanying smaller frame with auxiliary information. The main-frame features standard hyper-textual material. The auxiliary frame serves several purposes, i.e. to

1. present textual material that has auxiliary character (e.g. reviewing material from the Life-Sciences when dealing with Physiology, or links to medical applications when dealing with Physics).
2. provide access to a medical dictionary which has been specially designed to suit the needs of the accompanying hypermedia-texts.
3. answer to questions and comments when examining the self-test section in the main-frame.
4. give access to a *help-desk* with real-time audio access to a tutorial service located at the server site.

4. Implementation and First Experiences

Presently, as a core curriculum, material from Physics, Physiology, Histology (as part of the *HistoNet 2000* project) and Clinical Case-Studies are accessible from the IVA-Project. The material in Physics and Physiology is considered to be supplementary to the standard course-program and, therefore, is divided into auxiliary material for lectures, seminars, practical courses, and multiple choice questions. Furthermore, a set of well documented clinical case-studies has been included to enable even undergraduate students to link their newly-acquired knowledge to their later profession.

We have been able to examine the experience of some 600 students with this preliminary system using a questionnaire, which lead us to several curricular improvements and encouraged us to pursue our goals.

Acknowledgements

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Rethinking Algorithm Animation: A Framework for Effective Visualizations

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Computer science students generally find the topic of algorithm analysis and design a hard subject because an algorithm describes a process that is abstract and dynamic, while the methods used to teach them are not. For over a decade, researchers and educators have pursued the notion that using computer animations depicting the dynamic behavior of an algorithm could be an effective tool to help computer science students overcome the difficult task of learning algorithms. In fact, numerous studies and experiments have been conducted to prove that animations can improve learning of challenging, abstract concepts like mathematical proofs and the algorithms used in computer science [Stasko 1997; for a comprehensive survey see Hundhausen 1997]. While the pictures and animations seem to be enthusiastically received by the students, none of the studies have proven conclusively that these visual tools actually *improve* learning [Catrambone et al. 1996]. Is it because animation is an ineffective teaching medium? Intuition tells us this is not likely.

Ongoing research in the areas of multimedia, usability and cognitive science sheds insight into factors that contribute to the design of effective visualization systems [Price et al. 1996, Narayanan & Hegarty 1997], and suggests that previous attempts at using animation to teach algorithm behavior were unsatisfactory not because of a flaw with animation as a technique, but perhaps because of the approach used to convey the animations. Here, we report on a research project based on the hypothesis that animations are powerful vehicles for effectively conveying the dynamic behaviors of algorithms. Our premise is that a rethinking of algorithm animation design is required in order to harness its power to enhance learning. Our research explores the integration of previous work in algorithm animation systems with recent developments in the cognitive and educational domains to produce a new model for using software visualizations to improve student comprehension. The model is based on learning objectives that drive a top-down design that carefully divides abstract concepts into discrete chunks for learning. Unlike previous work, our model takes a user-centered ("what do we *need* to show") view rather than a designer-centered ("what *can* we show") view, and employs hypermedia and multimodal presentation techniques to improve learning effectiveness. We call this framework containing text, diagrams, audio and animation a *hypermedia visualization*--the term *visualization* suggests a richer process than merely watching an animation, and the term *hypermedia* reflects the use of multiple media, links and cognitive tools to help the student form accurate mental models of algorithms.

Under this framework, an algorithm visualization is more than a mere animation. It describes an environment that elicits active student participation using a carefully orchestrated presentation of information in various media (such as animations, text, static diagrams, aural narratives, video and more) with appropriate temporal, spatial and hyperlink connections. This framework extends previous research in several ways:

- Embedding animations within a hypermedia visualization that employs textual descriptions, audio narratives and static diagrams to provide contextual information. So, the focus is not on the animation, but on providing sufficient information in the appropriate media form(s) to meet the learning objective.
- Providing distinct levels of animations to illustrate different views of algorithm behavior. At the highest level, a *conceptual view* introduces the algorithm's basic operations using animated real world analogies and forms a bridge between the analogy, the abstract components of the algorithm and the concrete graphical representations used to depict the algorithm. Next, a *detailed view* focuses on and animates specific operations in tandem with pseudocode highlighting and textual explanations. Finally, animations in *populated view* show the algorithm's aggregate performance and behavior on large data sets.
- Presenting algorithm animations in discrete "chunks" accompanied by explanations of the specific actions being accomplished. By providing these logical pauses, the student can digest each small step before moving on. Allowing the student to adjust the size of the step tailors the flow of information to meet the

student needs. This is in stark contrast to current algorithm animation systems that present the detailed dynamics as a one-shot, stand-alone show that is entertaining to watch but tends to obscure the very details the student needs to learn.

- Encouraging student participation by allowing interaction with the data and using questions that stimulate thinking, foster self-explanation, and challenge understanding. Students are prompted to input data sets of their choosing to explore algorithm behavior more thoroughly. The system periodically poses questions to the student. The simplest form is what we call a 'tickler,' which is a question that pops up in random order but always in the appropriate context. Tickler questions focus student attention on specific issues and promote self-explanation as a means to improve comprehension, but the answers are not entered into the computer nor is feedback provided. We place other questions that require student input at 'articulation points' beyond which the learner cannot proceed unless/until the question is answered correctly.

We have designed and implemented a hypermedia algorithm visualization system, called HalVis, that incorporates the features described above, and conducted two sets of experiments to evaluate the effectiveness of our approach. Each experiment used a demographic survey to evenly divide the subjects into (1) a control group (referred to as the Text group) that learned selected algorithms using traditional, text-based techniques (specifically using extracts of current textbooks) and (2) an experimental group (referred to as the Algorithm Visualization (AV) group) that learned algorithms using HalVis alone. Experiment #1 evaluated the effectiveness of HalVis hypermedia visualizations using second year computer science students studying the MergeSort algorithm, and showed a significant advantage for the AV group over the Text group. The pretest average for both groups was 2.4 out of a possible 9 points. The posttest average for the AV group was 6.7 while the Text group's score was 3.8 ($F(1,31)=10.9$, $p<0.003$). Experiment #2 evaluated the same hypothesis using third-year students studying the MergeSort and QuickSort algorithms, again, with a significant advantage to the AV group. The HalVis group's average improvement was 6.9 points compared to a 3.0 improvement in the text group's scores, and these results are significant ($F(1,21)=10.2$, $p<0.003$). Figure 1 shows the pretest and posttest performance of each group in these two experiments, using box plots to further illustrate the distribution of scores and enhanced performance of the groups using HalVis.

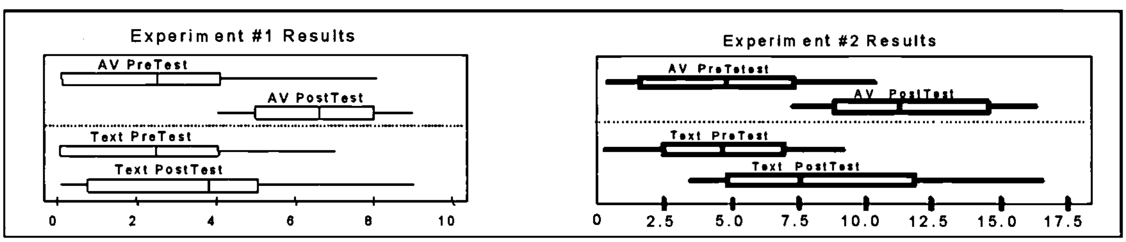

Figure 1. Group learning performance using HalVis algorithm visualization vs. conventional text

Our results indicate that animations can be very effective in teaching students about algorithms when embedded in a carefully designed hypermedia environment. Additional information about this research project and its future direction is available at http://eng.auburn.edu/departments/cse/research/vi3rg/vi3rg.html.

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Developing Skills in Ecology Research for Undergraduate Students: An Interactive Multimedia Simulation

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Abstract: One of the difficult challenges for tertiary education is to not only develop strong conceptual frameworks in academic areas with students, but also to develop skills in applying this knowledge to typical tasks that the graduates will need to carry out in their profession. This paper describes one such approach using the context of a simulated environmental project brief to develop the research and professional practice skills in undergraduate students. A new package entitled "*Researching Lake Iluka*" was developed from the successful product *Investigating Lake Iluka* to which were added modules to describe the tendering and statistical processes and data collection. The results indicated that students who were provided with this "situated" learning context developed skills in an holistic fashion at the time they were needed and understood the need to perform environmental assessments with appropriate controls.

Developing Research Design Skills for Biological Scientists

The balance of content and skill development for undergraduate students continues to challenge Universities and has been raised in reviews of the function of our tertiary education systems. Additionally, governments seek to influence this balance as their educational and financial agendas focus on tertiary education. However, in the applied sciences, there has always been a strong emphasis on vocational skills, and Universities do not always have the resources to give students opportunities to develop these skills in a vocational context. This current study was designed to address this problem in the area of applied ecology.

Natural variation is a fundamental part of all biological systems. In many disciplines within the biological sciences, experimental studies seek to minimize background variation in order to be able to detect even small-magnitude effects of experimental treatments. However, in the field-based disciplines, such as ecology and environmental science, the intrinsic variability is not amenable to minimization in surveys or experiments. A major challenge is therefore to design surveys and experiments, which have the power to detect effects, even against the background variability.

> *Experimental ecology is sometimes considered to be the preserve of 'academic' ecologists and has little to no place in the 'real world' of management of natural resources, conservation of rare species or environmental issues... This detracts from a more useful focus on whether the work is good science or bad science, regardless of whether it was intended to be applied.*
>
> [Underwood, 1990, p 386]

Land managers, students and even academic biologists are guilty of investing a great deal of time and/or money in studies that are simply unable to detect effects of the treatment of interest. For example, we are aware of a major forestry experiment designed to test the effects of logging on the water quality of streams. To answer the question, one large catchment was subjected to a logging treatment and another, nearby, was left unlogged. There were many measurements taken from many locations in each catchment - yet this expensive study could never do any more than indicate that the streams draining the two catchments differed in water quality because the unit of interest (the catchment/stream) is unreplicated either for the logging treatment or for an unlogged control. [Fisher and Wishart, 1930] nearly 70 years ago criticized this type of simplistic approach to research design in stating 'No one would now dream of testing the response to a treatment by comparing two plots, one treated and the other untreated.'

There is ample evidence that even well-trained ecologists and environmental scientists do not necessarily understand the principles of good experimental design [Green, 1979; Underwood, 1997; Whelan, 1995]. Teaching a better understanding of experimental design typically takes two forms: "dry" classes on experimental design theory, or field-based learning. Our experience in teaching at tertiary level indicates that a combination of "vocational context" and "field experience" are important elements of learning. However, field work and professional experience programs are expensive to set up and are instructor-intense. It is also very difficult to focus on key issues for large numbers of students in a way that will give them any real experience. We reasoned that simulation offers a great deal of potential for this type of skill development, because it offers the opportunity to devise a vocational context for the need to learn these skills and also offers a life-like way to give large numbers of students a way to set up sound environmental experiments with minimal costs.

Simulation

Simulations as learning environments have had a long history of use in education and training and have been based on a variety of theoretical views of learning. Along with increasing computational power, software has increased in complexity so that object oriented systems can now be used to simulate devices of great complexity making use of extensive simulation of this complexity.

The key feature of an educational simulation is that it makes use of a model to represent a process, event or phenomenon, which has some learning significance. The learner is able to interact with this representation and the simulation provides intrinsic feedback that the learner can interpret as the basis for further interaction. The underlying model may be mathematical leading to the generation of numerical results, rule-based with the intention of providing feedback on subjective input, or even context-based in that the learner is placed in a context that simulates a real situation.

[Bliss and Ogborn, 1989] have described computer based simulations as programs in which the computer acts as an exploratory tool, supporting a real world activity while facilitating user understanding of the processes involved in complex dynamic systems which may otherwise be inaccessible. Essentially educational simulations are experiential exercises. They are useful wherever real objects or processes are involved in a learning task—they are less dangerous, less messy, and, if well designed, can exactly replicate real world objects and processes. Simulations can not only display aggregated behaviour, illustrating the interactions of objects or processes, but they can also be decomposed into constituent elements which can be manipulated to simulate variation in systems.

Another view of a simulation is that they may be considered as "a special kind of model representing a 'real world' system, governed by a set of rules" [Crookall *et al*, 1987]. This view is based on models that may be regarded as 'black boxes', with their form and structure hidden from the learner. If the model is hidden, learners are expected to believe in the credibility and authenticity of the model as an act of faith. The model may also be presented in an inspectable form, thus allowing learners to observe how the model operates. In some cases it may even be possible to change the model or at least some of its parameters. A broader view of simulation can be taken if an 'in context' environment is considered as a simulation. In this form, the simulation is designed to place the user in a professionally-relevant context where they can investigate an issue and solve a problem, without necessarily receiving the intrinsic feedback characteristic of the more mathematically or rule-based simulations. While working with such models, the user often comes to see the simulation as a 'real world' in its own right [Crookall *et al*, 1987]. Such models can be considered as representing real-world systems as either an "in-place-of" or a "bring-to-life" format.

Regardless of the type or format of the simulation, the overriding purpose for simulating systems remains: to provide a learning environment that supports the learner to develop mental models about the interrelationships of variables; to test the efficacy of these models in explaining or predicting events in a system; and to discover relationships among variables and/or confronting misconceptions. Simulations can help learners achieve these objectives by providing a substitute experience for those processes and systems, which by reason of cost, scale, time or risk, would not normally be accessible.

Researching Lake Iluka

The increasing level of sophistication of interactive multimedia applications and their authoring tools provides an incentive for designers to produce software, which fully utilizes the capabilities of such applications. This is particularly evident in many of the simulation-based packages which exhibit a tendency to move away from the earlier reliance on a 'pre-set', 'fixed and repeatable outcome' model, which provided a very simple approximation of the real-world that it was trying to mimic. Within this context, an interactive multimedia simulation package called *Researching Lake Iluka* was developed based on the award winning package for high school ecology, *Investigating Lake Iluka*. [Harper and Hedberg, 1993].

The Design Context

The designers exploited the combination of the conceptual power of a prediction model approach together with involvement of the learner in actively constructing knowledge. The simulation allows students to address a typical problem based tender for a government body, research the background to the problem, carry out initial simulated sampling and design surveys and experiments which have the power to detect effects even against the background variability as part of a tender proposal. The learner is then expected to carry out the experiments, collect and analyze the data sampled and to produce a full report.

An authentic context is set through representation of a lake environment with a field study centre and a consultant office. The context has been set at two levels; firstly a coastal lake environment has been simulated to represent a 'real' environment, and secondly, the research design process has been simulated as an authentic task within the lake environment. The package represents a full version of the high school ecology package *Investigating Lake Iluka* with the addition of the consultant office [Fig. 1]. In addition, the simulation has been designed to employ the real-world metaphors and related resources in such a way that the students used to tools and reference resources in a similar fashion to the way they would use them in real-world contexts, thus reducing the need for complex description and instructions [Hedberg *et al*, 1994].

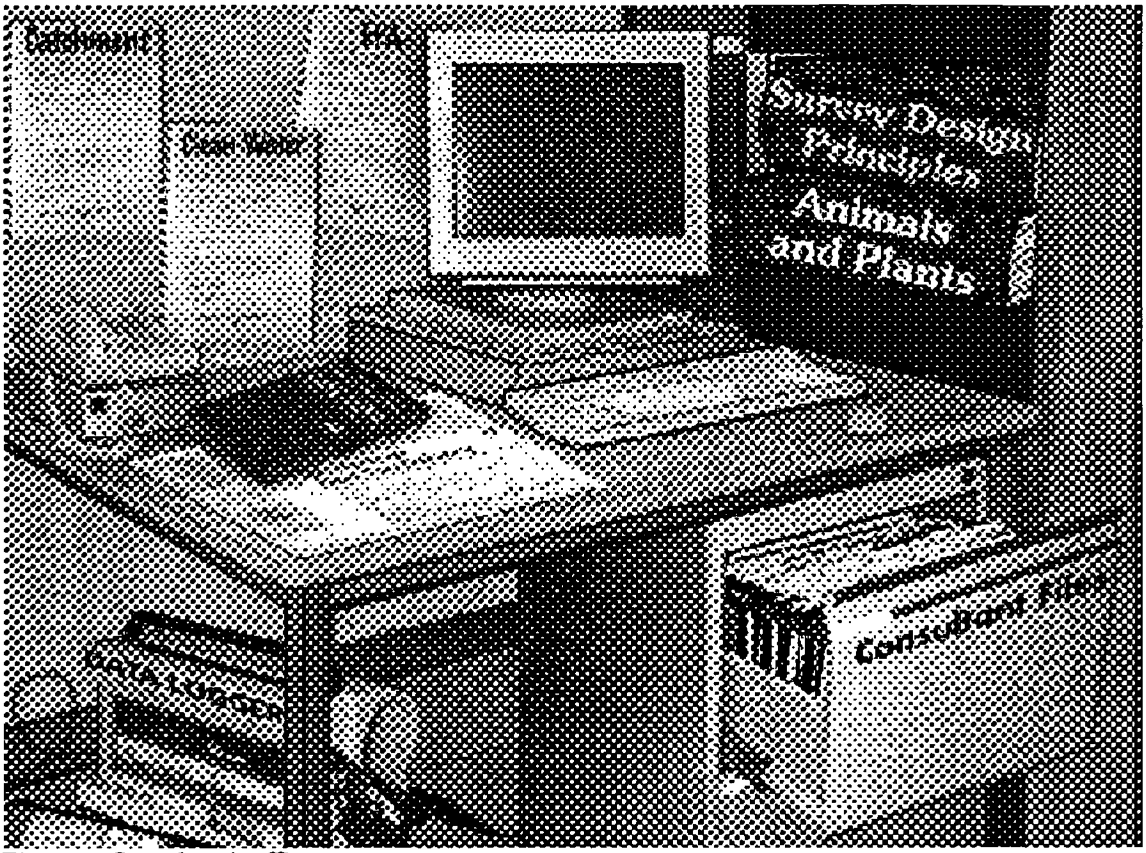

Figure 1: Consultant's office.

Objective	Activity
Gaining background information	User accesses background information by exploring elements within the general parts of the program, the ecosystems and the research resources on common access (video, audio, reference books, etc.).
Conducting a pilot study	The user can enter the simulation area of the lake (an aerial view) and take a set of readings of any water quality parameter at any number of locations associated with any of the 6 streams.
Resources for calculation of sample sizes and statistical power	Users can open a statistical methods module within the filing cabinet in the consultant's desk.

User should not know any more about the system than would be the case in real life	The user is allocated one of three scenarios at random (smell problem, algal bloom, fish kill) and has to identify the source of the problem (which stream(s) and which parameter). For each scenario, a single cause of the problem is selected at random by the computer (one water quality parameter is at elevated levels in one of the 6 streams) For each stream, data for each water quality parameter are recorded for each grid cell, embedded behind the aerial photograph. The data were generated to give a particular mean reading and particular standard deviation, with the data distributed randomly among the grid cells. Thus the data actually obtained by the user depend on (1) the scenario - chosen randomly by the program, (2) the offending water quality parameter, again chosen by the program, and (3) the exact locations of the water quality readings, selected by the user.
A real context illustrating trade-offs	The user acts as an environmental consultant preparing a tender for a large study to uncover the cause of the problem in the lake. The tender has to be competitively costed, yet the proposed study must have sufficient power to detect which water quality measurements are elevated
Unconstrained exploration of the problem	Once entering the program, the user is allocated the scenario by the computer, and the computer then allocates the water quality data to the streams (unknown to the user - but with an encrypted code). Every measurement taken is then costed and recorded on the user's diskette. There is no limit to the number of readings that may be taken (the cost just keeps going up!). The user can quit at any time, and return to the same scenario to continue sampling (data and encrypted code taken from the diskette). Otherwise, the user can elect to start a new simulation, whereupon a new scenario and new data set are allocated.

Table 1: A Mapping of Objectives and Activities within the Package

The biological context

In order to redress shortcomings, outlined above, in the training of environmental scientists, both students and professionals, we decided that the following elements were necessary in a simulation package:

1. the ability to gain background information about the system to be studied, as important issues, summaries of existing knowledge and access to relevant current literature;
2. a way for the user to conduct a pilot study, in order to gain information about the amount of background variation in the parameters to be measured;
3. some resources to guide the user in the calculation of the sample sizes needed for the generation of statistical power sufficient to detect a biologically important impact of some disturbance.

In addition, we wanted the simulation package to be realistic at a number of levels including:

1. the user shouldn't know what the data are until after conducting a simulated sampling program;
2. the context of the simulation should illustrate the real trade-offs, experienced by environmental consultants, between cost and accuracy, and between type 1 errors (false positives) and type 2 errors (false negatives); and
3. the user should be unconstrained in the design of the sampling program, and should therefore be able to explore the problem thoroughly – but with full realization of the real dollar costs of such exploration.

[Tab. 1] maps the package objectives against the activities that were designed to achieve the stated objectives. The simulated consulting experience commences on choosing the consultant office icon. Users are asked to start a consultancy or to continue a previous study. If the user chooses a new consultancy, the package sets up one of three scenarios as the consultancy task and places the appropriate statistically distributed data within the lake environments. If the student does not complete the task at the one time, they are prompted to save their data. When the user continues with an investigation, the application asks for a data file saved from the previous use of the package. The data file has an encrypted header, which is used to set the scenario so that they can continue with the same tender problem and preset data.

For new users, a phone message left on the message systems notifies the user that they should have received a tender document and Lake Iluka Management Committee. Users have access to a Ecological Survey Manual, a filing cabinet which contains 'grey' literature, aerial photographs of the lake, sample tenders and costing ideas, a computer that contains an ecological data base, a data logger that gives the user access to data logging in any of the five water inlets to the lake environment and the tender document itself.

Outcomes of the study

The package has been piloted to the level of tender production with two different cohorts of students, second year Environmental Engineers (n=25) and third year Ecologists (n=15). It is planned to carry out a more extensive evaluation of the package and testing of learner outcomes. These initial studies were carried out as part of the formative evaluation of the package and to support the design of a more detailed experiment. Qualitative data was collected from each student via a questionnaire, student interviews and tutor interviews.

Students report that they experienced no substantial problems nor learning difficulties with the application's useability, navigation, interface design, media access and access to information about sampling processes and constraints. They also reported that the language used in the package did not pose any concern nor did any lack of any previous experience with computer simulation (25% had no previous experience). Overall most students reported being satisfied and enthusiastic about the use of technology-based media as part of their curriculum. Most students agreed that they would recommend the strategy to future students and, more importantly, would themselves be willing to use the media in the future for similar purposes.

However, two common concerns for many students were the lack of any specific resources describing or modeling the production of a tender proposal, and the lack of a clear understanding of the task that they were to carry out. Even though students were given unlimited time to use *Researching Lake Iluka* in computer laboratories, they reported being unclear, initially, about how the package related to the assignment task. Despite this concern, the tutor felt that almost all students in both trials were able to produce a tender document that addressed the key issues. Some students immersed themselves within the context and produced reports of a professional standard, including fictitious company logos and covering letters outlining the quality of their tender and providing arguments as to why the Lake Iluka Management Committee should accept their very competitive and scientifically sound tender. All except one student were able to develop an adequate statistical argument about the sampling requirements and the experimental design, and most students (95%) were able to use the statistical approach to identify the possible causes of the randomly-assigned ecological problem. The most satisfying outcome for the tutor was the quality of the hypothesizing displayed by the students in outlining the problem to solve. Many used their data ampliative skills to derive more useful pieces of data on which to generate relevant hypotheses. However, the tutor also considered that the students were weak on interpreting information to further refine their hypotheses. One of the pilot groups in particular was weak on statistical analysis skills and most students in this group took too narrow a view of control data, offering only single comparisons rather than multiple control groups [a similar problem to that noted by Fisher and Wishart, 1930].

The initial studies have pointed to some important shortcomings in the package, which are currently being addressed. Example tenders and a tender document template will be incorporated into the filing cabinet information. Based upon other related studies on cognitive tools [Hedberg *et al*, 1997], the process of generating a tender response will be supported as a process and students will be provided with a pro-forma model if they request such support. To introduce the assignment task, more context-related explanation will be provided, such as an experimental design tutorial for students weak in that area. Currently, an experimental study is being conducted, which will examine more closely the outcomes achieved, especially the learning gains achieved by working with a set of resources in context compared with similar resources but without the option of exploration nor the simulation of context. This study has shown that the effort involved in building a simulation context and its links to real-world professional skills has been worthwhile. The remaining task revolves around the development of professional skills for those weaker students that might require more procedural help with achieving satisfactory learning outcomes.

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Supporting Human Instructors on Information Processing Education

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Abstract: Since information technologies have developed rapidly, information processing education has become more important and more widely practiced at educational institutions. We are currently designing and developing a computer assisted environment for exercise class of information education processing, focusing on the both assistance for teacher and TAs.

1. Introduction

As information technologies have developed rapidly, information processing education(we call IPE hereafter) has become more important and more widely practiced at educational institutions [Watanabe et al. 96, Kawamura et al. 96]. It is important issue that appropriate IPE is offered to students. IPE is generally classified into lecture and exercise. With regard to appropriate lecture, traditional approaches such as sophistication of educational material and instructional strategy are effective. On the other hand, with regard to appropriate exercise, several new approaches such as introducing CAI system or Teaching Assistant(we call TA hereafter) have been adopted.

Our research work focuses on improvement of exercise for IPE. In the exercise class for IPE, the teacher must deal with additional tasks such as checking student's exercise activity and so on compared with tasks in the lecture for IPE. Therefore, the teacher generally needs some helpers for the class. As this paper above-mentions, one of the solutions is to introduce TAs into the exercise class. At universities, an exercise form which a teacher and a few TAs assist the students is actually increasing and this technique enhances the performance of instruction in the class.

TAs usually deal with local instructional part of the class respectively and they seldom do their works by grasping the situation of whole the class. Therefore, the above-mentioned solution does not work well, unless the teacher appropriately manage the TAs' tasks according the dynamic change of the class situation. The arrangement of TAs' tasks is regard as a new additional task of the teacher by introducing TAs. They generally play roles for assistance of students in the class. However, in general, they are not instructional experts such as teachers. This suggests they do not have enough instructional skill so that it is important to assist their instructional activity somehow.

The above-mentioned analysis requires two kinds of assistance in the class including TAs: one is for the teacher and the other is for the TAs. We are currently designing and developing a computer assisted environment for exercise class of IPE, focusing on the both assistant points. With regard to the former, we are developing a class management application called PROGRESS which monitors the dynamic situation of the whole class and indicate it to the teacher. With regard to the latter, we are developing CAI systems called DAs: Domain Applications for each specific domain. DA is ordinary traditional CAI system but is enhanced to monitor the student's learning information which the TA use for her/his instructional task. This paper describes the educational features of the both systems based on some viewpoints such as task sharing between human instructors and computer (educational system) and so on.

2. PROGRESS and DAs

For IPE, a new style of the class which a few TAs share the teacher's tasks in order to reduce the loads of the teacher has been increasing. We call the form "class with TAs." The TAs guide students who cannot understand the teacher's instructions. We call such students "student-As" hereafter. On the other hand, the TAs advise students who have understood the contents of class in order to help them stabilize their knowledge. We call such students "student-Bs" hereafter. The ideal style of the class with TAs are following:

- The teacher can command the TAs to assist the students who need assistance immediately.
- If the both students need TAs' assistance, they can get assistance from TAs immediately.

To realize the ideal style of the class with TAs, it is necessary to find students who fall behind and to assist them appropriately. However the class style has several problems and it does not work effectively occasionally. The following are the problems of the class with TAs.

1. Because of number limitation of TAs, they cannot guide many students at once.
2. The student-Bs cannot get advice by TAs while the TAs guide the student-As.
3. TAs' assistance are restricted by the need to monitor understanding and progress status.

To solve the above mentioned three problems, we introduce a CAI system in the class with TAs. We describe our CAI system's features and advantages in the following.

(1) Sharing of tasks with the teacher, the TAs and CAI system
(2) Providing learning environments corresponding to the student's level of understanding
(3) Class management

As for (1), we divide tasks required in the class into two types. One is the teacher or the TAs' task and the other is CAI's task. We can expect the quality of the teacher and the TAs' assistance to improve because of reduction of their loads. For example, the students can ask questions to Domain Application (DA) or the TAs.

As for (2), Most of the students in the classes on information processing have little knowledge about computer and information processing. The students must form, confirm and stabilize knowledge. DA provides three learning environments:

- a trial and error learning environment (TELE),
- a knowledge confirmation drill learning environment (CDLE) and
- a knowledge stabilization drill learning environment (SDLE).

The students-As can study in TELE and CDLE and the students-Bs can study in SDLE.

As for (3), PROGRESS shows each student's progress status, drill marks and ID number to the teacher and the TAs. For Example, PROGRESS shows icons called Learning Status Symbols (LSSs). The colors, shape and motions of LSS differ according to student's progress status. The teacher indicates the TAs to assist students who fall behind appropriately by referring to all students' LSSs in the teacher's machine. The TAs can also guide and advise the student by referring to the LSS in the student's terminal. In addition, DA changes the way of assistance corresponding to the student's progress status according to the LSS from PROGRESS. PROGRESS generates and updates the LSS according to the student's learning status information from DA. LSSs are independent of the contents of class because every DA sends the information in the same form.

3. Summary

We have described a CAI system which assists classes on information processing. Our CAI system consists of PROGRESS and Domain Applications (DAs). PROGRESS assists the progress of class. DA assists the contents of class. Our CAI system reduces the loads of the teacher and the TAs. In future work, we will introduce our CAI system in classes with TAs. We will evaluate our CAI system by considering the reduction of the loads of the teacher and the TAs by sharing of tasks, tasks which CAI system does and tasks which must be done by the teacher and the TAs, and the quality of classes.

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Using E-mail to Support a Field-based Reading Course: An Evolution of Who E-mails Who?

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In recent years more and more university education students are using e-mail accounts for personal communication with family and friends. It is possible that university instructors can now more easily integrate e-mail use as a means to communicate with these students for course assignments and activities. Computer-mediated communication (CMC) can be used by instructors to meet axiomatic as well as ancillary course needs [Hedrick & McGee, 1996]. This paper presents a summary of experiences over the past two years where e-mail was used for axiomatic needs associated with supporting students in a field-based reading course. The authors acknowledge that the use of e-mail, one CMC tool, in university classes does not present a unique situation. They do, however, offer the experience of two years of manipulating various configurations to find what might work well for *this* particular instructor in *this* particular field-based course. The authors hope to stimulate ideas and discussions about the use of e-mail to support field-based courses and to inform research directions in the use of e-mail in field-based education courses.

E-mail Use in Preservice Education Classes

According to a 1995 national study by the Office of Technology Assessment [US Congress, 1995], technology preparation is not currently playing an essential role in the development of prospective teachers. Technology, however, could be logically integrated into teacher preparation programs. Using e-mail as a communication medium between class peers, students and their professors, or students with practicing teachers could provide support for field-based courses. The medium could bridge some of the communication hurdles that can exist in these courses since students are physically separated from their instructors and peers.

CMC may involve the communication of course information such as posting grades or disseminating course materials [Poling, 1994] and journaling [Cooper, 1996]. Additionally, CMC may include deeper levels of communication such as telementoring [Tannehill & LaMaster, 1996] [Traw, 1994], counseling [Poling, 1994] and moral support [Merseth, 1991], and exchanging ideas and information [Hedrick, McGee & Mittag, unpublished paper].

Research further indicates that CMC may facilitate more open and democratic conversations [Meacham, 1994] and questioning between teacher and student [Downing, Schooley, Matz, Nelson, & Martinez, 1988] It may make professors appear more accessible to their students [McComb, 1994]. Additionally, it may encourage engagement of students in course work apart from the regular class sessions [McComb, 1994].

Use of E-mail with Reading Tutors

The education course described in this paper engaged students in field-based tutoring in reading. The course design allowed students to apply the knowledge gained in previous courses to real school settings and real children with diverse needs. Therefore, the bulk of the course experience occurred on an elementary campus and involved a minimum of 30 hours of one-on-one tutoring with elementary reading students. The designated students (grades 1-3) had scored poorly on either a standardized reading test or other indicators such as an informal reading inventory.

The tutors met for three face-to-face sessions before going out into the field. E-mail provided a forum for discussing problems and concerns as well as delivering pertinent information between the tutors and the instructor. The instructor required tutors to e-mail weekly throughout the course with concerns, questions and comments on their experiences. The instructor was available for regular office meetings or phone calls, but e-mail provided the main medium of communication.

Evolution of E-mail Combinations in the Reading Course

For the last five semesters, the tutors have engaged in on-line conversations. Each semester the course instructor adjusted the guidelines in order to encourage increased student engagement, while continuing to make the large class sizes manageable for the instructor. Four different configurations of e-mail dialogue contexts provided over the two-year evolution of the course included: professor to tutor only; professor to tutor, tutor to tutor leader, or tutor to small group of tutors (tutors randomly assigned to groups); tutor to tutor leader; (leaders chosen from initial paper assignment and willingness to help others—group assignment based on knowledge presented in initial paper; tutor to graduate mentor; and professor to tutor and tutor to tutor. Each configuration built on the instructor's experiences—positive and negative--from the previous semester's experiences.

Conclusions

The use of e-mail has the potential to build a virtual community of learners where concerns, successes and questions can be shared [Norton, 1995]. Professors can provide support for their students in the field without expending travel time and money to go to the field site. In a large class of undergraduates, a professor could not hear each person talk about their field experiences during the week every week. However, using e-mail, they can. There is great possibility for the instructor to observe student's misunderstandings and help the student resolve them as the student presents them via e-mail. In this way, the professor provided an "individualized" learning experience difficult to replicate in more traditional class structures. Throughout each configuration, e-mail proved a valuable tool for the instructor to stay in touch with the students and address their needs.

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Multi-media Reading Assessment Tutorial Prototype Development

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This project, a work in progress, uses a multi-media platform to create a tutorial that assists preservice education majors in understanding how to assess children in reading. The product will enhance the learning of preservice teachers engaged in field-based experiences. Reading is a high priority in the United States. More frequently local, state, and federal mandates have called upon K-12 schools and universities to improve teachers understanding of appropriate pedagogical practices that will raise the level of reading, particularly in early childhood. A multimedia tutorial can allow just-in-time learning for both preservice education students as well as practicing teachers.

Multimedia and Learning

Hypertext has proven to be an effective medium through which simulated experiences can result in learning [Kahn & Lenk, 1995; Springer & Noblitt, 1995]. "Hypertext enables learners to construct, organize, and convey personal knowledge" [Jonassen, 1992, p. 84]. The more actively engaged a learner is when constructing knowledge, the more likely they are to acquire knowledge than if "they merely use it" [p. 85]. Hypertext can be used to create interactive multi-media instructional activities which support learning.

Multimedia programs provide many cognitive and pedagogical advantages that are particularly crucial in a field-based course. These include:

- user control [Bork, 1991; Marmolin, 1992; Kolb, 1984]
- non-linear organization [Gavora, 1992]
- individualized instruction [Bork, 1992; Kolb, 1984]
- active processing by user [Ropa, 1990]
- multisensory learning [Marmolin, 1991; Jenkins, 1990]

Problems in the real world of the practicing teacher are complex and ill-structured. It is difficult, if not impossible, to predict what problems will be encountered on a day-to day basis. According to Jacobson and Spiro [1993] hypermedia systems can provide complex and ill-structured contexts that support knowledge construction. Multi-media products can provide a wide range of situations that might occur. When these experiences closely resemble the real world situation, transfer of learning is more likely to occur.

Field-based Teacher Education

Field-based experiences are those in which the preservice teacher observes or is actively engaged in instruction or management of students. Teacher education may vary widely from campus to campus but most programs abide by the premise that field-based experience can contribute to developing skills. Although supported by student testimonials, it is not always substantiated by research [Hollingsworth, 1988; Cruickshank & Amarline, 1986]. There is some evidence that field-based experiences do benefit the novice teacher. In an analysis of perceived learning from a field-based experience, Goodman[1985] found that most students saw these experiences as the most substantive component of their training [Arenz & Appel, 1994].

Preservice teachers often have difficulty transferring what they learn in a class to their experiences in a K-12 classroom. Simulations and case studies can assist students in transferring information by replicating the critical attributes of the authentic learning environment in the schools [Kenny, Covert, Schilz, Vignola, & Andrews, 1995; Thurman, 1993].

Project Description

The concept for this project came from *Reading Problems*, a field-based course where preservice teachers deliver one-on-one instruction to children experiencing difficulties in reading. The field-based nature of the course requires students to spend most of the course in the field rather than in class with the instructor. Although there is ready access to the instructor and peers via e-mail, preservice teachers often confront problems while tutoring in the field that require immediate and informed feedback. One major concern for the field-based preservice teachers in this course is diagnosing reading problems. Print materials can not adequately describe these problems since auditory, visual and verbal cues must be analyzed. In absence of a trained professional during the one-on-one tutoring sessions, a multi-media interactive tutorial allows preservice teachers to review common problems and learn to diagnose and respond to these problems. The tutorial provides just-in-time learning as the preservice teacher encounters problems. It can also provide an anticipatory set that makes students more aware of student behaviors when the occur.

Materials development began with a print manual that illustrated a step-by-step explanation and sequence for using five assessment tools. The content came from established and tested reading theories, strategies, and instruments. The manual describes what each tool is, how each looks, how to use each tool, and what the test tells the user. The printed manual has been in use for one year. The second material is a video that illustrates the process of using assessment tools. The third component is the multi-media product that is a combination of the manual and video with an interactive component based on current cognitive processing within computer-mediated environments. The multi-media tutorial assists the preservice teacher in:

- following a reading assessment sequence
- identifying reading problems in K-5 students.
- identifying reading barriers in K-5 students.
- selecting appropriate strategies to resolve identified problems.

The first phase of field-testing involves expert review, followed by observation of undergraduates using the tutorial. Input from these two groups provided the basis for changes made to the prototype.

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Collaborative Electronic Library Framework (CELF)

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Abstract: The Collaborative Electronic Library Framework (CELF) is an architecture enabling a group of users to build a specialized digital collection organized around a set of topical areas of interest to a community of users. The system provides services to collect network-based information and tools to publish collected information into different topical areas through both manual and automatic mechanisms. Services are also provided to enable users to locate and retrieve useful information from the repository by browse and search techniques. All access to CELF is via a Web browser.

1 Introduction

The Collaborative Electronic Library Framework (CELF) provides an environment for developing an electronic library [Levy et al. 95] using an integrated suite of advanced data processing tools. The system incorporates data collection utilities and categorization services for automatically assigning collected documents into different topical areas. Document contribution and review services are provided to enable manually submitted information to be added to the library. A browse and search subsystem is also provided to enable users to effectively access and "mine" the information repository. Certain concepts of CELF have evolved from the MIDS project [Helm et al. 96], which is an ongoing MITRE sponsored research project involving research and development in the area of information organization and discovery.

One basic principle behind CELF is to provide a framework whereby a group of users can build a specialized collection that is of value to a particular special interest community. A pilot project is underway to test the feasibility of the concept, where a group of participants were selected to build a specialized collection using the CELF framework.

2 System Description

CELF includes two browsable and searchable repositories: a "core" manually generated high-quality collection, referred to as "library," and an automatically generated collection, referred to as "sources." The sources repository contains documents which are collected and categorized by automatic techniques, while the library repository contains documents that are manually published by a group of users. Information contained in the sources repository is collected by recursively harvesting Web documents beginning from manually specified top level URL's, as well as via a integrated search agent [Genesereth et al. 94] that issues canned queries against Web-based search engines to provide a more precise and focussed topic-based collection mechanism. Both the library and sources repositories are available for end-user access. The sources repository also serves as a primary collection that document contributor's will access as a basis for locating documents for inclusion in the core library collection.

Information submitted to the library is initially entered into an HTML form interface, which enables meta-data describing a document to be provided, such as URL, title, description, abstract, and topical categories. Documents for which meta-data are entered can be obtained from many different sources, including the CELF sources repository, Intranets, and the Web. In general, only meta-data is actually stored within CELF for all collected documents. A URL meta-field provides access to the full document stored at the remote location, although an option is provided on the document submission form to specify that a copy be made of the remote document. For copied documents, the URL meta-field points to the local copy and an "external-URL" meta-field provides access to the original remote document. A publishing option is also provided for a document contributor to create a document on their local computer and upload it to CELF.

After a document is submitted for the library repository, it goes into a "pending review" state, where a document reviewer will approve or reject the document using a review interface. Approved documents are periodically added and indexed in the library repository where they are made available to end-users via the browse and search interfaces. Rejected documents are removed from the system. A document reviewer can also add additional comments and/or update meta-data for a document prior to the approval stage.

3 Conclusion

CELF is currently being utilized in a pilot project that includes a group of users who are building a specialized collection focussing on the continent of Africa. The project will run for a number of months and will culminate with a report detailing "lessons learned" as a basis for building a more effective system in the future.

The CELF prototype includes a number of notable features. Among the most interesting are the two-repository approach that is comprised of the library and sources repositories, the contribution subsystem, and the automatic meta-data collection and categorization methods.

Preliminary feedback received during the pilot project has shown that the inclusion of both a manually generated and automatically generated collection proves to be quite useful. Typically, the information content in a manually generated repository can be of higher quality than one that is automatically generated; however, an automatically generated collection can include many more information items. This is primarily due to the fact that automatic techniques enable a larger volume of information to be harvested and categorized. The individual documents contained therein, however, may not necessarily be as relevant to the topical categories to which they are assigned due to recall and precision anomalies [Salton et al. 83] inherent with utilizing automatic meta-data extraction and categorization techniques. The CELF techniques available for enabling document contributor's to easily add documents from the sources repository into the core library repository have also proved to be quite effective. In addition, utilizing the topical profile driven search agent has been a very effective method to improve the relevancy of documents automatically collected for the sources repository, as compared with the technique that harvests documents from entire Web sites beginning with manually provided top-level URL's.

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Creating Interactive Constructivist Applications for Special Education

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Abstract

There is a great need for improved modalities of instruction for children that have learning disabilities. A new initiative originated by the Touro College called the SECP Project - Special Education Computer Project, a joint project of the Academic Computing Department, Graduate School of Education and a local elementary school, was created to produce software that uses constructivist theories which is centered around the needs of the individual student. This demonstration session will illustrate different software developed by the initiative and the design considerations for the software.

Software Overview and Design Considerations

The software was developed using a software development tool called Toolbook by the Asymetric Corporation. Toolbook is a Windows based authoring tool that is especially useful for creating educational materials because of its ease in combining text, graphics and animation. The design considerations of the educational software were using basic principles of instructional strategies coupled with a teaching philosophy for special education students.

The following where basic design considerations:
- Increased time-on-task
- Increase the relevance and amount of individual feedback
- Performance based progression system
- Pacing instruction to the capabilities of the individual student
- Cooperative learning strategies
- Constructivist learning theories

The SECP Project is on going joint project that has created educational software to serve the special education population. Initial formative evaluations has shown that the students are enjoying using the software and the teachers feel that it is enhancing the educational environment of these special needs students.

Software Description

The software development is based on instructional activities designed by educational experts in the field of education for the learning disabled student. The designer has retrofitted these educational activities to be simulated on a computer. The software development project was performed for instructional activities related to mathematics. The following are a listing of the games with learning objectives.

"Two Up"

Objective: To practice multiplication facts by rehearsing counting by twos, threes, fours, etc.
Grades: Primary through intermediate
Prerequisite Behaviors: Counting by twos, threes, etc.

Bingo Clock Reading

Objective: To give the students practice in associating the time on a clock face, to its written form on a game board, to its spoken form.
Grades: Primary

Fraction for Breakfast

Objective: To help students strengthen their understanding that fractions are subdivisions of whole numbers: also, to build students' conceptualization of fractions being added together.
Grades: Fourth - Sixth

Hurricanes and Hypermedia: The Use of Satellite Images in the Study of Rain Characteristics

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Abstract: During 1996, coastal North Carolina experienced an unusually frequency of intense weather events, ranging from hurricanes to tropical storms. Due to the unique characteristics of each of these events, the opportunity emerged to analyze the relationship between storm pattern and rain chemistry. A hypermedia system encompassing this data will then be used to help students understand the complex system by which both natural and human-made sources can modify the chemical composition of rain, as well as the resultant environmental and economic impacts of such changes.

Introduction

Coastal North Carolina is subject to a wide variety of weather patterns. Most familiar to the public are the hurricanes and storms which impact the area. During 1996, southeastern North Carolina was subjected to an unusually high number of intense weather events. Among these were two well documented hurricanes, Bertha and Fran, which made landfall in the Cape Fear region less than two months apart. This period also saw numerous intense tropical and coastal storms in the same area. This unusual diversity, as well as frequency of weather events provided an ideal opportunity for the comparative analysis of rain chemistry in relation to storm type and origin, particularly focusing up rainfall acidity as an indicator.

As the availability and quality of meteorological and climatological data has increased rapidly in recent years, so has the complexity of utilizing this data in both research and educational settings. Particularly relevant to the current project is the availability of satellite and radar imagery, combined with ground-based data gathering and forecasting systems. Online and real-time sources for such data are proliferating. The advantage of such media is that they lend themselves to integration into a hypermedia database, particularly one which is not only available online, but comprised of online data from diverse sources, as well. Through implementation of a user-friendly front-end to such data, the complexity of access and use can be minimized, for both researcher and student alike.

The focus of this study, then, was to analyze the chemical characteristics of rainwater in relation to storm type. The resultant data can then illustrate organic factors which can affect the quality of precipitation, as well as anthropogenic factors. In order to facilitate such research, an online hypermedia database encompassing related data and imagery was developed. The database, then, can assist in the educational process by helping students to understand the complex system by which both natural and human-made sources can modify the chemical composition of rain, as well as the resultant environmental and economic impacts of such changes.

Methodology

Data gathering focused upon chemical analysis of rainwater and storm type classification. Rainwater was collected using an Aerochem metric wet-dry sampler. Analysis was performed within two hours of collection, and included measurements of precipitation amount and pH, as well as hydrogen ion, non-seasalt sulfate, and nitrogen concentrations. Storm classification was based upon local climatological data [NCDC 1996] [NOAA 1996b], National Weather Service bulletins [NOAA 1996b], synoptic weather charts [NOAA 1996a], GOES satellite images [NOAA 1996b], Nexrad images [WSI Corp. 1996], and synoptic maps with a satellite overlay [Purdue University-WXP 1996]. The richness of the dataset, as well as the abundance and diversity of related local and remote electronic data, necessitated the development of a hypermedia database in order to render it usable and manageable. This created an opportunity to integrate these sources into a computer-based hypermedia database accessible via the Internet on a World Wide Web browser, such as Netscape Navigator [Fig. 1].

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

Figure 1: The hypermedia database front-end

In this project, in addition to rain chemistry data, the plethora of imagery assisted in the investigation and presentation of the various relationships. In essence, the networked hypermedia database provided access to necessary data in a variety of media formats (including text, graphics, and photographs) which were linked through a simple "point and click" interface. The advantage of such a hypermedia database format over traditional non-electronic media was that it allowed examination of the data in a nonlinear method which did not predispose an approach to the data in a predetermined manner. This is true whether the user is a researcher or a student.

Discussion

The results show that acidity of precipitation from coastal storms, tropical storms, and hurricanes is not significantly different. However, local thunderstorms have been shown to be significantly more acidic. If we are to consider that anthropogenic sources, or those with human-made origins, of sulfur dioxide and nitrogen oxides in the eastern United States exceed natural emissions by at least a factor of 10 [Lindberg 1982], then we have a basis for understanding these results. High levels of these sulfates in local thunderstorms should therefore lead us to implicate human activities in acid precipitation, particularly those derived from local sources.

These results of this project have implications not only for research, but also for education as well. This is especially true since a primary source of acids can be traced to human activities. Therefore, the hypermedia database which was developed can be used not only as an analytical tool, but also as a teaching tool. Its function can then be to assist students in fully understanding the influence of human activities upon acidity in precipitation, through illustrating the differentiation of storm type in relation to acidity levels. However, due to the complexity of this concept, as well as the diversity of data which illustrates it, a hypermedia database was essential. To this end, the system which was created and utilized embodied the essential aspects of an educational hypermedia system: 1) knowledge presentation, 2) knowledge construction, and 3) knowledge representation [Nelson and Palumbo, 1992]. In addition, the availability of the database through the World Wide Web not only widened the sphere of accessibility to the data, but also provided opportunities for collaboration. It is for these reasons that hypermedia is rapidly arising as a primary approach to the management of complex and related data due to its efficacy in providing a basis for new modes of thinking and communication [Conklin 1987].

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All the Bells & Whistles: Team-Teaching, Travel, Technology

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New Material Delivered in a New Way

During the spring quarter of 1998, we embarked upon a newly-created course entitled: "The Literature and Culture of Continental Europe after World War II." Though the course did not draw as much attention from institutions within the University System of Georgia as we originally hoped, it did attract one student at Waycross College in Waycross, Georgia, who decided to join the course via the GSAMS (Georgia Statewide Academic and Medical System) Network [http://www.gactr.uga.edu/GSAMS/gsams.html], thus allowing us to incorporate the telecommunications technology into our course delivery methods.

The course gives the on-site and distance-site students an exceptional opportunity to study contemporary Europe. While the main focus of study is the literature of both Western and Eastern Europe, the course also examines the contemporary history and politics of the European continent, focusing on post-war Germany and France as well as on communist and post-communist countries, such as Russia, Poland, and the Czech and Slovak Republics. Because so much of contemporary European literature is linked inextricably to its cultural milieu, this course explores Europe's complicated geography, its religions and religious denominations, its many languages, its economic development, and its popular culture.

The course format is that of a chronological survey which moves back and forth - not so much in time, as fromWest to East - in order to demonstrate the deep, resounding effects of life before and behind the Iron Curtain. The course awards ten-credits and is team-taught - with Ms. Cooke-Plagwitz teaching the segments on Western Europe and Ms. Hines teaching those on Eastern Europe. Both instructors utilize hypermedia and multimedia teaching strategies, including, but not limited to, an online (hyperlinked) syllabus, interactive hypermedia assignments for students, multimedia/computer-enhanced presentations, e-mail and online chat cultural exchanges, CD-ROMS, films, audio recordings, and distance-learning (telecommunications) technology. The course also includes an optional travel component to central Europe, which serves both to unite distance learning students enrolled in the course as well as to underscore the major themes and issues of study.

Why Teach Culture?

The rationale behind the development of this course finds its basis in the Georgia Board of Regents' initiative to "internationalize" the curriculum of the state's educational institutions. The introduction of this course constitutes a vital step in this direction. In order for graduates to be marketable in today's increasingly multicultural society, they must be exposed to cultures and ideas other than their own. Indeed, one of the primary goals of this course is to spur students into recognizing their own ethnocentric perceptions regarding the literary and cultural canon by introducing them to the major themes and works on the contemporary literature and culture of a number of Western and Eastern European countries.

Technological Applications in Teaching Literature and Culture

Technology plays an integral role in the course. Not only have the instructors developed multimedia presentations and hypermedia syllabi, but students are developing and contributing to a course Web site as well as taking part in e-mail and online chat cultural exchanges. A good deal of timely resources and materials, such as the speeches of Vaclav Havel and of Günter Grass, are available on the World Wide Web and have been integrated into the online syllabus. Other offline technology is involved as well, including films by notable directors, such as Costas Gavras and Krzysztof Kieslowski; CD-ROMs on various poets and writers; and audio recordings of selected speeches and readings.

Course Delivery and Structure

As the course earns the student ten credits (twice the number of the standard single-quarter course), the class meets Monday through Thursday from 1 p.m. until 3:30 pm (twice the classroom time as the standard single-quarter course). In order to allow the instructors to cover their topics as fully as possible, the classes are set up so that both faculty members alternate teaching weeks: one week on Eastern Europe with Ms. Hines, the next week on Western Europe with Ms. Cooke-Plagwitz, and so on. The first course unit, entitled "1945-1955: Postwar Concerns," begins with a reading of Günter Grass' novella, *Cat and Mouse*, and a discussion of an anti-Nazi satire on post-World War II Germany. In the following week, students learn about the political and social concerns of Eastern Europe in the same time period with Heda Margolis Kovaly's *Under a Cruel Star*.

The same format is followed throughout the ten-week course, covering the following units: "1955-1965: Communism and the 'Communist Threat'", "1965-1975: Pacifism and Revolution", "1975-1985: Disco to Punk", and 1985-1995: Reunification and 'Open societies.'" During their course of study, students are encouraged to choose an author of a topic of particular interest to them and to do extensive research on that topic. A cooperatively constructed course Web site constitutes a common final class project to which all participants contribute with their essays and with any interesting hyperlinks found during their research. Those students who participate on the Central-European tour are also encouraged to contribute photographs and journal entries made during their travels to the Web site.

Variations on a Theme

The course format encourages informal online discussion among the students as well as between the students and the instructors. Web-based forms prove to be useful forums for discussion of many of the works and concepts introduced to the students during the study. This course calls upon the special areas and interests of the faculty members involved. Because the topics are so specialized, it is highly desirable that the course be team taught in order to present these various themes and works most accurately and effectively. In future incarnations of the course, guest lecturers will underscore this commitment as well, and expand the collaborative effort. The course is transferable through humanities faculty members who have knowledge of contemporary European literature, art, music, language, etc., and lends itself very easily to a distance-learning format.

Computer Social Interaction and Individual Cognitive Growth: Vygotsky's Role of Language-Both Social and Private Speech

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1. Introduction

Constructivism is a moderately new term used to define an eclectic collection of theories that include ideas from the 1920/1930's(Piaget and Vygotsky), 1950/60/70's (Bruner and translations/interpretations of Vygotsky) and the 1980/90's (Wittrock and Duffy). The glue that forms these varied theories into constructivism is the belief that individuals actively construct knowledge by striving to solve real problems, and that they often do this in collaboration with other learners. In particular there have been many interesting writings comparing and contrasting the early work of Piaget with the writing of Vygotsky.

Although Lev Vygotsky was a peer of Jean Piaget, political issues kept most of his writings buried in Russian libraries until the last quarter of this century. This makes the "dialog" between these two psychologists anecdotal at best.

Among current researchers, it is widely accepted that Piaget underestimated the role of private speech in cognitive development. This paper presents the position that the two theorists were not as much separated by their differences on "egocentric speech" and "private speech", but rather linked by their ideas that knowledge is constructed via social collaboration. They both believed that the relationship between individual and social environments was much more dynamic than the simplistic division we often accept. Vygotsky believed that the very boundary between social and individual must be brought into question. This is why he stressed his well-known idea of a "zone of proximal development". He defined this as the distance between the level of actual development and the more advanced level of potential development that comes into existence in communication between unequal partners. He hypothesized that the lower ability individual could partake in more advanced activities that would be above their competence when working alone.

2. Approach

This paper looked at what we could learn from the views of these men (especially Vygotsky) and how we might apply them in a practical manner in the learning environments of computer-based lessons with young children. A review of current literature was combined with a basic quantitative study to determine if private/social speech affected kindergarten student's task performance on microcomputer based problem solving activities.

Earlier studies have shown that young children's private speech facilitates their performance, but none could be found testing these results in the context of computer assisted tasks. Included were hypotheses to determine: (1) variations in social/private speech (s/ps) between the keyboard (interface) possessor and the paired partner and between the more capable and less competent partner; (2) relationship among frequency of s/ps, task difficulty and improved task performance as related to keyboard possession and computer competency; (3) the effects of task repetition on these activities.

3. Summary

The social collaboration beliefs of Piaget and Vygotsky continue to be important in our study of children's success in a computer environment. Although the study provided no startling results, it did confirm the relationship of private speech and task performance. It also provided some interesting insights into the effects of computers on the use of private speech. In particular we need to further study the effects of various roles in a cooperative learning situation. The keyboard possessor appears to be more inclined to use private speech than his/her partners. This private speech activity may have led to the higher task success rate of the keyboard possessor (as well as the effect of "hands-on" benefits). It was also interesting to note that the keyboard possessor increased the use of private speech at subsequent sessions on the same software task. One could postulate that the keyboard possessor needs less external input as s/he becomes more competent and turns to private speech for further cognitive development.

Although current thought supports the idea that pairing allows for more opportunity for collaborative learning, future researchers and teacher practitioners may want to develop strategies to control this "keyboard-control" phenomena by rotating roles and stimulating social speech activities in multi-session assignments of computer teams. This may help create more level improvement on task success. Simply putting two or more students at a computer with the idea that "teams" will learn together may lead to very uneven results when individual improvement on task is charted. The findings demonstrate the importance of educating parents and teachers about the positive, self-regulatory function of private speech. It also accentuates the fact that computers and networks have created new learning environments that are slowly replacing older settings. The relationships among a student, his/her peers, and the electronic "virtual peer" (computer) must be further studied and the information disseminated; Vygotsky and Piaget told us so, over 60 years ago.

Coupling Physical Artifacts and Abstract Representations

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Most new learning media in classroom tend to separate concrete handling of artifacts from abstract, cognitive learning, as books did all along. Physical experimenting gets reduced for time and cost reasons. Yet physical models play an important role for cognition and communication. Sensuous experience of objects can contribute to conceptual understanding, helps to gain tacit knowledge. On the other hand computers are useful tools for analysis, simulation and animation. They can help us to understand the abstract and complex. Our approach aims at bridging those two modeling worlds: the real world of physical objects and the virtual of signs and images. The project described here will show the feasibility and the possibilities of a computer supported learning environment for the subject of pneumatic circuits in vocational training.

The name „*Real Reality*" was coined around 1993 [Bruns et al 93] in contrast to „Virtual" Reality. The concept [Bruns 93] bases mainly on a tight coupling of real artifacts with virtual counterparts. The real objects are either models of something (e.g. bricks symbolizing houses) or the thing itself. They are used to construct a system on a workspace. Users operate with sensorized hands (DataGlove) or in a scanning environment with these objects while the computer tracks and interprets their actions and gestures. It synchronously assembles a corresponding virtual model, including the dynamic actions of the users hands. Virtual objects may contain further information necessary for simulation or for a help-system. Both physical and virtual system can be used to experiment with. The users are able to freely change between operations on real and virtual objects. In some application areas it is even possible to export control signals generated by the virtual into the physical system.

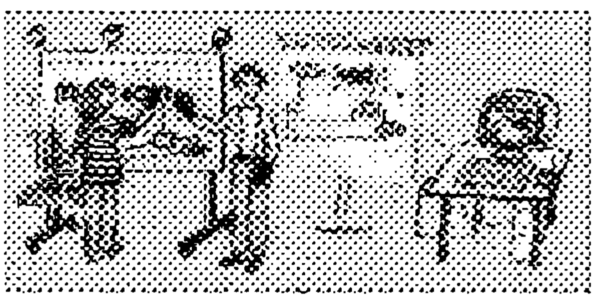

Figure 1: Envisioned Learning Environment

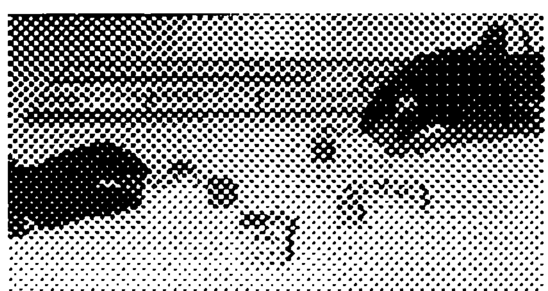

Figure 2: Building a circuit with wooden symbols

The envisioned learning environment [Fig. 1] consists of a traditional experimental workbench for pneumatics, enhanced with computer-media. This includes virtual models and multimedia elements. The students build a physical circuit, directing their attention on the actual task, tracked by the computer. Afterwards the virtual model can be used for simulation and further investigation (animation of inner behavior of elements) or for searching errors and optimization. During assembly the computer might also be used to give advice and add explanations on elements. Such commands can be given with gestures or spoken, thus staying in the „real assembly" mode or space. In order to let students stay close to the workbench and make the desktop computer as obsolete as possible, projection and audio techniques are used for computer output and feedback. If the subject of electrical-pneumatic circuits is taught, the students can write programs on the computer, which not only drive a simulation model, but also control real devices, thus closing the circle: back from the virtual to the real.

In vocational training, some students have a special need to grasp physical circuits in order to get a better understanding of abstract sign-languages. Our system provides visible, instantaneous links between the concrete and its abstract representation, thus helping to abstract, to translate, and to form mental concepts. Concrete artifacts offer an additional possibility to gain theoretical knowledge based on sensual-concrete experience, as physical and intellectual grasping interact. These ideas are based on Piaget and Aebli. As many technical processes in modern production have lost their former material relation, it gets harder for workers to experience physical properties and to acquire tacit knowledge of the still existing material background. Providing this experience in education & training (encouraging students to experience the obstinacy of the material) may substitute somewhat [Böhle 91]. Our system supports different experimental learning modes within the context of action oriented learning. Concentration on a complex task and physical work space constitute a common goal and a social space for collaborative learning. Students can see each other, interact freely, discussing ideas.

As our project is a feasibility study supposed to explore possibilities and problems, we intend to implement only part of the described. A following European Union project will develop a commercial version, using image processing. Because our DataGloves with electro-magnetic tracking don't allow us to handle metal we work with wooden bricks as graspable symbols [Fig. 2]. Up to now we are able to build a model of digital or pneumatic circuits. This is tracked by our Virtual Reality system. The resulting scene file can be processed and simulated by our extended version of the freeware simulator DigSim, PneuSim. Ongoing work includes an interface to the commercial simulator FluidSim-P ((C) Festo-Didactic). We developed an on-line connection, sending each event in the physical model to the simulator. This enables asking for help on elements or starting the simulation by gesture. Our work also consists of the didactical foundation for such learning environments and of HCI-issues. What does natural handling mean? Which kinds of multimedia add-ons make sense?

Another project demonstrates the power of the Real Reality concept in the domain of material flow, using small conveyors to model production plants. The conveyors and a robot can be programmed with Programming by Demonstration, manually teaching distribution rules and paths. [Schäfer et al97].

Our goal is to enable people to change fluidly from hand manipulation to abstract work and vice versa. Computers and their interfaces should assist, not get in the way. In the main application areas construction and modeling are central tasks, either in learning or working contexts. The concept can also be used to combine physical and digital planning tools. Related work stems mostly from Augmented Reality and Ubiquitous Computing research, for example [Fitzmaurice et al 95], [Ishii, Ullmer 97], [Resnick 93] and [Suzuki, Kato 95]. In contrast to all of these we do not sensorize the objects and keep a clear division, yet close coupling between physical objects and their virtual twins, between real system and virtual addition.

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For further information see: http://www.artec.unibremen.de/field1/eugabe/index

A Simulation Environment for an Intelligent Tutoring System On the WWW

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1. Introduction

In the field of education, interactive simulation is known for an effective tutoring facility. There are a lot of Intelligent Tutoring Systems (ITSs) on the World-Wide Web (WWW). But, so far the study of a simulation environment in an ITS on the WWW has been superficial. So, we proposed an interactive simulation environment in an ITS on the WWW.

We have developed an ITS on the WWW called CALAT [Naka 95][Naka 96]. The system has a server / client architecture. The CALAT server is implemented as a Common Gateway Interface (CGI) process executed typical WWW server. An ITS process on the server (ITS-S process) employs overlay student model. One ITS-S process manages one student process. A student requires typical WWW browser to use CALAT courseware. Two types of learning material, explanation and exercise are available in the CALAT courseware. First, the CALAT server provides the client with explanation pages for a student to learn new information. Next, an exercise page is downloaded to check whether the student has learned.

2. Design Issues for Simulation Environment

Interactive simulation is an important tool for helping the student to acquire procedural knowledge. But in some cases, on-the-spot experience is difficult to obtain. Examples in NTT Company training include operating procedures for switchboards and transmission systems. So, we are aiming to create, by means of the simulator, virtual environments for such training.

Certain design issues require resolution for interactive simulation in an ITS on the WWW like CALAT.

(1) The function of the simulation

The following functions are necessary for the simulation.

(a) Presentation of sample operating procedures

(b) Provision of a simulated environment in which a student can practice operating procedures

(c) Provision of a simulated environment with appropriate advice

(2) Object-oriented approach

It is important to re-use a simulation environment and other CALAT courseware elements. So, we use object-oriented methodology [Naka 98].

(3) Function distribution between client and server

In creating the simulation environment, it is necessary to examine the distribution of the functions between client and server. The trade-off between the distribution of the functions and the response time is an important concern. For example, if the simulation environment is deployed on the client, the initializing time to download the simulation environment on the client is long but response time under the simulation is short.

(4) Use of multimedia tools for designing graphical user interface components

In designing the graphical user interface (GUI), it is preferable to use multimedia tools currently on the market.

3. A Simulation Environment in CALAT

A simulation is placed as an exercise in the CALAT courseware to provide a student with a simulated environment in which he/she can practice operating procedures. The behavior of the simulated environment is described as a state transition model (STM). According to STM, the input event by student's action triggers the state transition and output action takes places.

This environment is deployed on the client and consists of three components, a GUI component, an STM engine, and a subset of the ITS process.
To make the response speed fast, an STM engine written in Java/JavaScript is implemented on the client [Touhei 97]. An STM engine connects a GUI component by using the liveconnect function in the Netscape Navigator [Netscape]. Thus students can use a simulation environment with quick response and courseware developers can design the simulation GUI using the multimedia tools that support the liveconnect function.
In this simulation environment, there is no communication between the client and the server during the simulation and ITS-S can not monitor the situation of a student. So, even if a student does not understand the operating procedures and simulation is wastefully prolonged, the ITS-S can not interrupt the simulation. This problem is solved by deploying a subset of the ITS process in the simulator on the client (ITS-C process).
The ITS-C process monitors the state transitions in the STM engine. When the sequence of the student's action goes into the wrong direction or comes to impasse, the ITS-C process interrupts the simulation and helps the student. For example, the ITS-C process asks the student whether he/she wants to stop simulation.

The protocol of the simulation has three sessions: Start, Learning, and Ending.
Start session: First, a student connects with the CALAT server through the WWW browser, and the WWW browser downloads a simulation environment from the ITS-S process.
Learning session: The input event by the student's action is sent to the STM engine through the GUI component. The STM engine checks whether the input event is correct and changes the state. The ITS-C process monitors the state transition in the STM engine to interrupt the simulation timely. Based on the STM, the STM engine controls the GUI component. These procedures are done on the client with no network traffic. The feature of this simulation environment is a point that the ITS-C process can help the student under the simulation.
Ending session: There are two ending patterns. In one, the final state is reached and the simulation is finished. In the other, the simulation is stopped by the ITS-C process or the student. In either case, regardless of whether the student is able to achieve the goals of the exercise, the ITS-C process sends the results to the ITS-S process through a network. The ITS-S process determines the next explanation page based on the result of the exercise.

In the CALAT courseware, the ITS-S process monitors the student's situation while he/she is studying an explanation page, whereas the ITS-C process monitors the student's situation while he/she is studying with the simulation.

4. Conclusion

We have described an interactive simulation environment in CALAT, an ITS on the WWW. Our proposed simulation environment, which is deployed on the client, consists of a GUI component, an STM engine written in Java/JavaScript, and a subset of the ITS process. The advantages for the student are quicker response and helpful advice during the simulation. Courseware developers can design simulation GUI using the multimedia tools that support the LiveConnect function. In future work, we plan to adapt student's mistakes and give appropriate advice that corresponds to them. For example, an subset of the ITS process in the simulator shows next correct operating procedure.

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A Survey on the Acceptance of Information Technologies in the Continuous Education

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Introduction

The motivation of the learner is essential for the success of learning. In case of the use of modern information technologies in further education we should pay attention to the acceptance of these technologies [Hitzges et al. 1994] together with a good instructional and technical design [Cremers, Lüssem and Sünderkamp 1997]. The acceptance of modern information technologies as well as motivational aspects have a great impact on the design of computer-based learning environments and vice versa .

In this paper we present a broad survey of the acceptance of information technologies from the point of view of participants of traditional further education seminars. The aim of this survey is to investigate the interdependence of the three factors mentioned above.

The Survey

The survey was carried out in order to find out to what extend new information technologies are accepted by participants of further education seminars. The profession of gas and water engineering was chosen for the collection of data, because the group of people working in this field is especially confronted with shorter and shorter innovation cycles and has therefore a high demand for further education. At the same time computers are not the actual subject of this profession, but are used at the most as tools or as components of other technical products. Most of the interviewed persons are graduated engineers and work in upper-middle positions in companies in the supply sector or work as self-employed engineers.

During the survey 394 participants of traditional further education seminars were interviewed on their opinion concerning the use of new technologies in further education. The data were gathered by means of a questionnaire.

15% of the interviewed persons use a computer only rarely on their job, whereas 64% use it frequently. 75% of the engineers neither have an e-mail-address nor access to the Internet. The age groups 30-39, 40-49 and 50-59 come to a proportion of approximately 30% in the survey. The age groups 20-29 and 60-69 are relatively small with approximately 5%.

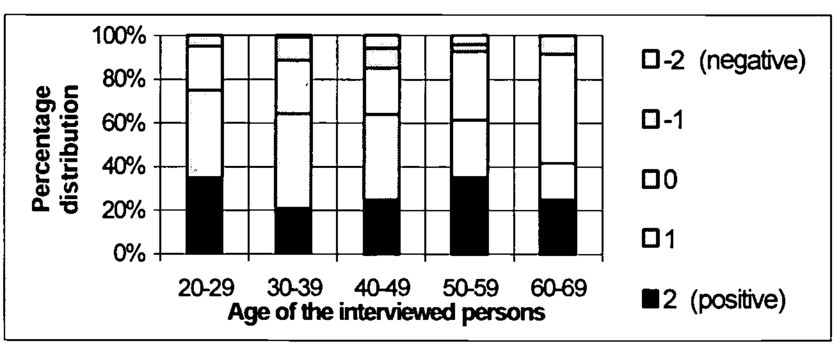

Figure 1: The overall judgement on the use of computers in continuous education

62% of the interviewed persons generally approve of the use of computers in further education, 26% are indecisive and only 10% disapprove. Figure 1 shows the correlation of the age of the interviewed persons and their judgement on information technologies in further education seminars.

60% of the interviewed persons support a supplementary use of computers (CD-ROM, Internet) as a means of preparing future lessons or to internalize topics of preceding lessons. 32% would approve of computer-based learning environments as a substitution for parts of a traditional further education seminar, whereas only 8% would support a completely computerized seminar without any teacher (see figure 2).

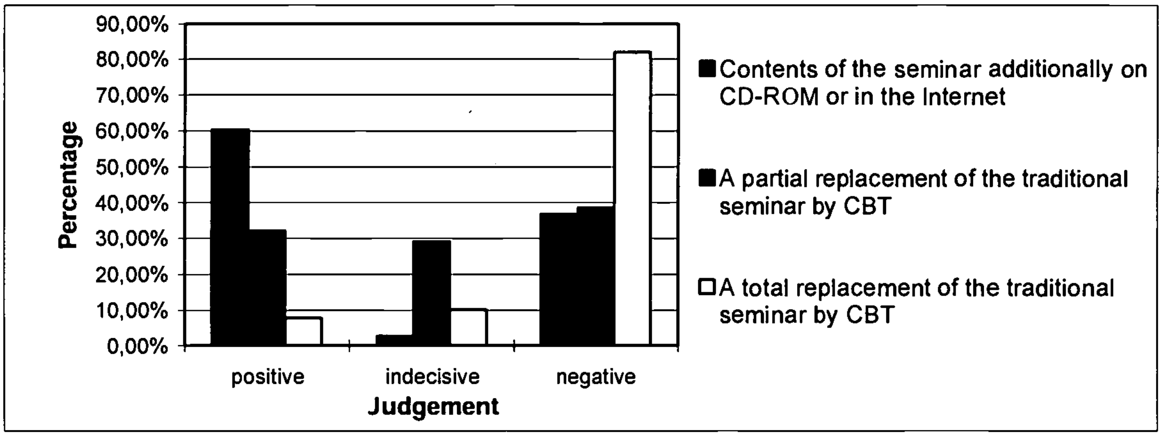

Figure 2: Acceptance of different computer-based training scenarios

As a conclusion of this part of the survey can be drawn that most of the interviewed persons do not want to dispense with the face-to-face communication with teachers and other learners. This might be explained by the assessment that an increasing replacement of traditional seminars by computer-based learning environments causes a neglect of the social needs of the participants of further education. 47% of the interviewed persons fear that social needs might be neglected if computers are to be used in further education. 27% cannot imagine any change resulting from this, whereas 21% think that the use of computers might even help to improve social contacts. It is important to note that for most of the interviewed persons the personal contact to the teacher is regarded as indispensable as far as queries are concerned. Contact to other learners contributes to the learning success as well. Furthermore, informal technical discussions that occur at traditional further education courses are regarded as another important source of knowledge.

Conclusions for the Design of Computer-Based Learning Environments

As we could derive from our survey, computer-based environments used in further education should be designed especially for the preparation of traditional courses and for the repetition of subjects already learned in the course. The integration of communication facilities should be emphasized in computer-based learning environments. We have seen that most of the interviewed persons have a positive attitude towards computerized parts of further education seminars. We should use this motivation to build learning environments that fulfill the requirements we have mentioned above.

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Virtual Collaborative Working Environments

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Introduction

In this short paper, we present a specific example of a studio classroom at Acadia University, which we believe applies equally well to any collaborative working environment. Consider a classroom in which the instructor and all participating students have access to networked computers and can interact, for example, through the use of downloadable files, an email facility, and a projector which can display images from a single computer. The instructor is a member of the Faculty of Computer Science, and the students are undergraduates in the Bachelor of Computer Science program and enrolled in the introductory programming course, COMP 1013. The students are organized into groups of four to facilitate discussion of problems posed by the instructor. We expect that the following hypothetical interactions would be possible:

- *Instructor to student:* The instructor gives a student exclusive access to the projector, perhaps revoking other students' access to the projector.
- *Student to instructor and students:* A student shares her or his group's solution to the problem with the rest of the class by displaying it on the projector.

TASK Framework

Building on concepts developed in previous research [Hussey & Tomek 1996], we introduce a general framework to support collaborative work, called TASK, which stands for Tools, Actors, Scopes, and Keys. Designing a framework to model a specific problem is somewhat similar to designing an object-oriented computer program; it consists of identifying the underlying objects and interactions between these objects. The collection of all objects relevant to a given problem might be called a problem's domain. In our electronic classroom, the domain consists of objects such as the following:

- students and instructors
- faculties, programs, classrooms, and groups of students
- files, email facilities, and projectors
- objects providing access restrictions

In modeling interactions between these objects, it is useful to consider different kinds of objects. The TASK framework consists of four basic kinds of objects - actors, scopes, tools, and keys. In the following sections we briefly describe each of these concepts, and how they can be used as a model of our case study. Note that TASK is a virtual setting, defined by the learning activity rather than by the boundaries of a physical classroom.

Actors

Collaboration occurs when two or more individuals engage in actions that are directed toward a common task (hence TASK). As such, we use the term *actor* to refer to the individuals who collaborate within TASK. An actor, then, is the embodiment of a physical user and represents an entity involved in performing an action, for example a student, an instructor, or a programmer. In our electronic classroom case study the students and instructor are examples of actors. The user embodied by each actor has access to a computer, and the computers are networked. The resulting interactions between actors are *direct* if no intermediate object is involved, and *indirect* if they involve a mediator object.

Scopes

We introduce the notion of a *scope* as a frame of reference for the actions that actors engage in as they collaborate in TASK. An actor enters a scope when it takes on a particular role associated with, or engages in some action bounded by, that scope. Conversely, an actor exits a scope when it is no longer interested in the actions that take place there. As a result, scopes are dynamic rather than static in nature - as actors enter and exit a scope, this scope binds, or holds a set of actors interacting within its boundary. Acadia University, Faculty of Computer Science, Bachelor of Computer Science, and COMP 1013 are examples of scopes in our electronic classroom.

Tools

In describing indirect interactions between actors, it is useful to introduce the concept of a *tool*. Tools are the primary means by which actions are performed in TASK and, as with actors, they are bounded by scopes. This has two consequences. First, the actions provided by a tool can only be performed by actors bounded by the scope in which it is held. Second, only the actors held by this scope are aware of the results of the performed actions. Another aspect of tools is that they can be taken or dropped by actors, thus providing a means for their displacement between scopes. The downloadable files, email facility, and projector are examples of tools in our electronic classroom.

Keys

Clearly, unrestricted access to all tools by all actors may not be desired, and therefore we define the notion of a *key* to facilitate access restrictions within TASK. Keys are assigned on a per-action basis; that is, in order to perform a locked action on an object, an actor must hold the key with which it has been locked. Actions can be locked or unlocked, and keys can be granted or revoked, dynamically according to specific permission or privilege needs. The first interaction described above illustrates the use of keys in TASK.

Discussion

The design introduced above can be used to describe various scenarios of teaching in an electronic classroom. However, the TASK framework is quite general; the case study presented here was meant to show its usefulness within a specific domain (education). Other applications of TASK range from simple ones such as file permissions on a Unix operating system, to rather complex ones such as collaborative work in a software development organization.

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Teaching news writing courses with the help of e-mail: the experience of a Malaysian university

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1. Introduction

Teaching writing in communication courses has normally been done in reporting laboratories. This allows immediate interaction between students and instructors. However, this is only possible if the situation allows students to meet instructors regularly. And this do not happen all the times, especially when there is a shortage of instructors or the instructors are a distance away from the institution. The Information Age on the other hand offers opportunities for doing education in new and creative ways. Technologies are capable of bridging gaps of distance and time to meet the demands for education.

2. Background

An example to this is the teaching of writing courses in the Faculty of Communication at the University of Sarawak in Malaysia. Apart from being new (started in 1992), the university has the disadvantage of being a distant away from mainland Malaysia. Sarawak is situated on the island of Borneo, separated from the mainland peninsular by the South China Sea. By flight, it takes about one hour forty-five minute to reach Sarawak from the peninsula. Shortage of instructors forces the university to engage instructors from the peninsula. However, it is too costly for the university to fly in the instructors every week. Hence, instructors from the peninsula could only fly to Sarawak once a month. Under the present economic crisis, the frequency of visit to the university may even have to be lessened. However, with the advent of new technology, the teaching of writing courses has been made possible despite these constraints. Students, for example, could communicate with their instructors through e-mail. Communication ranges from instructors' request for story ideas to students' submission of reports. Assessments of student performances are carried out regularly with a final test at the end of the semester.

This paper outlines the outcome of a study that analyzed the practicality of utilizing new technology in the teaching of writing courses in the context of giving instructions from a distance. It outlines the advantages of learning/teaching writing through the new learning environment. It also suggests steps for improvement and advancement.

3. Findings

To aggregate information from the students a survey questionnaire was designed and constructed. The survey consisted of seven open-ended questions soliciting in-depth documentary, description, and opinion from the students. The effectiveness of the delivery system was evaluated through a self-conducted survey in February 1998, after the students had gone through the system for two semesters. Learning from the experience of Desmond Keegan [Keegan 1995], the e-mail delivery model was evaluated from five aspects:

- Academic Excellence: Could academic excellence be achieved? Was it possible to produce a rigorous university-level teaching and learning system by e-mail

- Access: Did student get access to facility at convenient times?
- Quality of Learning: Would students be hampered with their learning by the absence of lectures from a physically present lecturer?
- Results: Would students be confident of passing? Would their assignment and final examination results be as good if lectures had been done in the traditional manner?
- Status: After the experience would they feel the same format could be applied to other subjects?

2.1 Overall Perception of the system

Students have mixed opinion about the delivery system. While the system has the advantage of speed and not having to have the instructor physically around, some students posed technical problem as a major hindrance. Some of the responses include "Faster but difficult to get respond "and" Technical problem.

- While a few students felt that it was possible to achieve academic excellence, the rest were uncertain. However, none "disagree" or "strongly disagree." One respondent said: "I am not sure but I think many problems need to be solved first before achieving this." Technical problems were mentioned, in particular "servers continually down:"
- One of the problems faced was that the students felt that accessibility to facility was a little bit restricted. They were not easily accessible at convenient times. One student said: "You will have to book the computer if there are many users"
- However, despite the problem of accessibility, students generally felt confident of passing. One of the response was: "Yes, I'm improving from the exercises done"
- On assignments, students generally prefer works given in class. A student said: "I would prefer to have exercises during class" and "Instant practices is needed. take home assignment should come along to enhance skill."
- Students felt that their final exam result would be better if lectures had been done in the traditional manner. One of the students explained: "Traditional manner helps in understanding."
- On the question of whether the same format could be applied to other subjects after their experience, students generally approve the idea. "Certainly, one thing it can cure the boredom and tiredness. A weekend of lectures is not enough to train the students." However, one student had some reservation, "It depends on what subject it is."
- On the quality of learning, students felt that having few face-to-face lectures hampered learning. "Sometimes we need direct guidance and depending on e-mail is not enough."

3. Conclusions

A few conclusions could be made from our experience of introducing teaching news writing courses with the help of e-mail.

First, news writing courses could be taught with the help of e-mail provided face-to-face meetings support them. While students need personal guide, additional exercises through electronic means provided students with additional opportunity to sharpen their skill. Students were happy by the fact although the instructors were not around they could still learn.

Second, to provide efficient communication channel, technical problems need to be solved. While new technologies promise speed, students were hindered from communicating because of technical problems such as server being down repeatedly.

Third, shared facility must be sufficient to cater everybody's need. Students were facing the problem of getting access at convenient time. Problems raised include having to book for computer time when there are many users.

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A Comparitive Study on Internet Utilization for Problem Centered Learning in Germany and Japan

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1. Introduction

Japan and Germany both are well networked industrialized countries. Their educational systems though are highly regulated and conservative with respect to new content. Internet technology is a great challenge for their respective educational systems. Introduction of Internet meets with calls for practising more forms of problem centered instead of subject oriented learning. In both countries consciousness is rising, that children of today have to be better prepared for individual learning and acting, have to be aware of environmental issues, and have to be able to learn and communicate under a global perspective.

We will present some of the basic elements of our different educational systems, identify some of the most common patterns of Internet utilization in schools and then try to point out differences in approaches as well as common solutions to the problem of using Internet for problem centered learning. In conclusion we argue that the introduction of Internet technology into the classrooms has already fostered elements of problem centered learning in our countries and will further speed up this process in future.

2. Problem Centered Learning and Internet in Japan

2.1 Outline of problem centered learning

Problem centered learning is going to be introduced officially by the Japanese Ministry of Education from grade 3 to grade 12 in 2003. It is gaining attention because of necessity of real experience, an international way of thinking, environmental education, information literacy and so on. Up to now students have dealt with these topics in different subjects, but fields like environmental education or information literacy have come to include a lot of content that goes beyond the capacities of each of these subjects.

2.2 Some educational projects with the Internet in Japan

As for the Internet, The Ministry of education plans to connect all schools to the Internet by 2003. At the moment all schools rely on commercial providers or universities. Besides each school is trying various ways to use Internet for children's learning, there are some nationwide projects of collaborative learning on the net like 100 schools project [http://www.edu.ipa.go.jp/kyouiku/100/], Media Kids [http://kids.glocom.ac.jp/MediaKids/index.E.html/], Konet Plan [http://konet.mbc.ntt.co.jp/]. One of the newest trials is to relate children's learning activities with TV programs and TV-related web materials using the Internet. Many collaborative activities, e.g. co-observation of acid rain, and co-survey of folktales, require broad area knowledge. It is needed in these projects that children learn in problem centered way and think from an international point of view. The Internet is one of the most useful tools in these activities.

3. Problem centered learning with the Internet in Germany

3.1 Internet Utilization in German School

Since around 1995 Internet connectivity has become an issue for national projects. "Schools to the Net" [SaN:http://www.san-ev.de/] is a joint initiative by the Federal Ministry of Research and Education together with German Telecom and other corporate sponsors to connect 10,000 secondary schools to the net by the end of 1998. Some of the states have ambitious projects, mostly as a public private partnership, too [e.g. NRW http://www.learn-line.nrw.de/]. On a local level we find different forms of cooperations and a variety of individual projects like international e-mail projects [Donath 1997].

3.2 Problem centered learning with the Internet

Today there are strong voices that demand educational content not covered by traditional subjects, like media and technology education, environmental and health education, etc. Newer documents of educational policy state that media education will naturally lead to problem centered and project oriented learning, to learning in the context of real world problems, to cooperation with partners outside of school. Projects like SaN also aim at opening up the schools through Internet use. There are examples of successful interdisciplinary Internet projects (ESP http://www.kc.kuleuven.ac.be/esp/; TAK http://www.tak.schule.de/welcome_us.htm and others), but in everyday school life (half day schools, 45 minutes lesson units, few computer rooms...) such projects are often difficult to organize. So mostly the teachers in charge have to take extra efforts like cooperating with another teacher of the same class or offering computer clubs in the afternoon. But even if only conducted within normal subject lessons, experienced teachers notice that many Internet projects turn out to be intrinsically interdisciplinary, because they often require language and communication competency, technical knowledge as well as other subject knowledge [Achtstaetter 1996].

4. Comparison of Findings

We found that many children in our countries are having the oportunity to use the Internet in school. Support comes from national projects, corporate sponsors, universities or other organizations. In Japan enterprises have discovered the potential market quite early, whereas in Germany educators have a tendency to avoid commercial support.

Still, the success of most projects depends mostly on the initiative of individual teachers, as well as on support by university researchers and other voluntary staff. In Germany, students often play an important role as network administrators, whereas in Japan teachers hesitate to share those responsibilities.

Other differences exist at the grade level of Internet introduction: Utilization of Internet is more flexible and wider ranged in elementary schools than secondary schools in Japan. On the contrary, few German elementary schools use the Internet, flexibility with respect to projects is biggest at the junior high school level. This is partly due to differences in grading system, but also reflects a more critical attitude to new technology in Germany, especially when young children are concerned. In Japan many elementary schools have their own computer room, in some of them all children of grade 5 and 6 have their own e-mail address. In higher grades, study for higher education entrace exams becomes more severe in Japan, so there is less room for experiments. According to findings so far the level of abstraction required for collecting useful information and constructing one's own opinion from them might be asking too much from children around grade 4, so the question is, whether meaningful usage of Internet can be made in lower grades and how.

We suppose that Internet introduction into schools in both countries will continue on several levels. Local initiatives will expand as well as national programs, and slowly curricula will come to include problem centered learning with the Internet, too. In the meantime schools will probably open up through the usage of Internet quicker than curricula prescribe it.

On the other hand the current situation is characterized by many experiments, and a considerable part of the teachers is in doubt about the usefulness of the tool. The national programs in our countries both have put networked computers into the classrooms first and then only slowly started to train the teachers. So the most important issue at the moment is content. What do children really learn by using the Internet? Only by communicating superficially and expanding globalism in terms of figures the usefulness of the Internet for education cannot be proved. We will have to investigate how learners reflect their experiences through collaborative learning and communication over the Internet.

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A System Based on Rodari's 'Estrangement' Principle to Promote Creative Writing in Children

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1. Introduction

Many children do not like writing, and when they do write, they usually write only short sentences. But [Uchida 1986] suggested that when the children are provided interesting material, they do write with enthusiasm. In this paper, we describe a system called Story TElling from Pictures (STEP) that is designed to promote creative writing in children. STEP uses a technique called *estrangement* [Rodari 1973], in which familiar objects are presented in strange contexts to spark imagination in children. STEP provides sequences (scripts) of pictures, and children practice writing as a game by making stories based on these scripts. Pictures (schemas) are composed of picture elements, which in turn are based on data gathered informally by having children fill out a questionnaire to ensure familiarity with objects in the pictures. Estrangement can be introduced at the schema level (a picture element that does not belong with the others) or at the script level (a picture that does not belong in the sequence). A prototype of STEP was implemented and, on informal experiments with 18 children, we found that many more and longer stories were generated with estrangement than without it.

We present here the background and an overview of STEP, and our experimental results.

2. Background and Motivation

In Rodari's proposed methods to promote creative storytelling in children, 'estrangement' figures very prominently. For example, in *the fantastic binomial*, a story is generated from the opposition between two unrelated words, for example 'dog' and 'closet'. The more unrelated are the words, the better is their potential for engaging the child's imagination, and the more fantastic is the resulting story. Or, in *Little Red Riding Hood in a Helicopter*, a story is generated from an idea extracted from a series of words, and another word that is not related to any of the words in the series. For example, Rodari gave children five words, 'girl', 'woods', 'flowers', 'wolf' and 'grandmother', which together suggest the story of Little Red Riding Hood, and then added one more word, namely 'helicopter'. This conflict sparked the imagination of the children, and they made up very creative and interesting stories. [Uchida 1986] also did some similar experiments using pictures instead of words, and confirmed this effect.

A key component of Rodari's use of estrangement is that it is introduced by using material that is familiar to children. Indeed, [Vygotsky 1930] has observed, and we have confirmed in informal experiments with an earlier prototype, that children are more forthcoming and expressive when writing about material with which they are familiar than otherwise.

3. An Overview of STEP

Using data from an informal questionnaire given to 12 children, in which they were asked to describe some of their daily activities and to write names of things which belong at home, school, playground, etc., we prepared a picture database of 452 picture elements. Each picture element represented some object that is familiar to children. These picture elements were organized into 37 schemas (pictures composed of many picture elements) and 5 scripts (sequences of schemas) [Schank & Abelson 1977]. STEP also has an optional tuning mode, in which children can create their own schemas and scripts.

In STEP, a story structure is defined as a series of pages, where a page is a pair of a picture and a description. A description, in turn, is a piece of (possibly empty) text.

In the making stories mode of STEP (there is also a replay mode that allows previously made stories to be replayed), children can choose to have no estrangement, estrangement in a schema or estrangement in a script sequence. STEP introduces estrangement at the schema level by combining a picture element that does not belong to a schema; and at the script level by inserting a picture in the sequence that does not belong to a script. For this, we use the information inherent in the organizations of schemas and scripts to present strange situations to children to encourage imaginative creation..

4. Experimental Results

We tested a prototype of STEP with 18 children in informal experiments. The results of these experiments are shown in Figure 1 below. The graph on the left shows the average number of characters in a page for all the stories that were completed successfully. The graph on the right shows the same data for younger (5-7 yrs.) children. From this we can see that children consistently wrote longer stories whenever estrangement was present. Indeed, we feel that the crux of creative and imaginative play lies in trying to assimilate strange contexts made up of familiar objects, and precisely this phenomenon is exploited in STEP to promote creative writing in children.

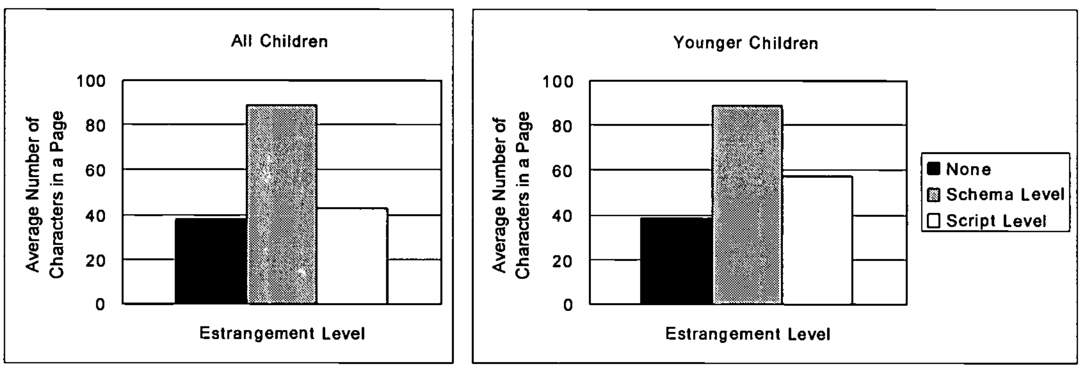

Figure 1: Effect of Estrangement Factor on the Length of Stories.

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Acknowledgments

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Template-based Authoring System for Internet-based Education

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Introduction

Through distance learning, tertiary education has become available to an increased proportion of the population. Improved computer and communication technologies have contributed to this change [Jones & Jo 1998]. With the advent of the Internet and the World Wide Web, distance learning has taken a step forward. When courses are prepared for use over the Internet, the designers are usually professional multimedia designers, generally trained in a variety of authoring software packages. They take the content of the educational course and adapt it. However, this may not be the most suitable method. Ideally, the teachers and lecturers should prepare the lessons just as in conventional education. This paper will discuss the current system of instructional program design. A new model, which allows the educator more control and easy modification, is suggested and a template will be proposed to demonstrate this theory.

Current System used to Design Instructional Material

The current system of designing instructional programs follows a three-step process [Fig. 1]. The educator, an expert in the field of study, provides information in the form of content material. This information is given to the multimedia designer, generally a professional, trained in authoring software such as Macromedia Director or Authorware, and a Web language such as JAVA or HTML. There is, by necessity, a certain amount of interaction between the educator and the instructional designer as objectives and strategies must be established and the sequence of delivery must be determined [Penney 1981]. During this interactive phase the designer will be constantly updating and improving the material until the finished product is completed.

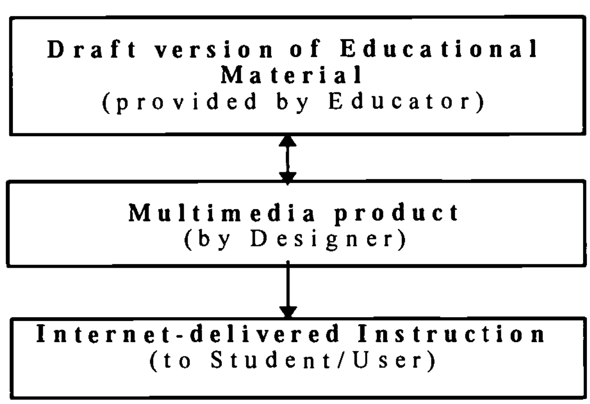

Figure 1. Current system to design educational material for Internet-based education

There is no denying that this system works. What this paper is offering is an alternative method of design that may allow the educator more control, not only of the content but also of the time and place of preparation and include easy modification. It would be more productive if the educator could both create and design the instructional program for Internet delivery. This system would be more efficient by reducing the preparation time and expenditure, and also avoiding misinterpretations between the educator and the designer.

New Authoring System using a Template

With this new system the template would only need to be designed once by the multimedia designer. There would, of course, be a large range of templates to suit the many presentation styles, fields of study, age groups, learning styles and learning strategies.

This system would also follow an interactive pattern. The designer would prepare and provide the templates. The content material would be provided by the educator who interacts with the template program, entering data, reviewing and refining as the instructional program develops. This process is represented below [Fig. 2].

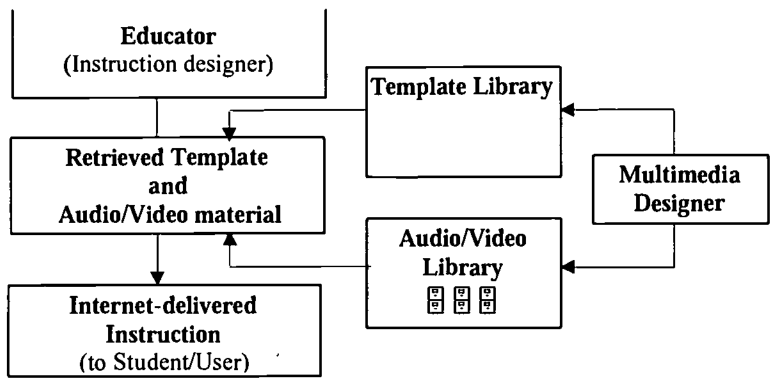

Figure 2. Template-based Authoring System Model. A template can be retrieved based on the nature of the subject, teacher's preference or learning strategies.

Conclusion

In this paper the current system of Internet-based, instructional program design has been discussed and a new model proposed. This research is presently underway and a template authoring system for Internet-based education is being produced. The new system will allow the educator the increased control and easy modification suggested, along with reduced preparation time. Ultimately, the educator will be provided with a range of templates, each offering a specific appearance, various learning strategies and content-specific style. This research aims at providing a better, more efficient system in a user-friendly, interactive multimedia setting.

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Designing Web-based Instruction: Research and Rationale

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1. Introduction

The World Wide Web (WWW) cannot guarantee learning. The rich media and linkages available on the web are not unique to WBI. What is unique is the pedagogical dimensions that it can be designed to deliver. These learning dimensions determine the WWW's ultimate effectiveness and worth. The design of WBI should focus on the goals of the lesson, the needs of the learner, and the nature of the task involved [Rieber 1994]. Factors in the hypermedia environment, such as visualization, goal orientation, motivation, and structure, must be taken into account so the design of WBI enhances the educational opportunities of the learners.

2. Hypermedia

Hypermedia can be effectively developed as an instructional tool based on information processing theory and dual-coding theory. Through information processing theory, hypermedia environments can capitalize on the following: gaining the learner's attention, informing the learner of the objectives, stimulating the learner's prior knowledge, providing scaffolding, eliciting performance, providing feedback, assessing achievement, and enhancing retention and transfer [Gagné, Briggs, & Wagner 1992]. Dual-coding theory assumes two independent, but interacting cognitive subsystems [Paivio 1971]. A verbal systems is responsible for the processing of verbal information while an imaging system is responsible for processing pictorial information. Only through sound design principles based on these theories can hypermedia reach its potential as an instructional tool.

When designing a hypermedia environment, careful attention must be given to the media used. Hypermedia should be enhanced by the use of the multiple modes of media to convey meaning. According to the dual-coding theory [Paivio 1971], information is processed through a verbal and nonverbal channel; therefore, enhanced semantic connections can be developed in a learner's memory by the use of multiple media. Common types of media used in WBI are text, graphics, animation, and sound. Whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning environment and how they relate to the needs of the tasks and learners. The design of instruction is instrumental in utilizing the medium's capabilities.

Although instructional problems can be classified as well-defined or ill-defined, they differ with respect to their complexity and specificity. The course objectives should be clearly stated to the learner and the design of the instructional environment should revolve around the goal of instruction. When a learner's attention is partially focused on the objective, the learners' disorientation is decreased and their retention is increased [Beasley & Waugh 1996]. The knowledge of the objective enhances the learners' goal orientation. Clearly articulated learning objectives and goals for learning are imperative for the learning process; therefore, by providing learners with a goal for browsing or aiding them in developing goals gives the learners a stake in the learning process and focuses their mental efforts in a positive direction.

Motivational conditions include attention, relevance, confidence, and satisfaction -- ARCS model of instructional design [Keller 1987]. It is imperative that the instructional designer gain the attention of the learner, make the content relevant to the learner's personal needs, support learners' confidence by enabling them to achieve, and foster their satisfaction through consistent rewards. Expectancies and values are an integral aspect of motivation. First of all, learners must believe they can succeed; they must have a high expectancy about their task performance. Second, learners must believe there are benefits in performing a task; they must place value on the task itself [Ormrod 1995]. Extended, challenging, meaningful, and collaborative learning enhances motivation. Motivation can also develop learners' confidence which enables them to persevere longer, engage at a deeper level, and learn more.

Several problems of learning in a hypertext environment arise from the structure of the hypermedia environment. Instructional designers must continually struggle with the unique capabilities of the computer without disorienting the reader. This problem of disorientation facilitates the cognitive overload of the learner and diminishes the instructional capabilities of hypermedia. In an ideal web-site, the structure is evident to the user and the information is organized coherently and meaningfully. Designers often include navigational tools which help learners organize the structure of the web-site as well as the connections of the various components. The text can be standardized to convey meaning; the interface design can imply relationships between items and the buttons can be clear, visible, and accessible. Structural considerations in the design of a hypermedia environment can aid a student in developing an overview of the environment.

3. Conclusion

WBI should capitalize on the positive aspects unique to its environment. The environment should focus on the needs of the learner rather than the learner accommodating the knowledge base [Nelson & Palumbo 1992]. With the potential of WBI in educational environments, instructional design must translate design issues and theories of learning into plans for instructional environments. While there are vast amounts of research on ways to present instruction via text and other linear approaches, such as computer-assisted instruction, there is little research on the design and presentation of nonlinear instruction.

By providing goal orientation, multiple media, motivation, and structure, the individual needs of the learners are accommodated through the design of WBI. By allowing learners to set goals and reflect on the information provided in the WBI, the learners' attention is focused and they are able to see the interrelatedness of ideas. The use of multiple forms of media provide the learner with rich and realistic contexts for multichannel learning. The learners' motivation is increased when they are in control of the navigation of the hypermedia environment and encounter realistic examples. Finally, the structure of the environment can be designed so it is user-friendly, simple, and the interconnectedness of ideas is clear.

Since there is a lack of research on WBI, we must rely on the research on hypermedia and extend this research into the realms of the WWW. Factors in the hypermedia environment, such as visualization, goal orientation, motivation, and structure, must be researched so WBI can reach its potential. Through research on WBI, we can determine the following: the impact of visualization on the learning and retention of knowledge, the importance of setting goals for learning on the learning and retention of knowledge, optimal motivational elements within the environment, and the optimal navigational device to enhance students' learning.

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Schools of Helsinki 2001
Information Technology Project

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1. Background

The Finnish Government decided in 1994 that Finland should be turned into an information society. The Ministery of Education made a strategy how this could be realized. At the same time the Helsinki City Education Department was preparing an Information Technology Project that was accepted by the City Council in 1995. This five year project started in 1996 and is worth FIM 200 million (34 MECU).

2. Schools of Helsinki 2001

The main objectives of this project is to develop information technology and services in the general and vocational education in the present decade so that:
- from the standpoint of general education:
- schools can provide each student with the prerequisites of the information society as well as the basic skills required for the acquisition of necessary information, information management and basic communication skills
- The primary and secondary education can give to each student the practical basic skills in information technology
- The use of information technology as a tool can be increased in different subjects on the basis of the new curriculum.

- from the standpoint of vocational education
- The institution can give such information technology skills that correspond to the continuously changing and increasingly international demands of working life.

The core network is serving the whole city and about 125 schools out of 175 (March 1998) have a local area network (CAT-5) and multimedia PC's in every classroom. These schools have been connected into the Internet with at least 512 kb lines, some will get ATM connection later this year.

A notable in-service retraining program -ICT for teachers- has been going on since 1996: every teacher may attend free ICT courses for ten days; last year more than 4300 teachers participated these courses lasting 1-3 days each.

3. ICT at Schools

The schools are using ICT in many ways. All computers have been equipped with basic software: text processing, spread sheet, database, www-browsers and e-mail programs. Pupils in upper comprehensive schools and upper secondary schools have a chance to produce multimedia works with text, images, sound, animation and videos. Problem solving can be practised by doing programming exercises. Pupils write their papers and presentations by means of various programme applictions. Students may produce their own www-home pages.

Multimedia programs, World Wide Web and CD-ROMS are used to find information which is later evaluated and reproduced by the students. Special education have their own educational programs.
Pupils write music, shoot videos and edit them, compile statistics and illustrate them with diagrams, calculate probabilities and edit school papers on computers. Forty schools are working together to produce a multimedia CD-ROM about the local history.

Language teaching makes use of interactive educational programmes. Multimedia equipment enables the pupils to practise listening comprehension and speech communication indiviually. Every new word can be looked up in an electronic dictionary and the written exercises will be checked right away. Pupils learn new words and practise grammar by playing educational games.

Some schools have facilities to design and make knitwear with the help of computers and to embroider cloth with a programmable sewing machine. Pupils can design trendy clothing and let the computer draw the patterns according to the given measurements. In some schools, pupils make chess pieces with a computer-controlled lathe.

Even the smallest children are eager to use computers. Already in preliminary teaching, computers help the pupils to learn the letters and to practise reading, writing and doing sums. A good example of innovative use of computers is provided by a class that has started to write books on computers. The group that includes both Finnish and immigrant childen edit the texts and make them even look like real books. This project has been most benefical for the children's Finnish skills.

4. "net.edu.hel.fi"

There has been a need to develop the pedagogical use of the computers and the use of the Internet/Intranet for normal and special education, serving as well the immigrants and different organisations. That is why a virtual site called "net.edu.hel.fi" has been produced for all schools. This is a site in the Helsinki Educational Intranet that opens automatically when a teacher or a student logs into a computer at school. This interactive site is to help both learning and teaching.

The net.edu.hel.fi consists of two collaborative main parts:

1) A virtual school using different forms of ODL starting 1998 with special interactive courses arranged for upper secondary schools and materials produced by teachers.

2) An interactive site/schoolyard where the students can meet freely and produce their own material. All users are automatically identified by LDAP-server thus minimizing unidentified junk mail and making it easy for teachers to create and maintain courses on the Web. Sructure is based on NT-windows platform and run by CGI-scripts (programmed by Perl language). No Java or java-sripts are included. So all the prossessing is done in the server, not in various workstations.

All three school levels will have their own different starting pages like an entrance hall. There are links to different subjects, courses, news-servers and other relevant links. Students may register to courses that can be administrated co-operatively by 1-4 teachers. A student shall collect his/her works to a digital personal portfolio which his/her teacher is able to see as well.

The teachers may create co-operatively ODL courses, transfer any digital material to special archives (including digital library with direct links to search engines as well), leave messages to their students or discuss with other teachers using the Web. Special Multimedia Delivery system has been created so that all teachers may order any audiovisual or other material and various equipment from the Education Department's Media Center using a normal web browser.

The interactive site is more informal place for the students to meet and to find information what they need when making decisions that affect their whole life. This material is produced in co-operation with students, authorities and different organizations.

An Interdisciplinary Multimedia Project Course

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Abstract: At Loyola Marymount University, we are currently defining the curriculum that will compose an interdisciplinary multimedia program. It is aimed at students from a variety of majors and includes courses in graphic design, multimedia design, on-line design, educational software, and a one-year interdisciplinary project course. The new interdisciplinary project course is aimed at bringing together students from a variety of different areas on campus whose skills can be combined to create interesting multimedia software. The focus of the course will be team-based development and understanding various technical and creative skills in multimedia software development. This paper looks at the design of the project course, its results so far and the issues of creating an interdisciplinary project course.

1. Introduction

At Loyola Marymount University, we are currently defining the curriculum that will compose an interdisciplinary multimedia program. This program will be aimed at students majoring in graphic arts, computer science, English, script writing, video arts, studio arts, management, marketing and education. The current design includes courses in graphic design, multimedia design, on-line design, educational software, and a one-year interdisciplinary project course. The new interdisciplinary project course is aimed at bringing together students from a variety of different areas on campus whose skills can be combined to create interesting multimedia software. The focus of the course will be team-based development and understanding various technical and creative skills in multimedia software development.

The project occurs over two semester courses designed to be taken in sequence and are entitled: *Multimedia Software Design* and *Multimedia Software Production*. The first semester takes a multimedia project from initial concept and client kick-off through a prototype and initial usability studies. It looks at the early stages of multimedia program development including project concept, audience analysis, needs analysis, creative & visual treatments, CD-ROM & Web technical issues, interface design, media format issues, authoring languages, and multimedia project management. The second semester takes the multimedia project from prototype through full script and final production. It looks at script writing, video production, audio production, graphics production, authoring, program engine development, media integration, packaging, marketing and duplication.

2. Course Design

The overall design of this course is an attempt to maximize the understanding of real multimedia projects. The only way to fully appreciate this subject is to experience it first hand. Thus, the project, which has a "real client", is the counter point of the course. This year we are creating a project for the Admissions Office with a working title of *LMU and You*. It will be a marketing piece for the university designed for accepted students who are trying to decide which university to attend. The course has students enrolled from graphic arts, computer science, English and business. This project is particularly good for a first offering because the students already understand the content and are proving to be good subject matter experts.

The real essence of the course is to capture the nature of multimedia in terms of working with people who are specialists in their discipline and who do not necessarily view and talk about the world in the same way. At the same time, students are under pressure to meet deadlines, learning a new process, applying the skills they've learned in another context and are working on a team for the first time. This gives us real learning opportunities for understanding team, social and cultural issues that are very important for successful multimedia projects.

Of course this means that the result of the course is highly dependent on the abilities and dedication of the class members. However, I find that most students become very excited and dedicated once they start working with a client and have a chance to utilize their knowledge in their respective disciplines.

In order to control the content and to assign grades, the course is structured around a very controlled development process modeled on processes used in multimedia production companies. Part of the intent of the course is for the students to not only hear about this process, but to live it and to live the issues that arise on a project that involves people from other disciplines and a real client. Grades are based on various "deliverables" which are written and/or spoken reports. These include project proposal, design document, creative treatment, prototype, usability study, script, alpha, beta, final presentation. Each of these are detailed with examples in course handouts. On most of these documents, I provide *free* feedback prior to its final grade and before it goes to the client. This extra feedback loop slows the process but greatly increases the students understanding of each deliverable, the concepts behind the deliverable and improves the quality of the result.

3. Results So Far

The result of the class so far is extremely positive. Students are engaged and are learning a lot from the course. The biggest issue so far is lack of time class time for presenting the "real content" of the course. Most of the class sessions are spent discussing the project, the next deliverable and issues that are coming up in getting work done. We have had to scale back lectures on related subjects and use the students interest to guide what will be presented. At the same time, this allows us to focus on the issues that are really going to be accepted and learned by the students as part of the project. While we may want to investigate alternate course scheduling plans, from our experience with the computer science project course, this is an extremely effective learning approach and the lack of time does not really impact learning. It's primary detriment is the impact on the ego of the professor who may feel that more learning is occurring even though they are lecturing less.

4. Broader Issue

The broader issue that this course raises, and in some ways the entire multimedia curriculum raises, is where the curriculum fits in the university. In other words, is multimedia part of art or computer science or is it a new discipline? My view is that the answer is that multimedia is inherently multidisciplinary and is not a new discipline. The ideal for medium and large scale multimedia projects is to have students trained as specialists in their respective majors who understand the issues facing other specialists on a team. Thus, students at a university should participate in courses outside of their major to understand the issues that face those specialists. For example, a computer science student should be exposed to the issues and concepts that underlie graphic design, video arts, studio arts, management, marketing, script writing, etc. At the same time, the computer science student should be training to be a specialist in designing and implementing programs. After all, a computer science student is likely to work on multimedia projects as a programmer and there is little expectation that they will have the same graphic design skills as a good graphic designer. Thus, the goal is not to make the computer science student into a great graphic artist. The goal is to make sure that the graphic artist and the programmer can work together to leverage their respective skill sets to create the best possible result. While I feel strongly that this is the right approach in theory, in practice there is a hard organizational problem of who owns the curriculum and who provides lab space and all of these other *mundane* questions.

5. Summary

The project course by all indications is and will be a big success at LMU. Across the campus, there is great interest in the project and the larger multimedia curriculum. Students are eager to participant because of the challenge and the fun learning environment that the curriculum offers. How this course can scale to incorporate more students is an interesting problem. Another interesting problem is the challenges for a university in instituting this kind of course and this curriculum. The current university models do not hold for this inherently interdisciplinary study.

International Integrated Educational Network

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1. Introduction

This trial is among eight schools in Keio Academy. They are Keio Hiyoshi (Boys) Senior High School, Shiki (Boys) Senior High School, Girls Senior High School, Shonan Fujisawa Junior and Senior High School, Futsubu (Boys Junior High School), Chutobu (Co-ed Junior High School), Yochisha (Co-ed Elementary School), and Keio Academy of New York (Grades 9 - 12). We've built an international dedicated T-1 line between Keio Schools in Japan and Keio Academy of New York. Among Keio Schools in Japan, there is a high-speed campus network of Keio Academy. The minimum speed is 1.5Mbps. Last year we've made experimental trials in Keio Academy [Kato 97]. We have developed CALAT [Nakabayashi 95], which is web-based educational system for self-study and now developing the integrated CALAT, which is combined with communication tools. They are E-mail, BBS, Chat, TV-Conference, and so on. Using these tools, teachers and students make collaborative activities through this system. We've been making some experiments and evaluations.

2. Communication tools

CALAT is a web-based Intelligent Tutoring System (ITS), aimed for self-study. In the real educational field, a wide variety of communication tools is needed for both teachers and students. So we provide many communication tools integrated with CALAT.

(1) E-mail

Time difference is very critical issue between USA and Japan. These non real-time communication tools are good to overcome this issue.

(2)Web BBS (Bulletin Board System)

This is also asynchronous communication tool. Web BBS is efficient to use because users should have only web browsers. No mailer is needed.

(3) Ordinal Web Page

This is needed for sharing the activities and schools themselves among eight schools.

(4) Video Conference

This is sometimes needed, not every day. It promotes a smooth communication and establishes a good reliability among teachers.

(5) Video Broadcasting

Video broadcasting is effective for distance learning and distance meetings. Not only US school, even seven schools in Japan are widely spread in Kanto, Japan. It makes possible to join the lecture and meeting from the remote place.

3. Educational trials

Some projects are planning, using this international educational network. Some of them are within a local school, but others are collaborative projects across schools.

3.1 Mathematics

We provide the new simulation environment in CALAT [Hoshide 98]. Using this system, students can learn math in the interactive environment and a teacher supervises students' progress in real-time. We are planning to make a math contest among some schools.

3.2 Language (English)

Collaborative work is made between the USA and JAPAN. In USA there are a lot of up-to-date information resources, such as newspapers, TV, etc. And students in Japan can know the way of thinking in USA. They can use CALAT and web-based BBS to learn and communicate the topics, which are set by a teacher. The objective of this project is to extend English ability and to promote communication skills.

3.3 Biology

This international project is to deepen the understanding of the scientific topic especially in biology. Students in Japan have knowledge of technical terms of Japanese, but they don't know them in English. The objective of this project is to extend the language ability, to promote the communication skills, and off course to acquire the scientific knowledge itself.

3.4 Earth Science

Weather station measures temperature, humidity, wind speed, wind direction, etc. Weather camera captures the real-time images and saves them on the web server. There are many web sites that provide the real-time picture, astronomical telescope, and images from satellite camera. We provide the weather information and real-time pictures of the schools in USA and JAPAN. Information of temperature, humidity, etc. and images are saved on the web servers. Teachers and students can see the information and pictures in real-time. And they also retrieve the old information and images from the web server. This up-to-date information brings good incentives to students for learning earth science.

3.5 Virtual Festival

School festivals are made and managed by school councils. This virtual festival brings the mutual understanding of each school and promotes the student activity.

3.6 Cyber University Campus

High school students especially in New York have a lot of concern of the department of Keio University and its campus. But they have less opportunity to visit, so we provide cyber university campus with rich video data. It will provide a hot information of Keio University to high school students. They can ask questions to university students via Web BBS.

4. Conclusion

We make the networked international educational trial. We provide CALAT as well as communication and measurement tools. Now we've prepared the network configuration and started the trials. A lot of projects are planning or running now. We'll be able to show the detailed results at the conference.

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The Relationship Between Learner's Goal Orientation and Their Cognitive Tool Use and Achievement in an Interactive Hypermedia Environment

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1. Overview

This short paper summarizes Katz's dissertation research (in progress) which proposes to extend the relationship between goal orientation (*GO*), self-regulated learning strategies (*SRLS*), and achievement in traditional learning environments (*TLEs*) to an interactive hypermedia learning environment. First, relevant previous research that reports on this relationship will be highlighted. Next, the linkage of this relationship to cognitive tool (*CT*) use in an interactive hypermedia environment (*IHE*) will be established. Finally, expected results and the paper's relevancy to current theoretical assumptions will be discussed. The following elaboration of *GO*, *SRLS*, *CT*, *IHE* will give clarity to this paper:

Similar to [Wolters et al. 1996] and [Ames 1992], *GO* is empirically conceptualized and measured as a reflection of individual characteristics (i.e., approaching, engaging in, and responding to achievement situations) that learners bring with them to a learning task. *SRLS* are "actions and processes directed at acquiring information or skill that involve agency, purpose, and instrumentality perceptions by learners" [Zimmerman 1989 p. 329]. Similarly, *CTs* are defined as devices that assist learners to accomplish cognitive tasks such as information processing and in general, learning comprehension [Lajoie 1993]. An *IHE* requires learner control in computer-based applications to access multimedia information resources via non-linear, user-determined, navigational paths [Burton et al. 1995].

2. Theoretical Background

2.1 Goal Orientation, Self-regulated Learning, and SRLS

The following highlights (a) relevant goal orientation (*GO*) research; and (b) the relationship between *GO*, self-regulated learning, self-regulated learning strategies (*SRLS*), and achievement. First, in traditional learning environments (*TLEs*), the type of *GO* that learners adopt can yield different adaptive or maladaptive patterns of affect, cognition, and behavior and help to explain why learners perform either positively or negatively in academic situations. Traditionally, goal research has used a *two-goal* theory (mastery, performance) when investigating how *GO* affects learners' cognitions, behaviors, and motivation. However, current research [see Urdan and Maehr 1995] has stated the need to migrate from this traditional *two-goal* theory to a *three-goal*. Recent research [see Wolters et al. 1996] has done this by separating the performance *GO* into two separate *GOs*--extrinsic and relative ability, in addition to the learning *GO*. Similarly, this paper moves beyond and proposes to investigate learners' mastery, extrinsic, and relative ability *GO* in an interactive hypermedia environment (*IHE*). Such investigation can yield *GO* research that is more comprehensive and discover if results from an *IHE* are consistent or divergent to previous *GO* research of *TLEs*. Second, [Hagen and Weinstein 1995] provide theoretical and empirical evidence for the relationships among mastery and performance *GO*, self-regulated learning, *SRLS*, and achievement in *TLEs*. Such current research purports that mastery *GO* students use more adaptive *SRLS* and have a higher incidence of positive achievement outcomes; while, performance *GO* learners generally use less adaptive *SRLS* and experience a higher incidence of negative achievement outcomes. Consequently, it is important to note that learners can simultaneously adopt both intrinsic and extrinsic *GOs* and still have positive achievement outcomes [Pintrich and Garcia 1991]. Moreover, [Wolters et al. 1996] empirical research lends further support to this relationship: learners' (a) learning *GO* yielded more adaptive motivational and strategy use; (b) relative ability *GO* yielded positive academic outcomes in motivation, cognition, and performance; and (c) extrinsic *GO* yielded maladaptive and negative patterns of motivation, cognition, and performance. Hence, the aforementioned theoretical and empirical evidence of this relationship in *TLEs* lends support for the proceeding linkage to *SRLS* and *CT* in an *IHE*.

2.2 Cognitive Tools in Traditional and Interactive Hypermedia Environments

Knowledge of this empirically supported relationship between goal orientation (*GO*), self regulated learning, self-regulated learning strategies (*SRLS*), and achievement can benefit both further research and the design of environments and educative experiences that facilitate individual positive achievement outcomes [Ford and Nichols 1991]. Applying this knowledge to the investigation of learners' cognitive tool (*CT*) use in interactive hypermedia environments (*IHEs*) can achieve the aforementioned. For example, the *CT* and *SRLS* definitions in [Overview] lend support that *SRLS* and *CT* are analogous--they both assist learners to acquire, process, and comprehend information. Moreover, research declares that *CTs* in computer environments can support cognitive processes, such as, memory and metacognitive processes (i.e., *SRLS*) and allow learners to engage in otherwise unattainable cognitive activities [Lajoie 1993]. Thus, it is apparent that *CTs* can also support *SRLS*. Therefore, it is theoretically deduced that the function of *CTs* within an *IHE* is twofold: they can (a) serve as *SRLS*, and (b) support *SRLS*. Hence, *CTs* in traditional learning environments (*TLEs*) and *IHEs* are similar in that they both provide learners assistance to elaborate, rehearse, and organize when processing information. However, they differ in that, *TLEs* require learners to initiate *CTs*; whereas, *IHEs* can make *CTs* readily available in a tool bar, provide guided *CT* instruction/tutorial via animation and sound, and prompt for *CT* use. This proposed research intends to investigate the following *CTs* in an *IHE*: bookmark, notetaking, sitemap, index, glossary, and help. Additionally, the *IHE* will provide introduction and tutorial instruction to orient learners to correct and appropriate *CT* use. Specifically, the following research questions are proposed: *How will learners' goal orientation influence cognitive tool use in an interactive hypermedia environment? What effect will this have on learner achievement? What is the relationship between learners' goal orientation, cognitive tool use, and achievement in an interactive hypermedia environment?* Expected results are similar to *GO* research findings discussed in [2.1] where mastery *GO* learners show greater *CT* use and extrinsic *GO* learners show less. Moreover, contribution of new *GO* results are expected from investigating a *three-goal* theory (mastery, extrinsic, and relative ability). Thus, yet to be determined results are expected to divulge if relative ability *GO* learners display *CT* use unique or similar to that of their mastery and extrinsic *GO* peers.

In conclusion, given the aforementioned theoretically grounded and empirically supported relationship between *GO, SRLS*, and achievement in *TLEs* and the linkage of this relationship to the two-fold function of *CT* use in *IHEs*, it is assumed both relevant and significant to extend this relationship to an *IHE*. This can allow for (a) theoretically grounded investigation of the relationship between learners' *GO, CT* use, and achievement in an *IHE*; (b) the extension of *GO* research from a *two-goal* theory to a *three-goal* theory via including relative ability *GO*; and (c) significant results to further interactive hypermedia research and design.

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Addressing Multiple Intelligences Via an Electronic Culture Box

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Introduction and Conceptual Framework

Education in most nations is in a state of major transition. It is a globally shared perception that if we could fix our schools we could better our societies. Policies resulting from national studies commonly reflect dual intents in increasing both student achievement scores and technological applications to the learning process. Too often, however, these goals are pursued separately rather than in tandem. This work shares one particular strategy for connecting technological skills and student learning.

This paper is grounded in two guiding concepts. First it distinguishes between the automating and informating capacities of technology as identified by Shoshana Zuboff (1988). Automating technologies make existing work more efficient. Informating efforts, on the other hand, cause people to think differently about the work they do and to use technology to redesign and reorganize that work. Second is grounded in contemporary research regarding learning, particularly the work of Howard Gardner (1993). We apply these beliefs to an electronic variation on a useful teaching strategy in the social sciences known as the culture box.

Curricular Application

Findings of the Teaching for Understanding (Wiske, 1997) project at Harvard University detail the importance of integrating skills and knowledge. Culture boxes help students and teachers to create meaningful links between personal identity and historic and contemporary shaping events in their world. And using Internet resources in the construction of a culture boxes encourages students to apply both new content knowledge and electronic skills in order to demonstrate an understanding of historic, geographic, economic, political, and social concepts.

Sarason (1993) claims there are four distinct curricula in most school settings. They are the official curriculum, the taught curriculum, the learned curriculum, and the tested curriculum. What students learn about their world is not necessarily what teachers teach. Nor is the curriculum presented to students necessarily apparent in what schools assess. We know too that curricular content, particularly as presented in traditional textbooks, has not necessarily reflected the cultural identities of all children. Use of the Internet as a resource, however, facilitates linking micro aspects of self to macro elements a larger cultural map. The history of the past decade affirms that individuals are not passive recipients of the prevailing culture, but active agents in reshaping personal identities and the larger society. Social historian Alaine Touraine

(1988) notes, "The theme of identity. . . must be played by the actor. . . as an appeal to life, freedom, and creativity." The presented cybercube, an electronic variation on the traditional culture box, facilitates this role, and at the same time enables the learner to utilize many dimensions of intelligence.

Case example

Choosing the contents of traditional or electronic culture boxes remains a personalized experience. Each part of the process involves making choices, choices that involve people, places, and events, and the significance of connections. Culture boxes creators must order text, photographs, videotapes, or audio clips within their presentation. Some choose to arrange their culture box contents chronologically. Others prefer political, social or economic themes. The example examined at this conference, located at www.shol.com/educate, reflects the individual and cultural identity of Tom Jones, whose identity portrays an era contemporary cultural labels as "baby boomer." Specifics of the construction process can be found at this site also.

Conclusions

As connections between schools and society grow increasingly misaligned communities are demanding changes in the ways schools do business. Today's educational challenges require teachers who can use more relevant and more meaningful resources and strategies and who can redesign and restructure traditional teaching/learning transactions.

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Preliminary Report on HyCLASS Authoring Tool

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1. Introduction

Various simulation environments have been used to enrich intelligent tutoring systems (ITS). Single-user and multi-user simulations using VR environments have been developed to support procedural knowledge acquisition [Rickel & Johnson 1997]. Likewise, HyCLASS [Kato et al 1996] is a simulation environment which also features learning by observation. In this paper we describe HyCLASS as an environment to facilitate procedural knowledge acquisition. The knowledge acquisition process revolves around learners' experience with manipulable 3D graphical objects in the virtual shared space. These objects can be complicated and thus are not trivial to produce. First, it is very difficult to model the target logically. Second, implementation of the target simulator is a time-consuming procedure including production of modeling data of the target. The HyCLASS authoring tool is designed to ease the process of building the learning material from the perspective of reusability and visibility of operations on the graphical objects.

2. The hierarchy of learning materials

HyCLASS learning materials are hierarchical in terms of their constituent objects and behaviors. Learning materials comprise one logic part to describe simulation behavior (described under point 3 below) and one or more *learning material components* which are reusable units. Learning material includes several graphic files and sets of behaviors attached to the graphical objects. The user of the authoring tool can attach various behaviors to the *graphic entity* such as "push" or "get". The graphic entity corresponds to a manipulable object in the HyCLASS runtime environment. Several behaviors are grouped into one *behavior set*. For example, the "on" and "off" operation for the switch can be recognized as one *behavior set*. Each behavior set is categorized into pre-defined types, *switch type*, *dial type* or *no type*. Each behavior set (except no type) holds a control variable to express its status. The switch type holds a boolean variable, the dial type holds an integer-like variable. Using this control variable, the simulation can recognize the current status and change this status according to input events. One behavior consists of several *behavior units*. A behavior unit is the implementation of a movement, sound or other multi-media outputs. The author selects the behavior units and enters them on the behavior time sequence chart according to when they want them to be invoked. For example, a power switch of a video deck needs movement, sound and modification of its material. Authors should select suitable behavior units and align them according to their sequential order.

3. Logical part of learning material

Various behaviors defined on the graphical objects should be related to emulate the simulation target. For example, the TV set and video deck, which are implemented as learning material components, should be related so as to "play" the video on the TV screen. The authoring tool provides a sheet to describe relationships among behaviors, using the key terms: *trigger*, *condition* and *action*. The trigger is the user-initiated event within the HyCLASS environment. The condition is the requirement for the execution of the actions. The action comprises one or more behaviors to be invoked when the condition is satisfied. There may be more than one condition clause or action for a single trigger. The structure is similar to the switch/case statement in programming languages.

4. Current Status of HyCLASS viewer and authoring tool

The HyCLASS authoring tool (Fig.1) runs on Windows NT4.0 and Windows 95. The authoring tool requires the VC++ environment to compile new learning material. This aspect will be improved in the near future. The HyCLASS viewer does not require a high-speed network. It runs comfortably, for example, over a 64k ISDN line. Within the HyCLASS runtime environment, the learning material is implemented as a Dynamic Link Library (DLL). During the development of the learning material, the authoring tool saves the logic and component inflammations HyCLASS intermediate code (H-CODE). Subsequently, to run the learning material within the HyCLASS environment, the authoring tool can be used to generate source code from the H-CODE, which is then compiled as a DLL.

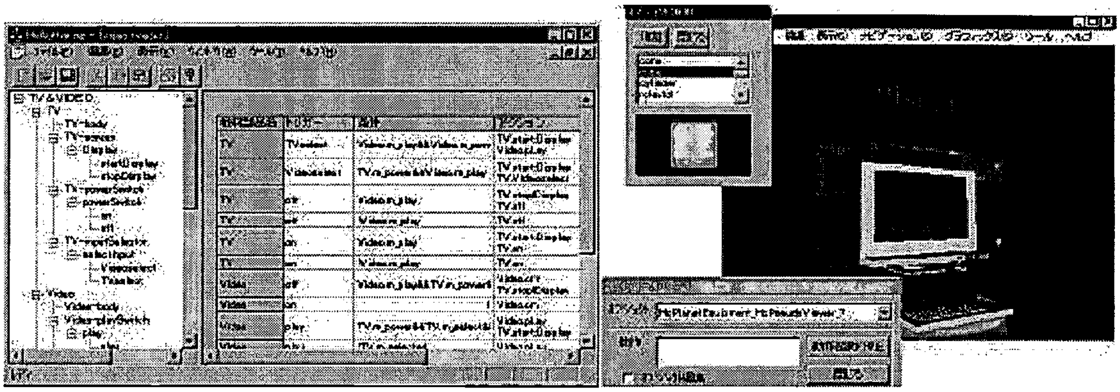

Figure 1: HyCLASS authoring tool and runtime scene

5. Conclusion

The hierarchical structure of HyCLASS learning material enables "cut and paste" of the components in each layer: learning material components, graphic entity, behavior set, behavior and behavior unit. This substantially reduces the effort of authoring. Learning material components can also be imported from other learning material. This aspect promotes the reuse of existing learning materials.

Using the authoring environment shown in Figure 1, authors can browse the behaviors attached to the graphical objects and modify them on the fly. Tree-like presentation of the components enhances the author's sense of the hierarchical structure.

H-CODE is more than description of the learning material and less than a script language. H-CODE is quite easy to learn, and serious developers may wish to extend this code directly. However it is possible to develop learning material with the authoring tool without any knowledge of H-CODE.

6. Future Works

The HyCLASS authoring tool currently requires the VC++ environment to compile learning materials. We are now developing the next version of HyCLASS, which reads HyCLASS intermediate code directly to generate the 3D graphical objects and their behaviors.

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VIRLAN

VR Community for Children to Learn and Speak European Languages

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Introduction

Currently, language learning is either class tutoring based or self-learning based using the following learning material: traditional books, audio tapes, video tapes, CD-ROMs. Each medium has its advantages and disadvantages and has not been proven to be the best and the unique tool for language learning.
It has been proven that the best way to learn a foreign language is at early age and in a real world context. The project called VIRLAN - supported by the European Community in the form of an ESPRIT programme - proposes to create a virtual world in which children can learn by interacting with foreign children without leaving their school or home environment.

The underlying technologies are now available to achieve this goal: wide availability of Internet access, VRML tools, tools for 3D realtime multi-user environments.
Thus, the goal is to set-up a virtual realtime language learning network for primary school children throughout Europe.

Consortium

A European consortium, consisting of four research organisations (UK: University of Wales Swansea, Finland: University of Jyvaeskylae, Greece: Institute for Language and Speech Processing, Germany: Fraunhofer IAO) an leading educational publisher (Germany: Klett), and two software companies (Germany: Blaxxun , Greece: Exodus) will design, develop and evaluate the language learning network during the next two years.

Description

The VIRLAN language learning network will allow young children to come together, as if they were physically present in the same place. Through facilities of virtual reality and avatar technology, the children will be able to "enter" the central meeting place and from there "travel", via the Internet, to different virtual countries, in order to meet and communicate with other children.

All virtual countries environments will be built upon open templates, such as interface templates for setting up a local country site, edutainment templates, linguistic templates for the incorporation of dictionaries and phrase books, etc. The software, with the templates and the methodology to set-up a local site will be included in a localisation kit, to be sold to local distributors, according to the licensing method.

VIRLAN will be used in primary schools as a complementary tool for language learning, but it will also have the potential to be used for child-to-child communication on a private basis at home.

During the validation phase, an extensive and thorough evaluation of the proposed approach will be carried out in 6 European countries and in Canada.

The goal of the project is to take advantage of the emerged global telematics infrastructure (Internet), as well as the latest advances in virtual reality and multimedia technologies, in order to develop and setup a virtual-reality language learning network for primary school children throughout Europe. This network will provide a new, highly innovative approach in language learning through the virtual interaction among children in a lifelike, fun environment.

The VIRLAN project intends to enhance, adapt, and integrate emerging technologies, in order to provide and validate an innovative experimental learning network for young children, which will encompass the latest trends in VR, VRML, 3D multi-user worlds, and multimedia. The current project brings two significant innovations: on the one hand, it intends to create a virtual reality language learning environment, offering real 3D representations and interactions. On the other hand, it intends to provide a language learning experiment for a target group with very specific requirements and needs, namely to primary school children. For that reason, the envisioned network has to be very user-friendly, easy-to-use, and entertaining for children.

As the partners involved in VIRLAN are leaders in their fields world-wide, the proposed project will combine world-class skills into a highly innovative service. The resulting network will keep all benefits of existing state-of-the-art virtual environments, and add 3D interactive representations, intuitive navigation, identification with the location, as well as "intelligent" assistance.

Skill Development in Multimedia Production - The Case of Singapore

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Introduction

Despite the importance in multimedia and wide area networks in Singapore, there is very little published research on multimedia development in the country. At the same time, there is no research, to my knowledge, on skills development in multimedia production in Singapore. This paper is part of a larger research study to report on and analyse, the results of a survey using ethnographic research methodologies. The survey respondents is a structured sample drawn from the major providers of multimedia skills development including tertiary institutions, government, quasi-government and corporate institutions. The survey is aimed at soliciting a wide array of data from the respondents to elucidate present and future constraints of and to project directions for, multimedia skills training. However, since it is being presented as a short paper, this paper will only discuss the multimedia education approaches adopted by the various government tertiary institutions in Singapore.

Multimedia Skills Development Study

Multimedia development skills training courses have only very recently been mounted in tertiary institutions in Singapore. This was mainly in response to the Singapore government's plan to develop information technology skills for the 21st century and to its push to provide high speed end-to-end infrastructure such as 'Singapore ONE', Singapore's 'national intranet' which is designed to use internet protocols and technologies to provide its citizens with a range of governmental, cultural and electronic commerce services. It will enable 'Singapore One' partners - both government and corporate - to plan on intense application of multimedia in delivery of services to corporate and personal network service customers. If these services were to eventuate, highly sophisticated multimedia skills are likely to be in heavy demand in Singapore. Internet-based multimedia skills availability is, then, one of the critical success factors for 'Singapore One', along with network construction, certification, security and marketing. In line with government plans to focus on IT training the two national universities and the four polytechnics started courses in highend IT courses in the late '80s and early '90s. Recently, in response to the plans for the Singapore ONE initiative which was launched last June specifically multimedia content development and technological skills programmes were mounted at the technological university and the four polytechnics. Although there were only a sprinkling of course components in multimedia production training previously, almost all the polytechnics since 1997 have mounted full blown course programmes leading to substantial multimedia development skills. Since these courses are so new, not surprisingly there have been no graduates and therefore no testing of the industry appropriateness of these graduate skills as yet.

In Singapore,• tertiary education is divided into three tiers. The first tier comprises the two national universities. About 20 % of all successful high school leavers enter the universities while about 40% of the same enter the four polytechnics or the second tier of tertiary education. The third tier comprises the vocational institutes. The universities have complementary specialisation in education and training. The polytechnics run technological and technical courses with a strong vocational slant such as in engineering and computing and award diplomas rather than degrees. Vocational institutes, on the other hand, provides strictly skills training in the trades.

Generally, all the four polytechnics offer courses in multimedia development skills, including world wide web design and production skills. These course programmes lead to diplomas such as the diplomas in digital media design, in multimedia software engineering, in multimedia computing, in data communications and networking and in information technology.

The entry qualifications are minimum 'O' level results for polytechnics and 'A' levels for universities. Basic subjects include English and mathematics and science subjects. For one polytechnic selection also includes interviewing shortlisted applicants who may be required to submit portfolios which show evidence of creativity and imagination. Interviewees may also be required to complete drawing/design exercises. The process seeks to ascertain applicants' aptitude, attitude, knowledge and potential for visual communication. These programmes constitute three-year full-time courses. Each of these have an intake of between 50 to 100 students per academic year.

The programmes have been designed to:

a) meet increasing demand for digital media professionals both locally and worldwide.
b) provide education and training in both creative and IT skills centred on the art and science of computer animation, multimedia and games design.
c) Provide a broad understanding of the graphics and media industries .
d) Provide training and technical knowledge in computer software development and multimedia computing.

Training range from multimedia programming to computer animation, graphic design, integration of video and audio effects and design and management of multimedia systems. Students will also learn about technologies that support multimedia production.

Course content and skills training area:

There are two main areas in which multimedia training/education takes place in these institutions:

a) Computing software skills including multimedia programming, database programming for multimedia information systems, network programming for multimedia communication systems and multimedia programming for windows.
b) Content production skills including converting linear, analog material into digital material such as digital video and audio, multimedia title design, multimedia title authoring, managing mm project, animation, interactive multimedia project, games design, virtual reality and development tools as well as basic art and graphics design, design for advertising, information graphics and packaging design and environment graphics.

Recently, however, there is an awareness that creative and artistic skills training is also needed. This is a difficult area to implement at institutional levels as currently the school and tertiary education curricula place high emphasis on examination skills and information retention.

Course methodologies, facilities and staffing

Courses include lectures, research work, case studies, laboratory workshops and hands-on tutorials, group and industrial projects and industrial attachments. In most institutions at least 50% of course time is allocated to laboratory practical work. Students also undertake a three-month industrial project and a 6-month industrial attachment where students work on live projects in the industry during their final year. All the polytechnics have very good high-end equipment and facilities ranging from high-end graphics capable computers to both Macintosh and PCs, digital audio and video equipment and edit suites However, there is generally a shortage of academic staff who are qualified to teach in this area and hence the ratio of staff to student is generally not as adequate as in the other disciplines. Almost all staff are expatriate staff with a mere handful of local staff and these have been trained overseas.

Conclusion

So where will the graduates go? The polytechnics envisage that their graduates will enter the multimedia industry of interactive entertainment, games production, computer animation, CD titles development, corporate communications and education. Graduates are likely to work as computer animators, multimedia designers/producers, content developers, computer graphic artists, games designers or developers. Careers will also include multimedia programming, multimedia consultancy, multimedia database specialists and multimedia network specialists.

It would seem, then, that the tertiary institutions have positioned themselves well in responding to the demand for multimedia production professionals. However, as the bulk of the graduates are not due to enter the industry until at least a couple of years from now, there is therefore a severe shortage of such professionals which cannot be entirely met by foreign expertise. At the moment most content production has been farmed out to organisations which have expertise in their bases in North America, Europe and Australia.

Using Multimedia to Improve the Assessment of Language Learning

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Abstract: In the United States, widely accepted standards for evaluating oral proficiency are provided by the *Speaking Proficiency Guidelines* of the American Council on the Teaching of Foreign Languages. Through live workshops, the Center for Applied Linguistics (CAL) has trained thousands of teachers to assess student oral performances using the *Guidelines*. To extend this training, CAL has also developed self-instructional Rater Training Kits. CAL is currently attempting to improve this training by harnessing the capabilities of multimedia to develop a self-instructional, adaptive, interactive training program.

While multimedia has been used increasingly for language instruction, student learning also needs to be assessed. In the United States, widely accepted standards for evaluating oral proficiency are provided by the *Speaking Proficiency Guidelines* of the American Council on the Teaching of Foreign Languages [ACTFL, 1986]. To effectively apply the criteria of the *Guidelines* to the scoring of performance samples, raters (usually foreign language teachers) require specialized training. The Center for Applied Linguistics (CAL) has trained thousands of teachers in the *Guidelines* through one- and two-day workshops, a traditional approach. While workshops are effective, they can be costly in time and money, and can offer logistical challenges

To extend the benefits of training beyond workshops, CAL has also made it available through self-instructional Rater Training Kits (RTKs) [Kenyon & Stansfield, 1993, August; Kenyon, 1997]. These kits consist of several audiocassettes containing student performance samples and training booklets. Samples of student speaking proficiency are drawn from the Simulated Oral Proficiency Interview (SOPI). The SOPI is a tape-mediated speaking test based on the ACTFL *Guidelines* that elicits speech by means of a tape recording and printed test booklet [Kuo & Jiang, 1997]. The test presents examinees with either seven or 15 (depending on the level of the examinee) relatively authentic, context-based speaking tasks. Examinee responses to the test tasks are recorded on a separate examinee response tape. Responses to each task range from 45 seconds to one minute and 40 seconds, depending on the complexity of the task. To score the examinee's proficiency, raters evaluate the examinee's task performances using the criteria of the ACTFL *Guidelines*. Examinees receive a final rating on the nine-point ACTFL scale based on their performances across the test tasks.

While the RTKs allow for individualized instruction at a time and place suitable to the trainee, we believe that at least four limitations of these kits can be improved through multimedia. First, no matter what their prior experience, all trainees must work through the materials in a similar, linear fashion. Second, due to practical space limitations of the audiotape, trainees can receive only a relatively small number of exercises to practice their rating skill. Third, working with audiotapes means that when trainees want to listen to specific samples, they must rely on manual rewinding and fastforwarding entire tapes, a time-consuming and inefficient process. Finally, the kit provides no opportunity for additional exercises if a trainee still lacks confidence in some levels of the rating scale, nor is there an easy way of quickly moving through the materials for persons who have had previous training or are already very familiar with the ACTFL *Guidelines*.

Using Authorware 4.0, CAL has developed a multimedia program that improves the self-instructional rater training process by allowing trainees to develop their skills in a way that suits their needs and adapts to their ability as raters. The program contains three sections. First, trainees progress through vital introductory information on the *Guidelines* and the SOPI in a manner that facilitates their theoretical comprehension of the material. The introductory material is broken down into units, each of which is introduced with a "pre-test." Trainees completing the "pre-test" activity successfully have demonstrated prior mastery of that material and may go on to the next unit. Otherwise, they learn the introductory materials in smaller units through hands-on activities. A "post-test" activity for each unit ensures that the materials have been learned successfully.

Upon completing the first section, trainees enter the "hands-on" training mode of the program. Here they first listen to sample examinee performances on one of the 15 SOPI tasks. These samples illustrate the different ACTFL proficiency levels, allowing trainees to hear benchmark examples of what they have been introduced to conceptually in an order that makes sense to them. The use of multimedia allows trainees to easily control what samples they listen to, the number of repetitions, and the sequence.

When trainees are ready to practice (or refresh) their new knowledge and skills, they can select the exercise for the task. This section tailors the presentation of new examinee responses on each SOPI task to the rating ability of the trainee. Trainees test their ability to accurately rate student performances by listening to and rating individual responses one at a time. These pre-rated performances are drawn from a large pool. For each task, after trainees listen to the first performance randomly selected by the program, they enter their rating. The program then gives them immediate feedback, keeping track of the trainees' correct and incorrect ratings. An algorithm in the program requires trainees to correctly evaluate a predetermined number of samples at specific ACTFL levels to successfully pass the exercise. The program does not select additional exercises for performance levels the trainees score correctly the first time. However, if trainees are having troubling rating two adjacent performance levels correctly, for example, the program will automatically provide additional exercise samples at those levels. In this way, the program is adaptive to the skills of the trainees, while providing ample practice to develop the rating skill. For trainees who cannot successfully complete an exercise portion for a particular SOPI task, the program will alert them to review all training materials on that task and attempt the exercise again. For each task, the pool of exercise performance samples is large enough for the two complete attempts to pass the exercise.

The final section of the program explains how to award examinees an overall global proficiency rating based on their performances on separate tasks. It provides trainees practice in rating examinees across several tasks, as well as in assigning global ratings.

An advisory council has evaluated a Spanish prototype program, which will soon be pilot tested with Spanish language teachers. The program will be evaluated in terms of its clarity, usability, efficiency, and effectiveness in training in the assessment of oral language proficiency. In this way, we will evaluate how multimedia language assessment training has provided improvements over more traditional approaches.

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An Assessment of Engineering Undergraduate Distance Learning Programs

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Abstract: The study discusses the practiceof distance education in universities worldwide with particular attention to universities in North America. The study revealed that cooperative and consortia type institutions composed of member universities offer the advantage delivering a wide variety of courses at the time of demand compared to single independently operating distance learning universities. Quality of learning in distance delivered education can equal traditional mode of delivery depending on the quality of faculty-student interactivity, information transfer and student attitude. The paper concludes by saying that distance delivered engineering education suffers from the traditional university evaluation criteria, norms and expectations imposed on it. It needs to establish its own standards with respect to assessment and evaluation of educational outcomeand validation of skills and competencies of its graduates in the workplace.

Distance education reverses the traditional way of providing education to the learning community. Instead of students coming to the university to get that needed education, the university instead comes to the student.

While 40% of competitive improvements are derived from direct investments, 60% of competitive advantage comes from advances in knowledge or innovation (Carnevale, A.P., 1992). In 1995, 21 % of all adults participated in work-related adult education.[1] Majority of this percentage took courses provided by businesses or professional organizations. Colleges and universities or government agencies provided others. Workers in the executive, professional and technical occupations were most likely to receive on-the-job training. Distance education is able to address this critical learning need.

The latter half of the 1980's and the early 1990's saw the emergence of many distance learning consortia based on satellite television and large industry of 'business TV ' delivered by satellite(Moore and Kearsley). Two advantages that are attributed to consortia-delivered distance education are: its capability to offer a broad selection of courses and the strong competition that exists among the member universities in terms of offering the best quality courses in the most timely manner. The customer's (students, employees, companies) needs dictate what courses are in demand and marketable (Moore and Kearsley 1996).

Established in 1985 and based in Fort Collins, Colorado, the accredited National Technological University NTU is a cooperative effort of 47 universities providing for graduate and continuing education for the busy engineer, technical professional and manager. NTU has no faculty or campus of its own and relies on courses taught by faculty of participating teaching universities. The National Universitites Degree Consortium NUDC is a consortium of 13 accredited universities across the United States working together to offer over 1,000 courses, 3 credit certificates, 11 Bachelor degrees and 24 graduate degrees through distance education. Funded by the National Science Foundation with matching funding provided by participating institutions, the Southeastern University and College Coalition for Engineering Education SUCCEED (is a coalition of 8 southeastern engineering colleges managed in the college of Engineering at North Carolina State University. It is committed to a comprehensive revitalization of undergraduate engineering education. SUCCEED's curriculum model called CURRICULUM 21 conveys the coalition's theme "Engineering Education for the 21st Century". The Florida Engineering Education Delivery System FEEDS was established by the Florida Legislature in 1982 to deliver graduate engineering education, primarily at the master's level to engineers throughout the state at their place of work through distance learning technologies. Independently operating Distance Learning universities offering different

[1] The Condition of Education 1996, National Center for Education Statistics, United States Department of EducatioOERI, 1996

certification in engineering e.g. associate, pre-degree, degree, diploma, post-graduate, continuing education, certificate and training exist worldwide. The Peterson's Directory of Distance Learning database revealed 24 universities offering undergraduate distance learning. Further exploration revealed that there are other well-established Distance Learning Universities.

Technology, Access and Interactivity

Distance education began its life through correspondence utilizing one of the earliest forms of communication i.e., print, which occurred on an international scale. The origins of some of most important ideas and techniques that are being used today have its roots to century-old events that occurred globally. Began in the form of correspondence study, distance education evolved into a total systems approach pioneered by Charles Wedemeyer which was adopted by the 'Open Universities' principally the British Open University. This approach used print, broadcast and recorded and distributed by radio and television. An Overseas Development Administration 1995 Education Report[2] revealed varied perceptions about distance education. The United Kingdom looks at it as a grown market, The United States views it as a second-class option and Developing Countries are yet to be convinced of its benefits. The report cited cultural adaptability, attitudes, local point of contact and student support as factors necessary for its success.

The most popular Distance Learning technology is the videotape system. Telecourses offer the convenience of taking classes while at home or in the office by way of the student's television sets. On-line courses facilitate instruction to any student who has a connection to the Internet. This is usually supported by a host of other technologies such as 2-way video conferencing live and interactive and electronic mail. Boston University's interactive-Compressed Video system utilizes three state-of-the art PictureTel videoconferencing system. These systems transmit at speeds of 56-384k (full motion video) capability. Stanford University's Stanford Instructional Television Network SITN utilizes a digitization and compression of courses in video format and stored on a video server making it available as an on-demand video streaming environment.

Distance education practitioners were the first to see the promise of the technological revolution as a means of unlocking the door of access for students and help distance teaching institutions become the leaders of the 'New University' (Hall, J., 1996). However, some distance learning critics would argue that since learning resources are scarce, bringing in more students would dilute the quality of these resources (Ehrmann, S.) With advances in technology these resources e.g. books, communication facilities, calculators, etc were mass produced making them widely available to many learners simultaneously with enhanced quality. Today the computer has taken over as one of the most important, if not the most important learning tool in accessing learning resources and enhancing learning at the same time. On-line communication facilitates communication between one another, transfer text/data files, obtain information from computer databases transcending time and space constraints. Computer Mediated Communication CMC or Distributed Learning Environment is a new medium in education and more specifically, distance education (Kaye, A.). The basic structural element of CMC is that all communications are stored on the system and are retrievable. Hence these information are researchable, downloadable and usable at any time. Its drawbacks include requiring access to expensive essential telecommunications facilities and equipment and familiarity with the technology itself. The interest is high in spite of these barriers because like the spoken word it is spontaneous and flexible. It is a powerful medium for communication and cooperative learning. Possible predictors of success in using CMC/DLE in distance education would depend on the teacher's interest and familiarity with the technology, trust in the value of cooperative learning and sufficient time to assess student contribution. Success of CMC use will also depend on the the student's being able to overcome all techno-socio-economic barriers in achieving mastery of the medium.

Quality of Learning

[2] Distance Education in Engineering for Developing Countries by Bilham, T. and Gilmour, R., Education Research Serial No. 13.

Research and evaluation studies show that achievement and satisfaction of students who learn via teachnology can equal those of students in regular classrooms (Johnstone, S. 1996). There are various factors at play in that transfer of learning. Information transfer is one. A survey of 400 students in two-way telecourses between 1988-1990 revealed that the amount of information transferred was the best predictor of learning and the strongest predictor of satisfaction was information transfer (Walker. K., 1992). Another factor linked to meaningful learning is interaction with faculty. This has been shown in several studies linking interaction with learning. Oklahoma Televised Instruction System 1992 survey showed that 83 % interacted with the instructor all the time and did not feel disadvantaged when it came to access to services. The same study revealed that distance education students performed equivalently in civil engineering but performed better in business, humanities, science and social science. The students cited problems with the telecommunication system, instructor style, method of instruction and lack of library resources hindered their performance. In a 1993 survey of 30 video-based distance education students of an independent university in various courses, course completion was directly correlated with faculty initiated contact by telephone call to their students (Towles, D. and others, 1993). A survey of teleconference DL students delivered by two Canadian universities revealed that the goals of deep learning and critical thinking were achieved when teleconference took place more frequently such as on a weekly basis compared to a bi-weekly frequency (Anderson, T. 1994).

Delivery mode is another factor that can have an effect on learning. A study was done of the same graduate class in Management Technology delivered in the traditional method at Georgia Institute of Technology and the University of Alabama at Hunstville and by studio broadcast to students enrolled at National Technological University NTU at Colorado. In that study, the traditional students outperformed the remote students on the examination calling for understanding and articulation of basic concepts. However the older NTU students outperformed the traditional students on questions calling for application and synthesis of course materials.

Student's attitudes on the distance education mode can also have a significant impact on the quality of learning. Students at Valdosta State University expressed a less positive reaction to the physical distance learning environment and to the overall course. At a large midwestern university (Remote site)Telecourse students were compared with (Broadcast)traditional students. High grades for telecourse students were associated with greater expediency, greater self-sufficiency and less compulsiveness. For traditional students high grades were associated with greater conscientiousness, emotional stability, soberness, shyness and liberalism. High rate of student retention and satisfaction with studies at the Open Polytechnic of New Zealand were attributed to students receiving a pre-enrollment counselling booklet.

Several factors can affect distance learners' satisfaction with interactive televised courses viz. Instructor/Instruction, Technology, Course Management, At-site Personnel, Promptness of Material delivery, Support Services and Out-Of-Class Communication with the Instructor (Ball State University survey).

Faculty attitude to distance education is mixed. A survey of faculty members in 57 public institutions revealed attitudes towards distance education. In general, faculty attitude was positive but became negative when it was applied to their own programs or courses. Experienced distance education practitioners and community college faculty had an overall positive attitude than faculty at four-year institutions. Faculty at 4-year institutions expressed positive attitude towards videoconferencing. In a 1994 evaluation of the seven Annenberg/CPB New Pathways to a degree learning projects of seven institutions, faculty was of the opinion that mediated teaching was not comparable to face-to-face environment. While the efficacy of technology is becoming less of a question in distance education the focus is being shifted to surrounding issues such as feelings of isolation of distance students who do not have any human contact with their instructors; how to provide effective advising and academic support services to distance students and a guarantee of continued support to electronically delivered program until the distance students complete their program.

Accreditation is a process that gives public recognition to educational institutions that meet published standards of quality. It is a fact that distance education is "becoming widely accepted but yet is still not mainstream and employers skeptical of a degree are likely to be even less accepting of one from an unaccredited school" (Occupational Outlook, Summer 1996 Vol. 40, Issue 2, p22).

Technology has precipitated a new era of educational paradigm. Distance education faces an enormous challenge because it is an evolving field and is heavily dependent on a rapidly changing telecommunications industry. The standards by which educational quality of a distance-delivered course is still based on norms set by the traditional university. If distance education will be judged through its own merits, it needs to have its own set of criteria for evaluation and not entirely based upon standards accorded the traditional university. On assessing the educational quality derived from a distance-delivered course emphasis would need to be placed on the quality of its graduates and outcomes of the educational process such as the skills and competencies acquired and validated in the workplace.

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A Technology Infrastructure for Enabling a Learning Community

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The construct of a "learning community" has increasing prominence both as a means for understanding human performance and learning outcomes and as a vision for guiding educational reform. Researchers see special value for for the utility of learning to performance in learning that is situated in the authentic activity of a community, such as a profession, a trade, or an academic discipline. These professions and disciplines create communities of practice wherein learning takes place through experience and induction takes place through apprenticeship. In these situations we can view learning as not a type of activity, but rather as an aspect of all activity. An implication of situated learning for educational institutions is the need to provide students with participation in the authentic work of communities of practice.

However, schools are not places of "authentic work" they are places for preparation and development, and the model of communities of professional practice may not be appropriate for school-based learners. [Scardamalia and Bereiter 1994] propose a knowledge-building community as a goal for educational reform. The knowledge-building community is based on a model of the academic or scientific community that is focused on building new knowledge. Their conception of a knowledge-building community emphasizes intentional learning as the product of the educational community of practice. This contrasts with a focus on expert performance held by other communities of practice. Communities of practice in educational institutions must engage students in knowledge building. Learning to learn becomes the authentic practice of schooling.

In some ways all communities are learning communities or they would cease to exist. High performing learning communities, however, can be defined as enterprises that place a special value on developing the capacity to learn, see learning as the outcome of the authentic activities of that community, use the outcomes of learning as scaffolding for future activity, and enable activities as social practices (e.g., not bound by arbitrary isolation of individuals, such as individual seat work in school).

Educators, such as Scardamalia and Bereiter, recognize the potential of technology to transform educational institutions from traditional transmitters of acquired knowledge to learning communities engaged in knowledge-building. This view of network-augmented learning differs from web-based courses similarly to the way that the experience of a graduate research assistant differs from that of the freshman student in the lecture hall course. Advancing technology has diminished the economic reasons for this distinction.

Dimensions of a Learning Community

Traditional educational institutions differ from learning communities across a set of dimensions. Some of the key dimensions are:

Abstract vs. Authentic: Traditional forms of scholarship isolate knowledge into domains for advanced inquiry. Schools have adopted these abstracted domains of knowledge for providing students with a knowledge-base for citizenship and employment. A learning communities model places learning and inquiry into the practice of the community, thus requiring integration and authenticity.

Hierarchical vs. Networked: School curriculum is organized into hierarchies of modes of instruction and sequences of knowledge and skills. Learning communities create networks of people and resources to enable right-time, right-place and right-form learning support.

Static vs. Dynamic: Curriculum represents an approved canon of knowledge. Learning in a community adapts to challenges and opportunities. In a sense the curriculum is found in the situation and new knowledge is dynamically added to the community memory as new situations are taken on and mastered.

Telling vs. Modeling: Situated learning is more likely advanced through role models, trial and error, and demonstrations rather than didactic lessons.

Testing vs. Assessment: Greater emphasis is placed on self-assessment and building the capacity of the learner to make beneficial assessments.

Grading vs. Reflection: In learning communities we expect that individuals will take more responsibility for their own development because they have authentic consequences for their actions.

Technology Enablers of a Learning Community

Technology has great potential to enable a learning community, especially the new technology of inter and intra-nets and network computing. Three key technological enablers for moving toward the Learning Communities side of the dimension matrix are:

1. Articulation of experience: media representation enables the user to communicate experience more directly to others.

2. Making sense of experience: Access to mediated representations of the experiences of others can enable the learner to compare and contrast experiences. These processes support reflection and develop a perspective for making sense of personal experience.

3. Contributing to the sense making of the community: Networks and the web create a potential audience for experience that can change the relationship of the learner to the sense making process for the experience. Having an audience, and in a sense a customer, can drive the learner to a deeper and more thorough processing of experience.

New network services support these enablers and offer the potential to design education based on a learning community model rather than on the traditional model of instruction.

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CAMELEON: Computer Aided MEdium for LEarning On Networks

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I. Introduction

A learning system can be useful in any application area where it is expected to be used by people with different goals and prerequisites. An adaptive system tries to overcome this problem by presenting differently information to learners.
This paper presents an ongoing research on creating an Intelligent Tutoring System allowing a distance learning via Internet / Intranet networks.

II. WHAT IS CAMELEON

CAMELEON is the English acronym of Computer Aided Medium for LEarning On Network, It's a system running across the Internet / Intranet, allowing teacher introduce his/her course and the learner to study (presentation of the course materiel, assessments, etc.) via an adaptive interface.

III. Why CAMELEON

CAMELEON is the French word of chameleon, which is small lizard famous for changing its skin color according to their surroundings and so to adapt itself to the environment.
We plan to have and adaptive systems, which can compare the student's model and the domain model and thus automatically change its teaching style.

IV. Architectural considerations

Because of the absence of the teacher during the learning session, the teacher should have an initial interaction with the system before that the students use it, in order to define the teaching behavior and material and then after to evaluate the students' work. This means that an authoring system in which the teacher is able to specify all the teaching material and teaching style is a definite requirement. A separate system would then deliver the teaching to the student.

V. Architecture of CAMELEON

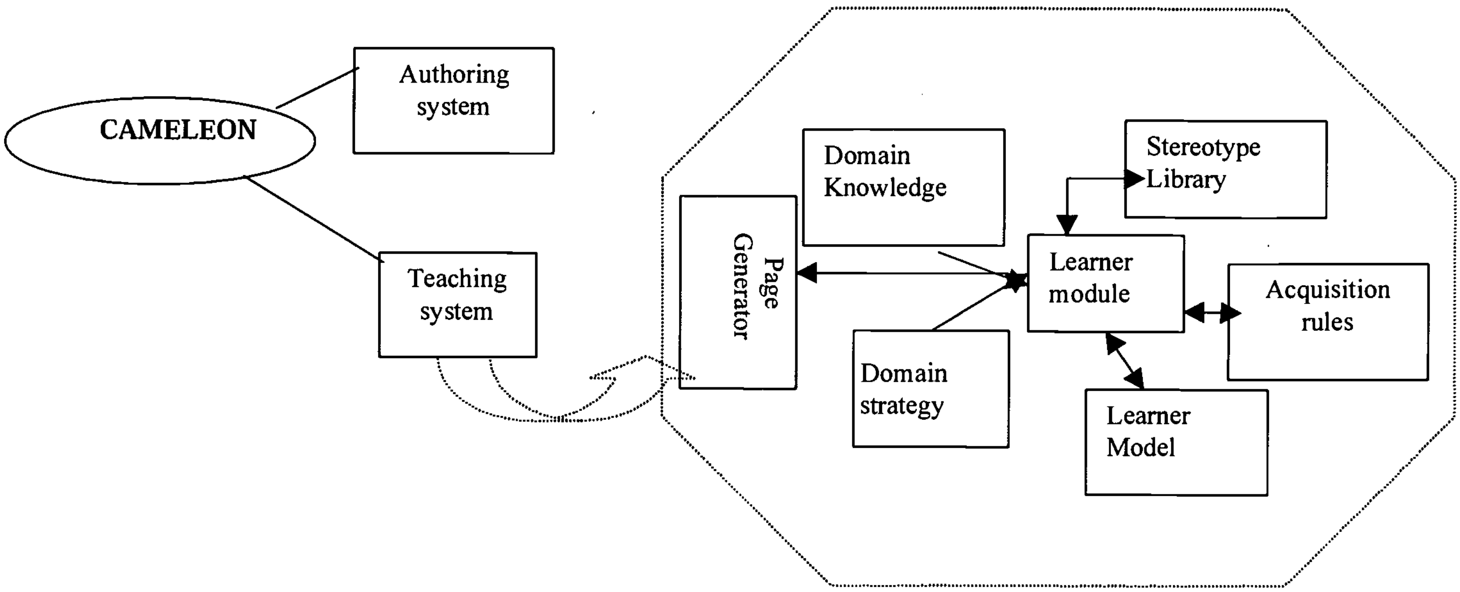

Fig-1 : CAMELEON architecture

The teaching system consults the learner module then selects from the knowledge domain the concept or the topic to consider, it also selects a tutoring style from the strategy domain to generate the corresponding Web page [fig. 1].

V.1 LEARNER MODULE

The learner module has four main components: a Learner Model Library, a Stereotype Library, Implicit Acquisition Rules, and an Inference Engine.
A learner model is the knowledge about the learner, either explicitly or implicitly encoded that is used by the system to improve the interaction [HOOK 1996]
It contains the model of the individual learner which is to be regularly updated in the course of his/ her interactions with the system

V.2 DOMAIN KNOWLEDGE

The domain knowledge contains:

- The contents to be taught
- The relations between different parts of the contents that may influence the teaching sequence.

All of the above knowledge are created by instructional designers when they create instructional material using the authoring system.

V.3 DOMAIN STRATEGY

The domain strategies denotes coherent set of guidelines (Theories, models, rules, constraints, algorithms..) for the creation selection and presentation of course contents.

VI. Current status and future work

We are currently implementing the authoring language supporting the writing of the course material in the Arabic, French and English languages.

In a near future, we plan to elaborate the learner model by including some cognitive characteristics that are relevant for the learning processes, like cognitive style or reasoning abilities.

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Phonetics and Linguistic Variation: A Web-based Courseware

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1. The project and the courseware

Traditionally, teaching linguistics at universities is very much a talk and chalk activity. Lectures are delivered in a very restrictive classroom discourse in which lecturers discuss ideas and linguistic issues with the help of a few teaching tools such as overhead projector, video and cassette. Though the Web has provided university teaching with a new paradigm, linguistics is still a land virtually untouched by Web explorers. Our project was an attempt to investigate theoretically and practically how the Web can be used to promote the teaching of linguistics (including applied linguistics), particularly in off-campus mode.

The initial stage of the project was to identify the key areas in general linguistics that the Web can make the best contribution. It was obvious that those areas or branches of general linguistics which dealt with speech production and visual illustrations were the appropriate candidates for developing web-courseware. They were phonetics, developmental psycholinguistics and communication disorders. The following discussion will briefly explain why the Web can play an important role in teaching those subjects and this will be followed by a detailed presentation of a courseware teaching phonetics and linguistic variation.

Phonetics: It deals with speech production. Articulatory phonetics describes how speech sounds are produced. The articulartory process involves the use of speech organs such as the lung, larynx, tongue, jaw and teeth. Each plays an important part in creating various types of speech sounds, tone, and intonation patterns. The IPA (International Phonetic Association) symbols are normally used to give students of linguistics some ideas of how human speech sounds are produced. Unfortunately, they are just written symbols and students can perceive their real production quality through cassette and video which are not always available at the right time, particularly in off-campus teaching. In addition, students of phonetics need to hear English spoken by speakers of different sociolects and dialects. In other words, they need to develop some awareness of different English varieties such as Australian English, American English, cultivated English, non-standard English, Singaporean English etc.

A Web-based courseware can facilitate the development of phonetic awareness by providing students with graphics and sounds which illustrate accurately the articulatory process, sounds, speech samples of different dialects and sociolects.

Developmental psycholinguistics: Students of developmental psycholinguistics need to hear speech samples of children of different age groups in order to ascertain their stages of linguistic development. This is normally shown in written texts in which children's speech samples are transcribed phonetically. The disadvantage of this approach is that it tends to portray more accurately syntactic information about child language development and less phonetic information. The problem mentioned above can be easily handled in a Web-based courseware which can provide samples of children's speech in a written text and oral text. For instance, a sample of a five-year-old girl talking to her father can be recorded and transcribed phonetically on the Web. Students can click the written text to hear the authentic speech produced in this social context.

Communication disorders: The severity of linguistic problems can be mild as seen in children with misarticulation or serious as in case of aphasia caused by leisons in the brain. It is important for students of communication disorders to hear and see a variety of deviant speech samples of speakers with communication disorders. It is no use just to introduce students to the concept of expressive aphasia without showing them authentic samples produced by aphasic patients. A Web-based courseware can provide visual and spoken language samples of speakers with communication disorders. The visual information includes transcribed texts as well as graphic information illustrating types of disorders. For example, deviant sounds produced by children with misarticulation can be heard and visual illustration of the way in which articulators are involved in the sound production process can be presented.

The initial part of our overall project was an attempt to develop a courseware using modern Java technology for teaching phonetics and different varieties of English on the Web. For example, Java applets was embedded in a Web-browser to play speech sounds and utterances in different English varieties. This courseware was used to support undergraduate and postgraduate courses dealing with language education in the Faculty of Education, particularly for off-campus teaching.

This project uses Java technology in the Web, for instance, embedding Java applets in Web-browser, to produce sounds and utterances with accompanied facial expression. Students can make use of two kinds of perception cues to recognise speech varieties on the Web:

- Graphic cues: different shapes and movements revealed through facial expression. For example, the shape of the mouth is rounded for the back vowels and spreading for the front vowels.
- Speech cues: sounds and utterances spoken by different individual speakers of different regional and social dialects of English. For example, students can hear the difference of English accents when they are introduced to samples of speech spoken by Broad and Cultivated Australian speakers.

2. Courseware prototype

As the main aim of this project was to teach linguistic awareness, the key task was to produce a practical courseware which has the following features:

- Content on phonetics and linguistic variation.
- A presentation of different English varieties: 1) English dialects: Australian, American, (BBC) English, 2) Australian sociolects: cultivated, general, and broad, and 3) Migrant English.
- Speech samples on three linguistic units: word, sentence and conversation.
- The use of Java technology for the Web to simplify the prototype without the involvement of other software and computer applications as seen in some courseware.

The courseware consists of the following components: content, facilitating experiences, and Resources. These three components represent different roles that the Web can play in teaching and learning.

Content component: The four content areas are phonetics, dialect, sociolect, migrant English. Each content area consists of five items or sub-components: 1) Modules: lesson-typed presentation, 2) Problems solving tasks: learning by doing, 3) Basic terminology: key concepts, 4) Review: what has been learned, and 5) Key references: important readings.

Facilitating experiences: Learners are provided with activities or facilities which can be used to enhance learning. This option consists of: 1) Stimulating questions: For arousing intellectual curiosity, 2) Feedback: About the courseware for improvement, 3) Test: In the form of mini-test with results, and 4) References: Including key references and others.

Resources: This function of the courseware includes: 1) Practical work, 2) Resources: for individual and group conferencing, and 3) On-line help: common problems.

3. Conclusion

In our past teaching of linguistics awareness, demonstration of speech samples on different English varieties was carried out in lectures with the use of audio-visual equipment. It was a big disadvantage for our off-campus students and for those who were absent from those lectures. This courseware was introduced as an alternative approach to teaching linguistics to university students. It is a stepping stone for continuing our work in the development of linguistics awareness courseware dealing with developmental psycholinguistics and communication disorders.

A Methodology for Selecting Technology to Meet Learning Objectives.

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A Methodology for Matching Technology to Educational Objectives

The purpose of this paper is to present a methodology that helps educators determine what technology they need to support teaching to educational objectives. This methodology consists of operationalizing learning objectives into the knowledge students need to learn, determining what sensory/learning experiences are required to enable students to acquire that knowledge, determining what learning environments can provide those experiences, and then selecting technology that can create those learning environments. Each step of this methodology is discussed in turn.

Operationalize Educational Objectives into Knowledge Requirements for Learning

The first step in our methodology is to translate educational objectives into their underlying knowledge requirements for learning. Our approach is based on our Integrated Knowledge Structure or INKS framework. Using INKS, an educator can operationalize an educational objective into the problem solving strategies, procedures, factual concepts and causal principles to be learned. We illustrate our methodology using the National Research Council (NRC, 1996) science standard for grades 5-8 that students learn science as inquiry. The standard includes:

1. identify questions that can be answered through scientific investigations
2. design and conduct a scientific investigation
3. use appropriate tools and techniques to gather, analyze and interpret data
4. develop descriptions, explanations and models using evidence
5. think critically and logically to make the relationships between evidence and explanations.

Actually, these steps collectively may be viewed as a science inquiry problem solving strategy. For the sake of brevity, we pick one of these steps, design and conduct a scientific investigation, and only map out some of the procedural knowledge components. These include: develop a hypothesis, design an experiment, collect data.

Translate Knowledge Requirements into Sensory Stimulus Requirements

Next, we translate the INKS-based knowledge requirements into sensory stimulus requirements. The goal of this is to determine what educational experiences a student needs to learn the appropriate knowledge. We provide a sample set of three dimensions to categorize the sensory stimuli. The dimensions are: modality (e.g., visual, auditory), fidelity (how realistic does the learning environment have to be?), and configuration (e.g., is there spatial grouping of stimuli, temporal sequencing?). The table below illustrates this process for the scientific investigation example:

Table 1: Sensory Stimulus Requirements for Each INKS-based Knowledge Requirement.

Procedure	Modality	Fidelity	Configuration
develop hypothesis	visual	low	spatial and temporal grouping
design experiment	visual	low	spatial and temporal grouping
collect data	visual/auditory	high	spatial and temporal grouping

Select a Learning Environment

The next step in our methodology is to select a learning environment that will present the kinds of experiences outlined above. The learning environment takes into account both the type and the fidelity. Learning environment types include such things as live or simulator-based practice, text-based instruction, lecture, etc. Fidelity relates to how close the learning environment must be to the actual experience in order to achieve the desired level of learning. We present some illustrative guidelines for mapping sensory stimulus requirements to learning environments. We present a continuum of non-classroom based instructional environments. Each are intended to represent a higher level of fidelity and can typically accommodate the ones that precede them. The environments (while illustrative and not exhaustive) are: text, graphics, audio, video and simulation. Given these environments, we present a hypothesized table of what the minimum required learning environment would be for a learning objective of a specified sensory modality, fidelity level and configuration.

Table 2: Minimum Required Learning Environments for Learning Objectives.

	Low Fidelity Sensory Stimulus Requirement		
Sensory Modality	No Configuration	Spatial Configuration	Temporal Configuration
independent	all environments	N/A	all environments
visual	graphic	graphic	graphics sequence
auditory	audio	stereo	audio sequence

	High Fidelity Sensory Stimulus Requirement		
Sensory Modality	No Configuration	Spatial Configuration	Temporal Configuration
independent	all environments	N/A	all environments
visual	graphic	3-D graphic	simulation, video
auditory	audio	stereo	audio sequence

We apply this analysis to our running scientific investigation example:

Table 3: Minimum Learning Environment to Teach Each Knowledge Component of Scientific Inquiry.

Knowledge Component	Modality/Fidelity/Configuration	Minimum Learning Environment
develop hypothesis	visual/low/spatial and temporal	graphics sequence
design experiment	visual/low/spatial and temporal	graphics sequence
collect data	visual and auditory/high/spatial and temporal	simulation

Develop Technology Requirements

Once the minimum required learning environment is established, the next step is to determine what technology will be used to deliver the instruction. We present sample technologies and their *current* capabilities:

Table 4: Current Capabilities of Sample Technologies and Media.

Technology	Maximum Learning Environment Supported
print	graphics
interactive courseware	video/simulation
videoteleconferencing	video
Internet	graphics/audio

We can apply the above technology capabilities to the scientific investigation example:

Table 5: Technologies to Support Teaching Scientific Inquiry Knowledge

Procedure	Minimum Learning Environment	Educational Technologies
develop hypothesis	graphics sequence	all
design experiment	graphics sequence	all
collect data	simulation	interactive courseware

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AOFwb - a new Alternative for the MBone Whiteboard wb

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Abstract: This paper describes a new whiteboard for telepresentation and teleteaching. The whiteboard substitutes a blackboard or an overhead projector used in a computer aided lecture, which is digitized and transmitted to remote locations. We examined different tools like *showcase*, *xfig*, *powerpoint* and the MBone *wb* and combined the most useful features of these tools in our own *AOFwb*. Thus we implemented a tool which can be used as a graphic editor, a presentation tool or a tool for teleteaching.

1 Introduction

For telepresentation [Gemmel and Bell 1997] a wide variety of whiteboards is available. The MBone *wb*, the whiteboards from *cooltalk* (a *netscape* plugin) or from *inperson* (a tool on IRIX Workstations) are well known. However they are very restricted in their features. Most of them support only drawing objects and writing simple text.

We have been using the MBone *wb* [Eriksson 1994] to deliver a substantial amount of lectures. Our experience shows, the features offered by existing whiteboards are far from being sufficient. In particular, this observation applies to sessions, which include graphics, images or external applications can be realized using our own *AOFwb* [Bacher and Ottmann 1996].

2 Description of the AOFwb

When preparing a lecture you usually write down your ideas and you create a paper or transparencies by hand or by using *TeX*, *powerpoint*, *showcase* If you want to use the MBone *wb* for telepresentation, you must create a postscript-file from each page. We have developed a language similar to *SGML*, that we use to save a document. Thus you can edit your prepared page while giving a lecture.

In the following, we explain the available features to prepare a lecture and to edit the pages. Similar to *showcase* you create text as a block or as line-text. If you want to change the colors of some objects you can select and group them for editing the color. The possibility exists to use a mesh with snap option to make the drawing of some objects easier. For talks with mathematical or physical content a *LaTex*-formula editor is included. You write the formular in *TeX* and point it to the position, where it should be placed. Pictures can be put in the background (tiled) or in the foreground.

When you finished the preparation of a lecture, the document is saved and can be reloaded later. Additionally the pages of this document are visualized as thumbnails, to give the lecturer an association, which page is next. Another useful feature for telepresentation is a telepointer also implemented in our *AOFwb*. While giving a lecture all actions can be transmitted to remote locations, recorded and later replayed.

3 Conclusion and further work

With our *AOFwb* you can prepare, transmit and record a lecture with only one tool. Our next step is to combine the classic style of lecturing by means of blackboard and chalk with the modern technology. This can be realized with a *lecture board*. In this case the screen is projected on a special board with a video-beamer. A pen is used to substitute the mouse. In this way the author can perform most of the actions on the board.

Availability

The prototyp of our whiteboard *AOFwb* and the neccessary viewers to replay the recorded lectures are available for *Solaris*, *Irix* und *LINUX* platforms at our ftp-server:
ftp://ftp.informatik.uni-freiburg.de/pub/AOF/AOFwb/

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Creating HyperMedia Materials For Russian Language Studies

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1. Introduction

This paper discusses and demonstrates Russian materials created for use in second language instruction at Wabash College, a small liberal arts college located in Crawfordsville, Indiana, USA. We will detail the evolution patterns and pedagogical foundations and concerns of our work with custom software, specifically faculty and student responses to such endeavors.

2. Background

Wabash College faculty opted for creating a digital computer language lab in favor of purchasing the more traditional language lab consoles which primarily use cassette media. In order to achieve the goal of creating the digital lab, a computing specialist was hired to coordinate technology initiatives among language faculty. In order to accommodate the need for audio-lingual work which would otherwise have been accomplished with a console system, faculty collaborated to create a simple HyperCard template called *Listen and Respond* which is used as a digital tape recorder.

3. Implementation

The template learning curve for both faculty and student users is not steep. Custom audio materials are created by faculty in less than 10 minutes and made available immediately via server to students for practice and testing use. Students and faculty both found using these materials easy and more productive than traditional time-consuming one-on-one interviews or tape-recorded activities in the target language.

Employing these materials proves more useful than traditional methods because of the following characteristics: there is random access to questions; corrections and feedback can be adjusted to student skill level and learner type (visual and/or verbal); their use is less time-consuming than meeting individually with students or using tape recorders; oral skills can be more realistically addressed compared to former practices of using written answers to verbal cues; materials are easy to modify and are readily available for use as testing or oral homework assignments; students and faculty can keep recordings on file.

4. Point of Departure

More recently, using a dedicated Modern Languages Computer lab containing 24 Mac7100/80s, Wabash faculty have been successful in creating lab or template materials that utilize a wide variety of multi-media, bringing cultural realia into each language course. These materials address various language skill levels. Both faculty and student assessment of template use has been positive, as development of materials in various languages has shown.

5. Specific Application

One such example we created for Russian is a multi-media program based on a speech by Boris Yeltsin. This utilizes the simple audio and verbal response template (*Listen and Respond*) described above and combines it with various authentic materials. Beginning with a taped speech made by Yeltsin from SCOLA (Satellite Communications for Learning), which gives full rights to educational facilities for classroom use, an advanced tool for the Russian curriculum was developed. Ultimately, this combined an interactive text of the speech in Russian, various forms of Russian audio (Yeltsin's actual speech, a native-speaker, a slow native speaker), options for speech segmentation, images, HyperLinks to news articles and cultural websites maximizing updatability, a glossary, online help, an English translation (text and audio), cultural hypertext sections, and finally, oral questions and verbal response options for students to test their comprehension.

6. Objectives Of Software

The described materials integrate skill development on three different levels: listening, reading, and speaking. Cultural information is provided with the objective of facilitating full comprehension of the text so that all elements combine to address the needs of students with varying skill levels (intermediate to advanced). The students must acquire a keyword vocabulary to answer the questions at the end of the exercise. The level of difficulty of questions can be manipulated by the instructor to meet individual student needs. Components of the program can be updated to counter the predisposed obsolescence of political texts. Developing these MultiMedia materials for Russian is a pilot-project which can serve as a template for teaching other languages or working in other disciplines persuant to the languages across the curriculum movement.

7. Evolution And Assessment

Assessment on two different levels was a driving force in the development and refining of this program. Student test-runs were conducted, and the faculty were able to assess comprehension by listening to student responses to content questions. We conducted a comparison of comprehension of students who used the computer template and those who did not. We found that the students who had completed the computer exercise had a higher comprehension than the ones who only accessed the video. Further, of the students using the computers, we found the same high levels of comprehension regardless of differing language skill levels. Students evaluated various components of the program which led to modifications and improvements, as well as provided data regarding benefits of our custom-created software over traditional lessons or commercial software.

8. Conclusions

Creating custom multimedia materials for Russian has proven pedagogically sound and of great benefit to students. Incorporating realia, addressing various skill levels, combining media, and continually assessing materials and course objectives has proven successful. Since enhanced student learning is the central goal in using technology, one student's comment summarizes the results of our work: "Almost overnight, the Department of Modern Languages was modernized beyond recognition. Students were able to use a new program called "Listen and Respond," which allowed the professor to assign oral questions and have students record their responses. One such template was a program which allowed students to watch and listen to native Russians speak. After listening to one speech by Boris Yeltsin, I answered questions, and was able to access background information on a number of topics. All of this made that speech much more enjoyable and meaningful. The questions could be accessed at anytime and repeated as often as one wished. Aside from the obvious advantage of increased practice time, the new technology created a more relaxed atmosphere and allowed the student to proceed at his own pace...Personally, I did not expect the changes to come so soon or all at once. Now, the available technology has made the study of foreign languages more complete."

Acknowledgements

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Examining Teaching and Learning Aspects of A Web Design Experience

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1. Project Background and Theoretical Framework

A distinction has been made between learning *from* computing and learning *with* computing [Jonassen 1994]. Learning from computing refers to situations in which computers are tutors, while learning with computing emphasizes the use of computers as cognitive tools to extent human minds. It is this second use of computing that has become the focus of educational research in recent years. Educators argue that when students are learning with computing, they engage in an active partnership with the technology and are able to construct their knowledge with the assistance of the technological tools [Jonassen 1994], [Salomon, Perkins, & Globerson 1989]. One specific way of learning with computing is to engage students as multimedia designers. Literature shows that the benefit of a learner-as-designer environment is the opportunity to integrate a variety of activities such as designing, researching, presenting, and reflecting, and tap a diverse set of higher order thinking skills in one single meaningful context [Carver, Lehrer, Connell, & Erickson 1992]. Recent research studies have shown some encouraging results in this area [Beichner 1994], [Lehrer, Erickson, & Connell 1994].

To implement such a learning environment, the author engaged a group of university students in designing a web project for a real audience. This web design experience occurred in a graduate level course of *Interactive Multimedia: Design and Production.* This course is offered to the students in the College of Education at the University of Texas - Austin. Students attending this course include teachers, educational technologists, and future instructional designers. It is designed with an intent to provide students with a learning environment where they can apply the theories of the multimedia technology into practice. To simulate real-world multimedia production and encourage collaborative learning among the students, students attending the course are asked to design and produce, collaboratively as a class, a web site on multimedia uses at the University. The audience of the web site is students, teachers, and other individuals who are interested in knowing how multimedia is used at the University of Texas - Austin.

2. Project Process and Activities

Using literature on the topic and practice in the multimedia industry as a guide [Liu, Jones, & Hemstreet in press], a four-phase instructional model was used for the web design project: (1) Phase I: Planning, (2) Phase II: Design; (3) Phase III: Production; and (4) Phase IV: Evaluation & Revision. The emphasis for the planning phase was to identify the objectives, audience, available resources of the project, and determine the timeline of the project. The focus of the design was to apply and adapt instructional design theories and principles for the recent web technology. The production was a hands-on phase in which students produced the media elements and put the pieces together into one coherent web site. The evaluation and revision phase was an on-going phase for getting feedback from different parties and making revisions to the site. Table 1 [Tab. 1] details the specific activities related to each phase.

This web design experience has the following characteristics: (1) the classroom was simulated as mini-multimedia production house in which students assumed various roles of being a writer, a video producer, a programmer, an artist, a project manager, or several at different times. Each week, students negotiated in the group the tasks they would carry out based upon the guidelines given by the instructor. Each student was responsible for a certain part of the project and his/her work would feed into the work of others. (2) The design and production process was a group process from the beginning. All the decisions on the interface, media selection, content, fonts/styles were based on group consensus. Each group was responsible for the quality of its section and at same time for making sure its section was consistent in design with the sections from other groups. (3) Students were engaged in the design process very similar to the practice in the industry (Liu, Jones, & Hemstreet, in press). They identified the needs of the project and learned what was needed for completing the project. Because the final project had a real audience, students needed to be aware of the audience's like and dislikes throughout the project.

Design Model	Activities Used
Phase I: Planning	• brainstorming & discussions about the project • evaluating related web sites • evaluating commercial CDs • searching for information • researching • reading and class discussions on related literature
Phase II: Design	• storyboarding • researching • group discussions • learning multimedia tools (Adobe Premiere, Adobe Photoshop, HTML, Macromedia Director, Shockwave)
Phase III: Production	• learning multimedia tools • creating graphics • creating audio/video • creating animation • HTML programming
Phase IV: Evaluation & Revision	• peer evaluation & revision

Table 1: Activities related to each phase of the web design project

3. Teaching and Learning Issues

From an instructor's perspective, this web design experience illustrates several important points. The constant change of the technology demands the continuous change in the teaching practice. It is important for instructors to continue inventing ways to enhance teaching with the technology and use technology as tools to extend students' thinking. Providing scaffolding in different ways is essential for the success. While it is important for the instructor to provide a structure to the course, he/she must create an environment where students are free to think and be creative. Teaching with rapid change of technology is a challenge and instructors must be willing to learn continuously with the students.

The authentic aspect of the learning experience motivated many students because they perceived it as helpful to get them better prepared for the job market. The collaboration and interaction among groups enhanced students' understanding of the web technology. The team work offered students an opportunity to engage as professionals and learn to cope with others. The tools the students learned and the web site that they accomplished gave them a sense of accomplishment and enriched their portfolio. A number of the participants from the project have played key roles in a number of subsequent projects.

In the presentation, the teaching and learning aspects of the experience as well as the design process will be shared in detail. The web site will be demonstrated.

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Texas Tech University Online

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Institutions of higher education are being pushed to choose alternatives to the traditional modes of course delivery by a number of forces. Increasingly "non-traditional" populations are requesting access to higher education opportunities which may not be conveniently available or reasonably affordable through the current infrastructure. Business and industry are seeking "qualified" employees from "just in time" training. States are asking higher education institutions to increase the number of residents holding advanced degrees and certificates, to provide options to building new campuses, to develop creative ways to meet the needs of an increasingly traditional student population, and to play a role in moving welfare recipients to paid employment.

In order to serve the needs of these forces, Texas Tech University is turning to distance education options. According to Moore and Kearsley [1996], "Distance education is planned learning that normally occurs in a different place and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements." By selecting distance education options, Texas Tech is overcoming barriers that have kept it from serving potential clients in the past.

Texas Tech University formed the Telecommunications Infrastructure Fund/Distance Learning Vision Committee in the fall of 1996 to develop its mission of distance learning. That visions states that:

> Early in the next century Texas Tech University (TTU) must establish itself as a national leader in changing the paradigm of higher education and health care via distance learning as part of its goal to become a national Tier I comprehensive institution. The necessity of responding to needs at appropriate times and locations convenient to students across the world, as well as across the campus, is the primary force driving this transition.

Texas Tech is making progress toward achieving its mission. Presently in place are a Distance Learning Strategic Planning and Policy Council; the Division of Extended Learning; the University Library System; the Teaching, Learning, and Technology Center; HealthNet; KTXT-TV; and the SCATE consortium.

The Distance Learning Council is responsible for monitoring and recommending academic policy impacting the integration of distance learning into the "culture" of the institution. The Council is also addressing the practical aspects of faculty involvement in program development and implementation.

As the largest distance learning program of its kind in the United States, Texas Tech University's Division of Extended Learning has extensive experience in designing and delivering self-contained curriculum. The Division offers over 200 courses through open enrollment to nearly 50,000 students in 50 states and 16 foreign countries. These courses do not follow semesters and can be completed at the student's own pace wherever he or she may be. Extended Learning courses are delivered using a variety of media which include WWW-based courses; computer-based courses; courses delivered via interactive video; courses using "transportable media" including video tape, audio tape, and CD ROM; and "hybrid" courses designed to use combinations of these delivery technologies. To serve students who do not have ready access to technology or who are constantly traveling, Extended Learning maintains much of its course inventory in a print-based format. On the college level, Extended Learning has a complete curriculum for a Bachelor's in General studies, and collaborates the colleges of the University to provide a wide range of distance delivered courses and programs. On the public-school level, Texas Tech University Independent School District offers a public high school diploma program at a distance, a middle school curriculum, and an elementary school curriculum. Professional development and personal enrichment courses are also available to students at a distance.

The Division also provides a student services team, a distance learning bookstore, an instructional design team, counseling/advising services, and faculty incentives and training. The student services team is comprised of eight full-time student services representatives who are available five days a week to provide personalized help and support to distance learning students. The distance learning bookstore ensures that students all over the world receive all required materials for courses promptly and efficiently. The instructional design team works with University faculty to ensure the quality and accessibility of all distance learning courses. Faculty members receive instructional design support for the design and development of their distance delivered courses. Production specialists are available to support the production of various media components of the courses and adapt them to the selected delivery medium. Extended Learning counseling services are available in person or at a distance. A full-time, qualified college advisor helps students select appropriate courses to compliment their degree programs free of charge to students. Extended Learning offers grants to faculty members interested in using technology to create distance learning courses and group training sessions on the effective instructional design of distance learning courses.

The latest technology is integrated into the Texas Tech University Library System search and retrieval systems. The System consists of a variety of on-line services including TechPAC, the catalogs for four University libraries. The system provides access to a number of library catalogs at other major universities. Extensive coverage for periodical indexes, abstracts, and other bibliographic and full-test databases is provided by FirstSearch and other database suppliers. Additional on-line features include an interlibrary loan request form, a monthly listing of new books, and new items about the TTU libraries. CD-ROM databases are available which include indexes, abstracts, and government documents.

The Teaching, Learning, and Technology Center (TLTC) enhances distance learning by training faculty on the use of the Internet through competitive grants, roundtable discussions, and teleconferences. In addition, the TLTC maintains a faculty computer lab with both PC and Macintosh computer hardware and software. TLTC personnel conduct workshops to train faculty in the use of technology.

Texas Tech University Health Sciences Center's (TTUHSC) HealthNet utilizes its extensive distance learning network as follows: (1) a two-way interactive video system links the four campuses of TTUHSC, (2) a digital satellite television network supported by interactive audio delivers continuing professional education, (3) a two-way interactive video system links rural primary care with specialists at tertiary centers for diagnostic and consultative support, (4) a two-way VSAT, satellite-based, interactive video system provides interactive education to any location in the continental U.S., and (5) a Ku Band teleport facility delivers programming to Texas state satellite networks as well as to any Ku Band capable receive sites in the continental U. S.

KTXT-TV is a noncommercial educational television station. The broadcast operation includes a seven-channel cable system capable of feeding instructional television programming to classrooms throughout the campus, and a multiterminal telecommunications receive-only earth station providing the university's principal access to communications satellites. The station broadcasts approximately 105 hours of diverse programming each week to a 60-mile radius of Lubbock reaching a populations of approximately 380,000.

Texas Tech University is a member of the Southwest Center for advanced Technological Education (SCATE)--a consortium of colleges, universities, schools, and business and industry partners partially funded by a grant from the National Science Foundation. The mission of SCATE is to promote advanced technological education through exemplary efforts in curriculum development, program improvement, and distance education at colleges and high schools. The focus of SCATE has been to experiment with and demonstrate how advanced technological education could be delivered over distance learning systems to improve access. The Center has focused on the development of a distance learning infrastructure, preparing technical faculty to function in interactive distance learning environments (using both the Internet and interactive television), and revising and developing ATE curricula for delivery through such systems.

Texas Tech has distance learning options which may be modeled by other institutions to deliver courses, degrees, and professional development to students at their chosen locations and at their own pace.

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PATSy: A Case-Based, Distributed Multimedia Approach to Patient Assessment Skills Training.

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1.0 Introduction

This paper describes the development of an interactive, distributed, multimedia system (PATSy). When completed, it will serve as a repository of brain-injured patient cases and their test data for use by speech and language therapy students and researchers in the neurosciences. The aim of PATSy is to teach students how to generate hypotheses and diagnose the source of speech impairment in brain-injured patients.

1.1 Changes in Educational Teaching Methods

The development of PATSy addresses several current challenges to clinical educators. Education in the health professions is turning increasingly towards case-based teaching where knowledge of the subject is represented in the form of many example cases that embody the relevant principles. This method is advocated in the teaching of knowledge intensive domains such as medicine and law. In these domains, it is difficult to give a set of rules to the student that they may use to make inferences or deductions [Williams, 1993]. Case-based teaching has been demonstrated to be effective but it requires students to have access to a fairly large database of patient cases. [Hmelo, 1995] has shown that medical students taught using problem-based learning produce more accurate diagnostic hypotheses than non-problem-based learning students.

Speech and language therapy students traditionally receive clinical skills training during placements at hospitals and community centres. This of course, is an important and vital part of their training. However, in some areas of the U.K., there is a problem of access to brain-injured patients. Even where brain-injured patients are available, the quality of a student's experience in acquiring clinical assessment knowledge depends upon the *type and variety* of patients available during their placement period. For these reasons, some students' assessment experiences, knowledge of various speech disorders, *etc* may be acquired on a somewhat *ad hoc* basis. Under current regimes of clinical training, students usually do not have any interactions with brain-injured patients until they are on clinical placement. It would, of course, be more desirable for students to have access to patient cases *prior* to this time. They would then a) be familiar with an adequate range of speech disorders and b) have more technical knowledge of assessment before meeting 'live' patients.

1.2 Aims and Objectives

A demonstration prototype of an interactive multimedia patient assessment training system (PATSy) has been implemented. The full version will address the training issues described above. This clinical resource will be an adjunct to current clinical training practices. PATSy will: i) support teaching approaches such as case-based teaching, problem-based learning, student-based guided exploratory learning and traditional lectures; ii) provide more control over the range of cases to which students are exposed; iii) provide a standardised corpus of cases against which each student's performance may be appraised; iv) allow students to engage in assessment training independently of the clinic setting and at times convenient to the student; v) allow students to practise and experiment without compromising ethical requirements. The full system will contain data from many speech and language disordered patients. Data for each patient will consist of a short (1-3 mins) digitised video film clip of the patient speaking with the therapist, digitised audio recordings of the patient undergoing a range of assessment tests and graphical images showing patient responses to pictorial test stimuli.

2.0 A Sample PATSy Session

This section describes a typical student interaction with PATSy. Using a standard, Javascript and Quicktime capable Web browser, the student logs into PATSy, selects a patient from a menu of cases and observes a video clip of the patient speaking. She is then required to formulate a clinical hypothesis based on her initial observation of the patient. The student then 'administers' a neurological test to the patient by selecting the desired test from a structured menu A wide range of test data will be made available for each patient, consisting of medical history data plus assessment data based on the presentation of visual and auditory stimuli. Students will be able to step through any test item-by-item. For example, in a test where the clinician presents auditory stimuli, the student will be able to listen to a digitised audio clip of a clinician presenting the test items to the patient followed by digitised audio clips of the patient's actual responses to those items. An example test item is shown below [Fig. 1].

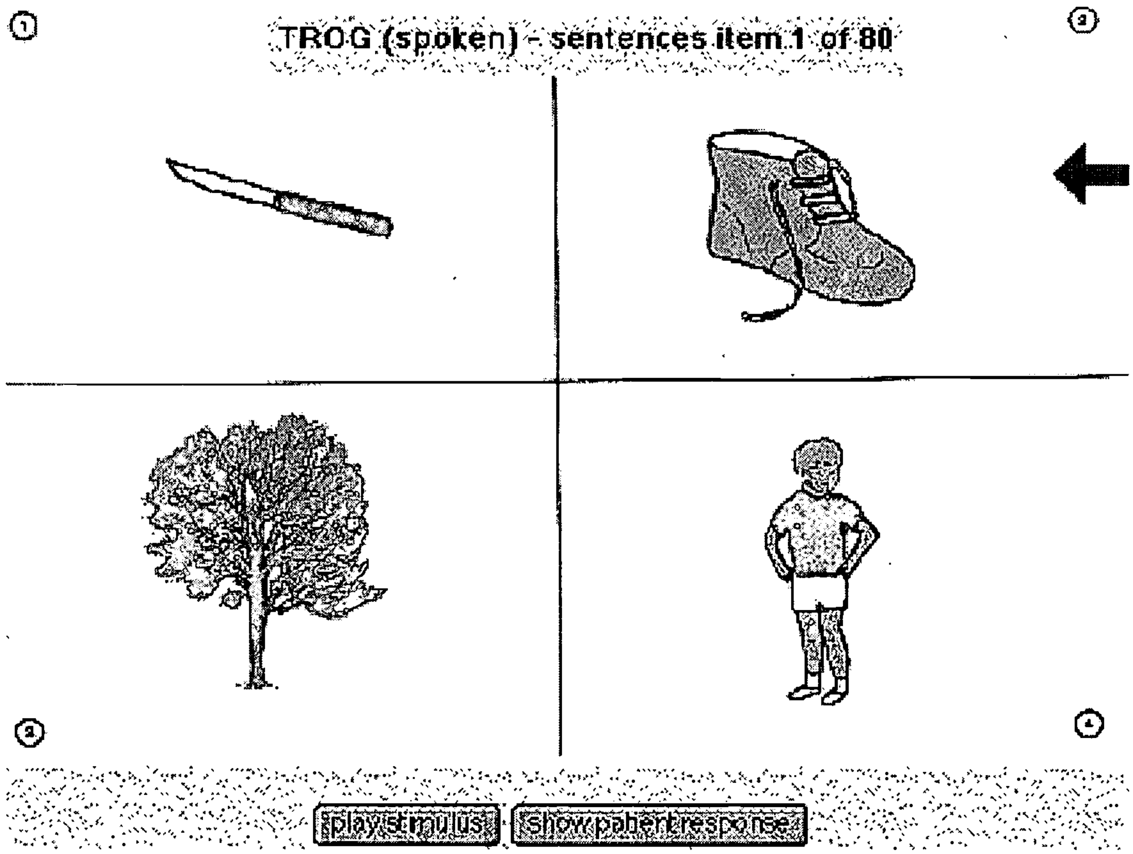

Figure 1: Example test item. In this test, the student can play a sound file of the (spoken) stimulus (in this case the word "shoe") and then click on a second button to reveal the picture that the patient pointed to in response to the stimulus (red arrow)

The full version of PATSy will record which clinical tests were 'administered' by the student and in what sequence. A note-taking facility for users will also be provided. Following a PATSy session, the student will be able to print out the test log and notes. These can then form a basis for discussion with the lecturer or tutor in a problem-based learning session.

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Learning Strategies for the Internet: Playing Catch Up

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At least four key clusters of factors impact and mutually influence each other in every learning situation, including Internet based learning: a) characteristics of the learner, b) learning goals, c) nature of the learning media, and d) appropriate learning skills and strategies (Lyman in press).

This paper focuses on one of the factors most neglected relative to the Internet: learning strategies. In the dizzying excitement about the possibilities for using the Internet to support learning, much of the emphasis has been, somewhat understandably, on what the medium has to offer. For example, Martin (1997) has identified five types of Internet sites available to support learning: a) databases, including on-line libraries and virtual museums, b) learning communities, e.g., listservs and collaborative study projects, c) classes and tutorials, d) simulations and games, and e) multipurpose learning centers serving as sites and conduits for a variety of learning experiences. However, questions of how learners can most productively employ various Internet resources to learn effectively have received much less attention.

Needed Learning Strategies

In order to take advantage of the vast opportunities afforded by the Internet for learners, they need appropriate strategies. Learners must develop information literacy involving the ability to:
1. know when there is a need for information
2. identify information needed to address a given problem or issue
3. locate the needed information
4. evaluate the information
5. organize the information
6. use the information effectively to address the problem or issue (Brevik as cited by Rakes 1996, p. 52).

The need for these skills is heightened in the context of Internet based learning, especially when the Internet can induce information anxiety, so vast is its capacity for data archiving and access. The Internet's vastness, relative newness, and ever developing nature only intensify the importance of developing appropriate learning-to-learn, critical thinking, and problem solving strategies.

However, we continue to lag behind in helping learners to develop appropriate Internet based learning strategies. The use of search engines provides a good example. Novices and even expert users of the Internet are hard pressed to understand the relative advantages and disadvantages of different search engines and their appropriateness for different purposes (Maddux 1996). Even as one may gain, often through personal trial and error, familiarity with a few favorites, new tools become available whose specific search capabilities are unknown.

Navigating hyperlinked information represents another challenge. Effective navigating calls for the highest possible familiarity with the topic (obviously a barrier for novices to a subject) so as to target the most relevant information. An important navigational skill is the ability to resist delving into intriguing links containing seductive information which, however interesting in its own right, is not relevant for present learning goals (Quinlan 1997). However, a learner must at the same time be able to recognize when new found information necessitates modifying one's original goals, thus changing the nature of the search. Navigation skills and strategies are complex, recursive processes, about which much more needs to be understood if we are to help Internet based learners become more effective.

Even if a learner can successfully navigate the Internet while investigating a topic, as the student locates relevant information the question of information management comes to the forefront. Thus students not only need planning and navigational skills, but also database, spreadsheet, and presentation skills (Metcalf & Nolan 1997). Learners need organizational tools to put information gleaned from the Internet into databases arranged according to learners' own purposes and needs.

Likewise, learners need spreadsheet skills to effectively summarize, manage, and represent information from the Internet in different forms, for example, tabular and graphic displays. Finally, learners need a new array of presentation strategies, i.e., multimedia presentation strategies to communicate their understandings in ways that appeal to their audiences. Obvious presentation skills include building web sites to communicate learning project findings.

Promising Directions

As this paper was being written, insufficient systematic attention could be found in the literature concerning development of learning skills and strategies specific to an Internet based learning environment. However, promising directions are suggested by the National Educational Technology Standards Project (Thomas & Bitter 1998). This project is developing performance indicators for learners, many of which have direct relevance for Internet based learning. The indicators address performance in five domains:
1. Basic operations and concepts
2. Social, ethical, and human issues
3. Productivity tools
4. Communications
5. Research, problem solving, and decision making (Thomas & Bitter 1998).

The National Educational Technology Standards Project represents one example of much needed systematic attention to learner performance in technology based environments.

Catching Up

Internet based learning if it is to live up to the early promise and, in some cases hype, will depend on increasing our attention to standards for learning strategies for the Internet. To neglect research and development of learning skills appropriate and indeed indispensable to the Internet is to undermine the potential of this evolving medium to meet the multifaceted goals of learners.

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Design of a Collaborative Distance Learning System

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Introduction

To facilitate collaborative distance learning for problem based learning (PBL) a computer based teaching-learning system has been envisaged. The system is consisted of three main modules. These are Teacher module, Student Individual Learning Module and Collaborative Learning Module. In the Teacher Module the faculty can go through tutorials and help menus on general instructional strategies for PBL before setting the problem. Similarly in the Student Module learner can get help and instruction on cognitive strategies for solving a problem and developing the concept map of their learning respectively. In the Collaborative Learning Module learners get cues on how to carry out discussion and peer review. It also facilitates collaboration among teacher and learner(s) and among the learners. Using this system the teacher can access the progress of an individual learner and the group activities at any time.

One of the effective uses of such an instructional system is to support work on a task undertaken collaboratively by a number of dispersed teachers and students.

Description of the System

In order to design the system we did background researches on identification of cognitive strategies [Madhumita 97a] and on the effectiveness of collaborative learning [Madhumita 97b]. We have proposed an instructional model for the system and developed its functional model. The design of the present system is based on the profound educational research findings.

A special feature of one of the Start screens consists of space provided for recording the courses already taken by the student. This information would be particularly helpful for the teacher in designing the introductory session and tutorial 1.

The screen on the formulation of objectives, shown as 'Objectives of the Course', in the flow diagram, would provide some sample objectives developed on different domains of learning. These examples would provide a clear idea to the teacher in order to formulate objectives.

Introductory Session screens consist of facilities for the teacher to provide a background, and to explain basic terminology and concepts that the student is supposed to know before going through the course. At this point the student has the option to go through the course or not to go through the course. The student can make the decision by referring to the objectives of the course and the introductory session by using the HyperCard facility.

After the student opts for the course then he/she is directed to go through an Entry Test. The Entry Test is designed by the teacher based on the prerequisites of the course and following some guidelines on test construction with appropriate examples through the system.

For the preparation of content of Tutorial 1 the teacher considers the courses already taken by the student and his/her performance in the entry test. After this every student's performance in the entry the computer from its database accesses test and courses already taken by the student in order to form mixed ability student-groups for PBL. The teacher may decide group size. The group size may vary from three to five.

Each group of students is now faced with a different Problem Statement. A problem should be designed in such a way that there is a mismatch or at least a gap between the students' knowledge and the problem. Before stating the problem teacher would be given instruction on the construction of problem. Immediately after the problem statement each students-group gets a set of Problem Solving Strategies. Explanations of these strategies have been included in the system.

Problem solving strategies may be selected manually by the student by taking into consideration the available resources and latter may be discussed with other members of the group or may be left to the computer. The system as envisaged would have a component of strategy selection based on the problem type in that case the teacher would be required to click the appropriate Problem Type. Teacher would be provided with a list of problem types, e.g., prediction, explanation, invention, etc. If, the teacher is not clear about the problem type he/she may access the definition and example of each type from the help menu, which would be provided in the system.

In the Group Discussion 1 students would be provided with instructions through the computer on aspects to be taken into consideration in the session. For example instructions such as: interpret the problem, discuss about strategies, make a timetable, divide the task, if required. At this stage the students would be provided with techniques of group dynamics by the system. Similarly, instructions would be provided for group discussion 2.

Every student's progress through self-study is recorded in a database with date and time. This facility would allow the teacher to monitor the progress of the student, in terms of how much time the student is spending on the course and the information collected by him/her is relevant or not. Teacher and students can interact through tutorials and Feedback Session. Students of a group can interact with each other through group discussion 1 or group discussion 2. Students would get guidance on concept map formation through the system. As we know that concept mapping is a useful spatial learning strategy. Therefore, concept maps have potential, especially for assessing students' structural knowledge.

The teacher considering the student's progress and concept map developed by the student prepares tutorial 2. Student who does not need tutorial 2 may proceed to Probable Solution of the problem.

Besides improving the process of developing performance assessments, peer review can yield a profound result: the beginning of a truly professional relationship with colleagues. Peer Review and Teacher's Feedback on the probable solutions leads to the most Suitable Solution. At this stage, the system would support decision making by evaluating the probable solutions against the teacher's comments (accessing from teacher's feedback) and students' decision (accessing from peer review), and a set of preset criteria. Teacher may proceed for Performance Assessment of each of the student separately and also their assessment as a group using a checklist generated by the computer. Peer members assesses each other on performance in problem solving using a checklist generated by the computer. The assessment of both teacher and students' would be compiled by the system and would be displayed as student's result and group score along with qualitative feedback.

Work in Progress

We are working on the development of the system, using HTML programming language. We plan to hold the interaction among the group members and the teacher using NetMeeting. This will be a *web* based Teaching-Learning-Evaluation system. We plan to implement the first prototype of the system in order to evaluate our system for further developments and modifications.

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Teachers' Work and the Technology Bypass

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Work anywhere at anytime. Paperless offices. Mobile phones. Pagers. Fax machines. Video conferences. Even ordinary phones. Scanners, digital cameras, direct retina projection and smart access cards, with automatic attendance recorded. Visa and MasterCards with unlimited funds. Hand print identification, a company car and the odd school fees for the kids.

No one is shocked to realise this conglomerate of extras and incentives is offered to high flying executives in the business world. While this is part of the life of the executive, the lowliest members of the corporate office take notes, publish and disseminate all the workings of the place using the latest in computer technology. The Pentium 200+ PC is never turned off. The answering machine is attached to the PC, and can perform functions only dreamed of a few years ago, the mobile phone is directed to the answering machine, which is attached to some paging device – all with the intent of moving information to the appropriate location as rapidly as possible.

The office can run without anyone attending - enquiries being referred through a series of telephone keypad entries to their correct (more or less!) destination.

Yet, in education, coloured chalk is seen as the big innovation.

Industry has taken to the new technology to such an extent that its integrated use in the workplace is now widespread, relevant and, most of all, presumed.

Schools and education systems are different. It is rare in Australia to see a full and comprehensive use of Information Technology, other than as a replacement to the typewriter, to change the nature of teachers' work. The equipment is old- more suited to a museum collection than to educate the current "next generation".

The staff is uninvolved in the school-based decisions about the technology, and is indeed often unable to be involved due to lack of knowledge. With severe cuts to education budgets generally throughout Australia, money for professional development is grossly inadequate, while tied to the pet projects of the government of the day. Soon after the current government in Victoria was elected, an "innovative" satellite dish project was initiated. Each public school was issued with a satellite dish, and encouraged to tune the children in to "interactive" programs, such as Japanese language classes. There was, and still is, too few teachers of Japanese to cater for all needs. The government's definition of "interactive" was telecast one direction, fax back from schools. The project, according to teachers, has bordered on total failure, while at the time a great public relations exercise, that bled from the education system many millions of dollars. The chances for real and positive change diminishes further.

The front office in the average Australian school is well equipped with technology, to serve the needs of the principal, and to enhance the workload of the administration people. The chief school administrators know the value of the right equipment, but the will to enskill teaching staff in a variety of new and innovative practices, and to resource their classrooms seems, on the evidence, to be lacking at a variety of levels.

In Victoria, Australia, schools are responsible for the management of their own budgets. Self managed schools. The number of children at any one school determines the number of staff assigned to the school, and the budget deemed "appropriate" is also assigned to the school. One needs to question the government pronouncements on numbers of children per teacher under this scheme compared to the anecdotal evidence that exposes it for the fiction it is. In Victoria we are told there is one teacher for every 15 children. In a survey of schools in the western region of Melbourne, involving approximately 70 teachers, the minimum number of children in any one class is 22, the maximum is 34, and the average is almost 30. There often appears to be a misrepresentation of 100%. It also appears that if every adult member of the school community is included in the count, i.e. the principal, the specialist teachers, the special task staff, the government figure is closer to the mark. That, of course, does nothing to ease the stress on the teacher of a class of 30 active children, with the consequent drop in attention per student.

It appears the same stretching of the truth is employed to bring the number of children per computer to a level that will satisfy the parents/voters.

The Victorian government boasts one computer for every 7.5 children in State Government schools.

On the same survey previously mentioned, many classrooms had no access to computers. Others had equipment up to 15 years old. A few had access to a laboratory of Pentium based computers.

But with the current industry standard being a Pentium based computer, and with that standard applied to classrooms, for Victorian classrooms, there is one computer for every 75 children, a figure 10 times worse than the figure offered by the government authorities. In a world of communication, access to Internet, and multimedia authoring, to suggest that anything less than the best is good enough for schools sits uneasy with the author.

While the use of information technology in the classroom learning environment is increasing relative to the funding for equipment and professional development, little advancement has been made when considering the workload of the teacher.

The nature of teachers' work lends itself to the widespread use of information technology. Teachers' work, according to the teachers surveyed, is varied in its nature, and incorporates knowledge from a wide variety of fields. Teachers identified "educator" as one of their key roles, but for many sessions throughout their working day, by no means the most time consuming.

The survey asked teachers and Year 2 undergraduate teacher education students working with them to document the teachers' role in the first hour of each day.

It soon became obvious that "normal" was not a definable term for the classrooms being observed. Variations of the teacher's role occurred from day to day in the same classroom. Variations also occurred at different class levels, and also dramatic variations occurred between different schools, both private and public.

Four main headings have been used to group the roles teachers see occupy their professional time. These are:

· Educator

· Administrator

· Counsellor

· Health care worker

On many occasions these roles overlap, involve other significant people in the children's lives, and occur in class time, school time and after hours, as well as the first hour.

Teachers are expected to teach, but the results of this survey indicate there are many other expectations, within the first hour each day, that interfere with that primary role. Collecting money from students appears to be one of the key roles expected of teachers. For reasons as varied as lunch orders to school fees, and special money raising events through to collecting savings on behalf of banks, teachers' work of teaching takes a lower priority.

Marking the attendance roll is also on the first hour, and in Victorian schools, is required to be taken by 9.30 am. Depending on the number of students in each class and their ages, this task can take up to ten minutes of class time. There is a recent decree from the Department of Education that requires these numbers to be sent to head office by a certain time each day, and to occur twice per day.

In many schools in the Western region of Melbourne, well documented as being predominantly lower socioeconomically than many other areas of Melbourne, another key role of teachers is as a counsellor to parents who drop their children at school. In the schools associated with this survey, counselling of parents was an almost daily occurrence, taking both time and energy from the teachers.

Other tasks, such as administering minor first aid to children who may sustain a playground injury is also a very regular, daily occurrence, that requires administrative support, even for a minor scratch.

Teachers also find that the school administrators (principals) interrupt the flow of their work on a regular basis, with calls through the intercom for a multitude of reasons, all apparently urgent at the time. On other occasions children from other grades arrive at the door with special requests from their teachers, adding to a feeling of collegiality, but again interrupting the teaching/learning flow in the classroom.

Interruptions are the norm, rather than the exception. From attention seeking children, bathroom attendance, inappropriate physical contact, boisterousness, through to the resultant behaviour from lifestyles entrenched in poverty, such as aggression, timidity, lack of concentration and others, it is easy to see that teachers' work is not simply defined.

How can information technology assist teachers achieve their goals, which are the goals of the general community?

If we were able to peer into the distant future, would we see:

computers networked throughout a school, and with an investment in some identity scanning equipment?

Would each child be issued with a "smart library card", also able to be linked to parental bank accounts?

Would the computers at the school be linked, from the library to the main office, to the other classrooms, and the school canteen, and perhaps to the local banks?

Parents might have access to some terminals at the school, a system of passwords having been developed.

Smart card readers installed at each classroom door, and the entrances and exits to the school? Children leaving and entering the school grounds and the classrooms swiping their cards through the readers?

Automatically, the following would have occurred:

Children's attendance would be recorded.

Any absences would be recorded. At an appropriate time, absentees' homes would receive an automated phone call, requiring the keypad response informing the schools of reasons for any absences, and knowledge about them.

Children absent one day would receive an automatic update in their computer log regarding any missed information upon their return. This would also include all the missed school work, as the teacher does her planning and organisation on a computer.

The school canteen would automatically receive any lunch orders from the appropriate children, and have them delivered. The smart card would have the amount automatically deducted.

Teachers from other grades would need to email messages rather than hand deliver them, allowing the responding teacher to choose the moment, rather than be constantly interrupted. The school principal, in cases other than REAL emergency situations, would need to do the same.

Perhaps close to 40 minutes in the first hour would be given back to teaching and learning. Over the course of a week, this is approximately an extra half day - or in Australian terms, an extra working month every year.

It is also acknowledged that teachers don't see this approach as a high priority, as they are aware of the realities in education funding in Australia at present.

There are five key hopes those surveyed have identified for the next five years for their classrooms:

1. ongoing professional development in Information Technology

2. access to computers for their classroom (5 or 6 in each room)

3. classroom access to Internet and the World Wide Web, and other

appropriate software

4. ongoing technical support for their classrooms and

5. reducing class sizes

It is interesting to note that the teachers have not included any personal gains in these key hopes.

Teachers have recognised the value of sophisticated Information Technology in the teaching and learning environment of their classrooms. Governments have recognised the importance of adequate equipment in schools, otherwise there would be no need to misrepresent the schools' access to the technology. Parents also know that Information Technology is a key to their children's future. All that is needed is the funding. So simple!

"The Watershed": New Technologies Supporting New Forms of Educatin

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There is no doubt that significant progress in both educational technologies and their integration into classroom teaching has taken place over the last decade. The growth in the use of microcomputers in schools especially has been staggering [see OTA, 1995]. Growing access to the Word-Wide Web has given students a new information resource which often outstrips their school library.

Despite this progress, many educators who use new technologies have not taken full advantage of the possibilities they present for restructuring basic approaches to curriculum and pedagogy. As Michael Hannafin noted in 1992, "Advances in computers and related hardware technologies have far out-stripped prevailing design methodologies. The field remains insulated from developments of considerable consequence for improving learning" (p. 49). In such a fast-moving field, however, it must also be acknowledged that there is a growing body of theory and practice which incorporates constuctivist epistemologies and collaborative curriculum designs into technology-rich classroom environments [see Adams & Hamm, 1996; Koschmann, 1996]. Canada has been a primary site for some of these developments [see Harasim, 1995; Scardamalia & Bereiter, 1996].

In the province of Ontario, a recent Royal Commission reinforced earlier government policy statements strongly supporting both integrated approaches to curriculum, and expanded use of information technologies [Ont. RCoL, 1995; Ont. Min. of Ed., 1995]. Yet, as the Royal Commission report pointed out, much of the potential of educational technology is as yet unrealized, poorly developed, and little understood. The ways in which recent developments such as local-area networks and World-Wide-Web access are to be incorporated into the curriculum are yet to be specified. Despite the repeated emphasis on the principle of integrated curriculum, there has been little guidance given as to how exactly teachers in the upper grades are to transcend their traditional approaches to curriculum, and the subject boundaries which have for so long guided their professional practice [see Goodson & Mangan, 1996b].

The Watershed Information System is a response to these challenges. It has been designed and implemented by a collaborative team of university professors and researchers, private software developers, business sponsors, and teachers and students in provincial high schools. A pilot project was begun in 1996 (with funding from Environment Canada and several private sources). It is spearheading the application of leading-edge information technologies in the high schools of the Grand River Watershed, in and around Cambridge, Ontario. The concept, originated by architect and environmentalist Fred McGarry and his colleagues, is to build a multi-layered database of economic, demographic, and environmental information, keyed to finely-detailed digital maps of the area. Using custom software *(ecorp connections)* which projects a computer-rendered version of the map onto a monitor screen, users can point-and-click on various parts of the map to call up information about the natural features, buildings, history, and demographics of the region.

The uses of such a finely detailed database are many and varied: students can explore local history, genealogy, economic development, and environmental change. Equally important, however, is that the database, when fully developed, will be accessible to anyone in the community, via the World Wide Web. Individual citizens who wish to research their family history, or the context of a heritage building site, will be able to do so, by using the database from any Internet-connected computer. Existing community resources, such as oral histories and private memorabilia collections, have been incorporated into what are being called "neighbourhood databases."

The educational purposes of The Watershed are not limited to its use as a storehouse of information, from which students can make "withdrawals." They are also expected to make important contributions. The neighbourhood databases will be continuously updated and expanded by the users themselves. The major contributors will be high-school students, working on course-related assignments. Class projects developed to date, for instance, have included the mapping of a cemetery in the town of Blair. For each headstone, the epitaph was recorded as text, a video image of the stone was captured, and the precise location was determined using surveying techniques. All of these data were then incorporated into the on-line database. Teachers involved with this and similar projects reported such enthusiasm among students that many continued participating after school hours, and even after classes ended for the summer. The students who took part in this project not only came into direct contact with some of the important historical artifacts of their town, but practised skills in mathematics, media studies, English, historiography, and computer science. [see Pollock-Ellwand, 1998].

As interesting as the educational applications are, the Watershed has also been designed to promote the restructuring of relationships among the participants in significant ways. Although the software systems are being developed specifically to support this project, the developers are not simply selling a software product to schools. Instead, each installation is financed by a contribution from private industry. The contents of the database will be publicly accessible, and owned in common by all participants, through a non-profit organization known as The Copper Trust. Once the basic implementation of the system is accomplished, further development will be conducted through a democratic process, which will use the telecommunications abilities of the network to conduct ongoing dialogues and "town hall' meetings among participants. Students, teachers, and private users will have equal input to these discussions. An "on-line academy" will supervise annual awards recognizing "best practices" in using the system. These awards will be given based on feedback from all participants.

Within the school system, development of integrative curriculum design is being conducted as an action-research project, involving teachers from several disciplinary areas in different schools, working in co-operation with each other and with a team of university-based researchers. Participating teachers develop new lessons by working together and exchanging ideas, with the goal of using the technology to promote cross-disciplinary learning and a collaborative model of student interaction. University researchers provide theoretical background, and convene reflective sessions on the problems and possibilities of the initiative [see Goodson & Mangan, 1996a]. Negotiations are under way to provide participating teachers with graduate-level course credits from the universities in recognition of their work, as well as support from their school board in the form of release time and conference travel subsidies.

Through these various aspects, The Watershed is using educational technologies as a catalyst to radically transform high school curriculum and pedagogy, school-university-private sector partnerships, and the relationships among the various teachers and learners who make use of the system. Our goal is to at least partially realize the vision enunciated by [Adams and Hamm 1996]: "As state-of-the-art pedagogy is connected with state-of-the-art technological tools, it will change the way knowledge is constructed, stored, and learned." (p. 217).

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Interactive Learning Environment for the Education of Computer Engineering

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Introduction

In order to meet the ever-increasing need of the electronics industry for engineering professionals, Computer Based Learning Centres are being established to ensure the required amount of university and polytechnic graduates in this field.

Computer-aided training and learning requires a high level of interaction between the computer and the learner in order to ensure the quality of the learning in situations where the role of the teacher increasingly resembles the role of a tutor. In addition to machine-human interaction, interaction with peer learners (peer support) has been observed to be beneficial for the student. When considering sparsely located learners (distance education), this human to human interaction requires adequate tools and abundant support from the telematic systems. In this paper, examples from the two interaction types, machine-human and human-human are described. In addition to these, the demonstration scenario of computer based training is briefly represented.

The Institutes of Higher Education (IHE) pilot of the IDEALS project (in the EU TELEMATICS programme) is currently in its demonstration phase (until June 1998). The IHE pilot is demonstrating the interactive learning environments as well as co-operative learning (teamwork) and authoring between three European universities located in Germany, Portugal and in Finland [Ideals 95]. In the demonstration phase, the evaluation of the learning process and the evaluation of user satisfaction are also conducted. A special contribution by the Raahe Laboratory of the University of Oulu (RATOL) to the IDEALS-project, in addition to the produced User Interface Programming course, is the linkage of the telematic CBT-system to the real CASE-environment [Paaso and Manninen 97].

Machine-Human Interaction

In the course material of the IHE pilot, the proportional division into the various learning process phases is as follows: Presentation 30 %, Exploration 50 %, Tests 20 % [Paaso et. al 97]. This reflects the view that the computer is utilised to its height in the experimenting and exercising phases of the learning process. This suggests that there is no point in using the computer merely as a replacement for a book.

There are two main implementations of machine-human interaction specially tailored for the programming course conducted at RATOL. The first one is the Virtual Compiler, which is used for practical experimenting with the programming projects in a safe learning environment. The second implementation is the didactic tests which, in turn, are designed for small-scale quality assurance of the learning [Deming 93].

The Virtual Compiler simulates the features of the real compiler, although in a much restricted scale (see Figure 1). The virtual environment provides the learner with the opportunity to explore, modify and test some ready-made software components without causing the system to crash. This feature can be obtained by providing the author of the course with the freedom to accurately set and specify all the modifications that the learner is allowed to make to the program. The possible modification points are clearly visible to the learner and, thus, make it easier for the learner to maintain the appropriate course of action. After adjusting the modification points, the learner compiles and runs the program, which, in turn, enables him or her to view the direct results of the modifications in the actual executing environment.

The Virtual Compiler is a fast and effective method for the learner to study the different aspects of the programming project. The immediate feedback produced by the system ensures that the learner is not forced to struggle ineffectively in order to obtain sensible results. The "guiding" role performed by the system also prevents the learner from going astray and, thus, reduces the overhead of the learning process by keeping the learner on the right track.

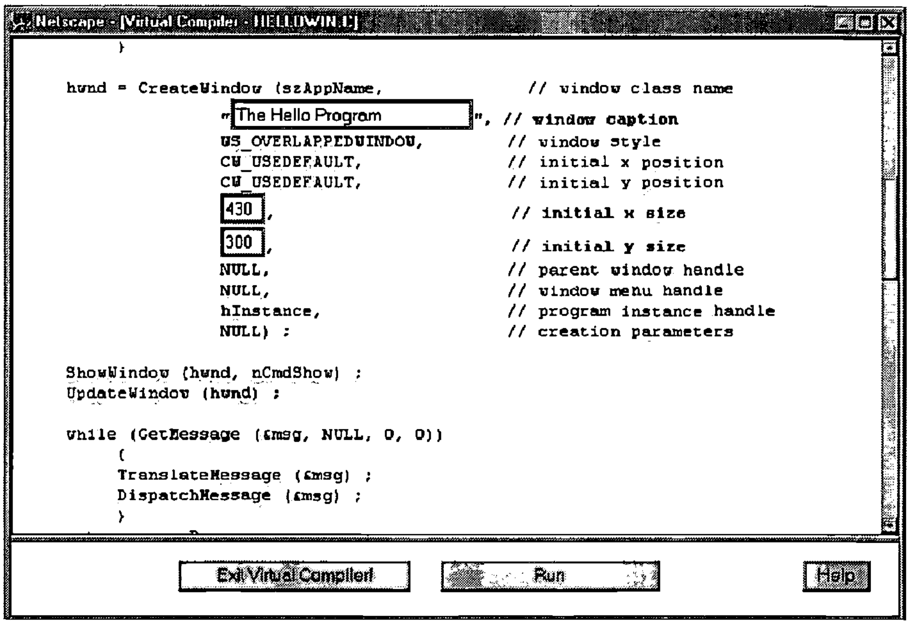

Figure 1. The Virtual Compiler

At the end of each section of the course material the learner is required to pass a test based on the newly acquired knowledge. The majority of the tests is intended solely for didactic purposes and, thus, will not affect the overall evaluation of the learner. The aim of the didactic tests is to force the learner to sufficiently study each section of the material before proceeding onto the next section. This is ensured by creating a course flow containing a repetitive loop, which guides the learner back to the beginning of the section and, eventually, forces the learner to repeat the test after going through the contents once again.

The tests also serve the learner in that they are the final phase of the actual learning process. The answers are immediately evaluated and commented on by the computer and provided to the learner for reviewing. This method of repeating the tests (with various question configurations) enables the learner to absorb at least some level of information. Figure 2 illustrates a sample of the test feedback.

The utilising of the user profiles collected about every user of the learning environment may alter the configuration of the questions, i.e. the contents of the tests. This method makes it possible for the course material author to create a test structure which, based on previous tests, emphasises on the weak points of the learner.

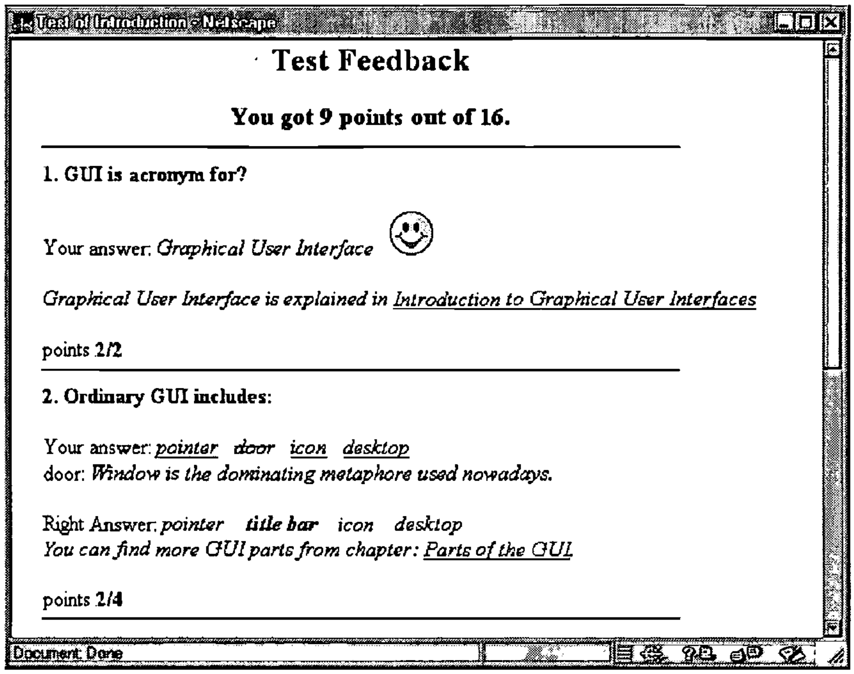

Figure 2. The test feedback provided to the learner.

Computer Driven Human-to-Human Interaction

In addition to the machine-human interaction, there are features in the demonstration course that significantly motivate, activate and even occasionally force the student with human-to-human interaction, either directly or telematically. The virtual laboratory formed by individual workstations (connected to a single learning environment) provides adequate means for communication, and even encourages co-operation and interaction between the various parties. Apart from these sufficient means of communicating, it is the responsibility of the course designer to steer the learners towards a more interactive learning style, i.e. collaborative learning. One example of this is, for instance, that every software module included in the programming project to be accomplished as teamwork, should contain a great level of interaction with other modules in order to ensure the need for communication and co-operation [2]. The interaction between the team members is thus "goal-driven" in a natural way, although in reality the members are steered towards this interaction by the computer. The interdependence between software modules "forces" the various team participants to approach the problems collaboratively, even when the entire group is geographically widely spread.

Demonstration of the Learning Environment

The aforementioned interactive learning techniques and environment are being demonstrated in the Raahe Laboratory of the University of Oulu between May 1997 and July 1998. The demonstration includes a total of 60 students (B.Sc. and M.Sc students) who have selected the optional Computer Graphics course as part of their curriculum. The course, which is being carried out with the aid of telematics and CBT, and without conventional lectures, consists of approximately 16 hours of studying and experimenting (including short exercises and tests). At the end of the learning phase, the students are required to produce a final software development project in collaboration with the other group members, i.e. implementing software modules for a common user interface window ("goal-driven" co-operation). All communication between learners is handled with the aid of telematics. The final evaluation of the learners is conducted through a written exam, which is performed at the end of the "lecturing" period.

Conclusions

The great need for engineering professionals requires new methods for increasing the output of graduates from universities and polytechnics. One proposed solution is the Computer Based Learning Centres, which enable more efficient and integrated learning, even in sparsely populated areas.

To ensure the high motivation and illustrative level in the CBT, a high level of interaction between the computer and the actual learner is required. In addition to machine-human interaction, the human-to-human interaction with peer learners (peer support) is also beneficial for the student.

The Institutes of Higher Education (IHE) pilot of the IDEALS project is currently undergoing the demonstrating of the interactive learning environments in practise, in three European Universities. The demonstration phase will end in July 1998.

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Control of Applications from HTML documents. Resonance in Mechanical Systems

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1. Introduction

Within a project named CoLoS, twelve groups of scientists from eight European countries are working together to explore the didactic potential of modern computers and to develop adequate learning material. CoLoS stands for Conceptual Learning of Science and reflects our major goal of using modern technology for a better and more direct approach towards presentation and understanding of basic concepts in science and technology [Härtel 94]. Within this group a method was implemented to overcome the obstacle of complex interfaces, that usually constitute a barrier between the contents to be learned and the support provided by the computer.

The proposed method is based on a control mechanism using Internet standard TCP/IP communication protocol. It allows controlling our simulation through active links within a Java-powered HTML document. It offers to any teacher or authors the choice to make the adequate selection of interaction accessible to the learner and to define the proper balance between freedom to explore and guidance to successful learning experiences. All applications developed with our authoring tool, Xdev [Esquembre 94], automatically include those communication possibilities.

In order to show the capabilities of the above-mentioned procedure, the application to a short course on Resonance in Mechanical Systems is presented in this short paper. The application used for this purpose is xyZET [Härtel 96], a simulator developed at IPN (Kiel, Germany) that allows to show the behavior of sets of particles interconnected by different interactions or acted on by external fields. The didactic part consists of a short HTML document with the content that we want to teach, and with the necessary control on the simulation in order to allow a guided instruction on the selected topic.

Control method.

One simple, and very effective, way to write the didactic text that accompanies a simulation program is to produce an HTML file that can be read with any of the nowadays so popular Web browsers. These files allow not only reasonable editing capabilities, but are also prepared for hypertext behavior and can be distributed from a central depository over the network. This facilitates the distribution and maintenance of the related documents.

At this moment, and though new tools, like Java, are very popular standards that have improved the state of the art in the recent years, some computation- or graphic-intensive - simulation programs must still be created separately, since these browsers are not suitable for creating this kind of presentations. Hence, the simulation program runs as a separate process in the operating system and we need a way to interact from the HTML file (i.e. the browser that is reading it) to the simulation and viceversa.

Some browsers also allow the reverse process, that is, changing the text according to changes of the simulation or to user interaction with it. We do not explore this feature in full. More interesting for our purposes is the possibility of changing the behavior of the simulation from the user interaction with the browser that contains the learning unit.

In our case, and since we use UNIX and Windows 95 or NT as our software platform, we use the standard TCP/IP mechanism, present in most computers with network connection, for interclient communication.

With this method, a simulation program written in any of the most popular languages can, with some added libraries that we provide, offer a series of commands in natural language as equivalents for internal procedures and export this list of command strings to be used in other applications. In technical words, the application turns into a specialized TCP/IP server. Other programs, acting as TCP/IP clients, can send messages to this simulation program that will cause some internal procedures being executed (initialization of some variables, start/stop of the simulation, load of a file, and others).

The actual implementation of client programs that we use in our HTML files is a small Java applet that represents a button. This button can be customized using the applet parameters to read different messages, with different colors, fonts and other effects. When this button is pressed a message is sent to a machine in the network (usually the local host) at a specified port. This is also configured via parameters, thus providing with a single applet a wide range of use. The server program, i.e. the simulation that is being controlled, will be listening at the specified port in order to receive and process the message.

This recent work improves and extends a previous implementation that we used for X window programs under the UNIX environment [Esquembre 96]. There we exploited the Inter-Client Communication Conventions Manual present in these systems [Scheifler 92]. Both systems have proven to be simple to implement and very effective in their educational usage.

2. Resonance in Mechanical systems.

Resonance is an omnipresent phenomenon in nature and it is included in all Physics curricula at an introductory level. Therefore we have selected this topic, and have chosen mechanical systems as concrete examples because there the effects are good to demonstrate and to visualize as compared with electrical or acoustical systems. In this didactic unit we use xyZET to simulate the resonance in systems like pendulum, mass-spring and vibrating strings. This unit has been designed and used for training high-school teachers.

The basic content of this document has been distributed in the following sections:

1 The phenomenon
2 Background knowledge
3 Some Examples of mechanical systems with natural frequencies
4 Preparation of Experiments (free oscillations).
5 Experiments with resonant systems (forced oscillations)
6 Theory of Forced Oscillations
7 Energy analysis

After a description of Resonance and the systems that show that behavior (Section 1), an introduction is made to the basic knowledge needed to understand the main concepts involved (2). In Section 3 some systems capable of showing a resonant behavior are presented using xyZET: Pendulum, mass-spring, vibrating string (fundamental and higher order modes) and vibrating membrane. Section 4 explains how the different systems can be characterized by measuring their natural frequencies and other relevant parameters. A comparison between the "measured" results and the theoretically predicted ones is also included, together with some assignments for the user. In sections 5 the resonant behavior of the mass-spring and vibrating string systems is analyzed in detail. Sections 6 and 7 include a revision of some advanced concepts, always with the support of the simulations.This didactic unit has been tested with high-school Spanish teachers. A translation into English is also available. In this document, the active links to control xyZET do not work.

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Hypermedia Pronunciation Power Program For Learners Of English As A Second Language

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Abstract: We have been developing the Hypermedia Pronunciation Power Program which helps students of English As A Second Language to improve their listening and speaking skills. When using this program, students see a movie of a native speaker. They can then imitate mouth positions as well as the sound of a native speaker. In addition, we are including two new features. With the new features, students can record their voice and can compare graphically their intonation with that of a native speaker. Moreover, students can make a listening practice with noises added intentionally, and they can also hear echo effected voices. We think this feature is useful for ESL advanced class students who can understand what native speakers are saying fairly well but cannot always understand every person. This paper describes the outline of the Hypermedia Pronunciation Power Program.

1. Introduction

Students of English As A Second Language desire to acquire clear and correct pronunciation of English words, phrases, and sentences but sometimes have difficulty in this area. ESL students cannot expect to greatly improve their pronunciation simply spending a few hours in a pronunciation or oral skills class. Materials are needed that allow students to work on their pronunciation skills in a language lab. These materials can be used on their own or as a supplement to a class.

In order to fulfill these needs we have made an English conversation education support system [McCarthy, Matsuno, and Swan 1997]. This system includes a video of native speakers pronouncing individual sounds, words and sentences. The learner is then able to imitate the mouth position as well as the sound of the speaker. The system includes opportunity for practice and includes materials designed to keep the learners interested while studying. Added to these features, we included two new features. We call the new system Hypermedia Pronunciation Power Program (HPPP). One of the new features allows students to record their own voices and to compare graphically their intonations with that of a native speaker. The second feature can create various kinds of noises, and can add them to original sounds. It is sometimes difficult for ESL learners to understand a person, who has a peculiar way of speaking, even if the students can understand a familiar person who speaks rapidly, like a radio announcer. In order to cope with those problems, students can make a listening practice with noises added intentionally, and they can also hear echo effected voices with HPPP.

2. Outline of HPPP

2.1 Required Hardware

To use HPPP, a student will need a multimedia personal computer with a soundboard and CD-ROM, which runs Windows 95. In other words, HPPP does not require any special equipment, as almost all of the computers produced at this time are equipped with such kinds of devices. However, it would be more convenient if a computer is equipped with a video capture board. Teachers would be able to make their own materials including video movies, and students would be able to check the shape of their mouths when speaking English.

2.2 The previous version of HPPP

In the previous version, HPPP offered the following three features.
[see McCarthy, Matsuno, and Swan 1997 in detail]

1. Students can listen to a teacher's explanation - how students should shape their lips and where they should place their tongue in order to make the target sound.
2. Students can see a movie of the teacher pronouncing the words and sentences, and can imitate the teacher.
3. Students can check their listening ability.
   Students hear the quiz sentence. Take the "th" sound for example: ten words containing the "th" sound or similar words containing the "s" sound are selected at random. The student then hears a native speaker say a sentence containing the quiz word. The student must decide if the word they hear was a "th" word or a "s" word. As the sentences are chosen at random, the student cannot memorize the correct answers-they will be different each time.

2.3 Added new features

2.3.1 Visual Voice

It is sometimes difficult for ESL students to judge whether their pronunciation is correct or incorrect, even if they can hear a playback of a recording comparing it to a teacher's voice. We examined the Microsoft voice recognition system to judge students' pronunciation. This system, however, is too severe to understand ESL students speaking as it is developed for English native speakers. HPPP helps students improve their pronunciation using a graphic pattern. When students want to make a practice for intonation, for example, students listen to a teacher speaking and see the teacher's stress pattern graphically. After ascertaining the teacher's intonation with both their ears and eyes, students can record their own speaking, and then can hear the playback of the recording comparing the teacher's intonation pattern with their own.

2.3.2 Noise Maker

Ordinarily, most English conversation support tools try to make students listen to clear speech. This is true for ESL beginners, we believe, but not for advanced level ESL students. Some of ESL advanced class students, as we mentioned above, can understand a person who speaks clearly like a radio announcer, but cannot understand a person who may have a peculiar or unusual way of speaking. HPPP can create several kinds of noises, and add them to a teacher's original sound. Students can make a listening practice under discords added intentionally by HPPP, and they can also hear echo effected voices. This is a kind of virtual reality. Students can make a practice under the situation as if they were in a crowd of people and/or on a busy street. A teacher does not have to offer all those materials. All the teacher has to do is to prepare materials recorded clearly word for word. HPPP can playback it slowly for beginners or faster for seniors with various kinds of noises.

3. Conclusions

We have reinforced HPPP. New added features are aimed at ESL advanced class students. A lot of ESL students are eager to acquire the correct way of speaking. However, we do not think HPPP is completed. We are not ESL teachers. We have developed HPPP from one ESL student's standpoint. Therefore, we would like to offer the HPPP to ESL teachers. We would appreciate it if some ESL teachers could use HPPP and give us their feedback to develop it into an even better teaching tool.

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A Genetics-Like Taxonomy to Describe the Navigational Effect of a Link

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More than any other attribute, making associative links between two locations within the data, is the cornerstone of hypermedia. Bush's (1945 p106) *"selection by association rather than indexing"* was an early description of this process although Macknight (1996) suggests that its origins lie a thousand years earlier in the practices of medieval scribes and scholars. A great deal has been written about link mechanisms and the consequent process of using these to move from one part of a system to another.

Links are not all the same. [De Young 1990] addressed the issue of link type by defining a taxonomy which included links that indicated the nature of the data at the destination, structured sets of links, links which define relations and those which identify a finite number of steps that together form a unit. In the Hyper-book implementation, [Catenazzi 1993] used a classification that was a mixture of the nature of the data involved in the link and the source of the data. [Richards 1994], identified links which have a constant target, contextual links in which the target varied depending on the location of the link, typed links which were similar in operation to class links [Messing 1993], [Messing 1994] and intelligent links which involved calculation of the strength of a relationship based on user profiling or expert system techniques. [Tomek, Maurer & Nassar 1993] suggested an entirely different approach which calculated indices for the relevance of each link and allowed the resulting values to categorise the links.

One attribute that was not properly addressed in any of the above taxonomies, is that of the navigational effect that a link has. If navigation is such an important component of hypermedia use, then one would have thought that such a taxonomy would have been established by now. Geneticists have, since the days of Gregor Mendel, used a method of describing the characteristics of an organism in terms of a set of different forms of a particular trait, an allele. When such a technique is applied to links, a useful way of describing the nature of a link results. Given the highly researched nature of hypermedia navigation this might prove a useful and easily extensible, taxonomy.

One of the basic traits of links would whether they do or do not result in a change of node location as a consequence of following that link. The alleles for that trait could be represented as n (new node) and s (same node) or in the style used by geneticists, N (new node) and n (same node) where the capital letter version of a dicotomous trait represents having that attribute while the lowercase version indicates its complement. This is consistent with the *"hj-link"* and *"w-link"* operators proposed by [Catenazzi 1993] (p98). Further differentiation of link types could be based on the type of data involved at the source and target. Alleles for the type of data could be represented by t, g, a, v to denote the media type (text, graphics, audio, video). Other traits such as whether the link target occurs in the existing window or a new one could easily be added to the taxonomy.

The sample space of possible link types is determined by the number of traits that one is interested in investigating. For example, in a study which seeks to analyse link activity in terms of navigational effect on nodes (N, n) as well as data type at destination (t, g, a, v), there would be 8 different genetic combinations or 'types of organism' (Nt, nt, Ng, ng ... etc.). Link classification based on navigational effect, data at source, data at target and window effect would consist of 2 x 4 x 4 x 2 possible link types such as Ntgtw (New node from a graphic link to a text target in the same window i.e. clicking a graphic button that displays some text on a new node).

Practical demonstrations of the use of this type of taxonomy are not difficult to construct. [Messing 1997] used such a taxonomy to produce link activity ratios and measures which were able to objectively combine data from hundreds of links. Simply categorising the links available in a hypermedia / multimedia application may provide valuable insights for the designers. Being able to focus on individual traits of links may allow results from quite different research projects to be more accurately compared.

The purpose of having such a taxonomy which caters for many different link types is to be able to report, in a consistent form, the research associated with links without having to resolve the conflicts between the many different ways of describing link attributes. It is possible for instance to interpret past research on disorientation in terms of link types which carry the 'N' instead of the 'n' gene. Rather than inventing a variety of different descriptive classification schema, a researcher need only discuss the attributes of the particular 'gene' to be added. Such an approach has proven extremely successful in the biological sciences and may serve a similar role in hypermedia.

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School Presentation On The World Wide Web – Conclusions From A Working Group Project At A German Secondary School

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WWW-Publication

Using the World Wide Web as a medium for publication is of special interest to all subjects at school. The students could change from passive recipients into active producers of information; an unbeatable advantage for the appropriation of subject matter [Emig 77]. The creation of a school homepage could be a first start – spreading the subjects – in the production of multimedia hypertexts, it could be the basis for all school publications and support the "corporate identity" with the institution school.

The advantages of using the Web as a medium of (hypertext-)publication are:

- The motivation for text production arises out of real (communicative) needs;
- The Web itself offers a lot of material for the creation of texts;
- The number of potential readers, the audience is enlarged;
- Worldwide publication leads to intrinsic motivation and therefore to a higher awareness of the texts' quality.

Theses and results from own experiences concerning the work on designing a homepage with students are listed below [Meyer 97]. The homepage itself can be find at: http://www.shuttle.schule.de/do/stg/

Getting Started

A school presentation is a complex and extensive write and design-project, especially if a multimedia hypertext is the objective. Therefore the typical scheme of a writing-process (collection and organisation of material, production, revision) will not be realized in normal 45-minutes-lessons. In order to concentrate and focus on the product (homepage!) and to get foreseeable results, we decided to work on the project limited in time (three weeks in the afternoon). Before our undertaking was started, all necessary hard- (scanner; cd-drive; microphone with soundcard; videocard) and software were installed and tested extensively (we use almost sponsored commercial software or common freeware and cheap shareware programs). At the beginning inexperienced students should be introduced to the basics of all used software, so that there is not such a great division in experts. These steps help to avoid a domination of technical problems while students create the demanding homepage.

Study Group

Presenting a school needs a high degree of division of labour (according to interests, capabilities) and of team-working [Zammuner 95]. To enhance the ability of cooperation, the total number of students should not be too large (a maximum of 15 to 20 students). After decision on the writing themes were completed, smaller groups (1-3 students) were built for every topic. To promote the writing capabilities of younger students, we made excellent experiences with mixed aged student groups (13 to 18 years).

The Unknown Hypertext

The production of a multimedia hypertext needs an idea of the overall construction and capabilities of linking concepts and references. Most students are unfamiliar with the reception and production of multimedia hypertext. First of all they have to train their 'synesthetic' reception of hypertext [Schmitz 97] by reading and discussing its characteristics and opportunities [Wichert 97]. We have realized this by simply "surfing" through preselected homepages (e.g. schools).

Following this phase the active production can begin by drawing special attention to the structure of a hypertext school web. We used a great poster for the visualization of all possible themes and links. After making necessary arrangements for principal layout styles and dates for regular plenum discussions, all students began to collect material (text, graphics, sounds, videos) and scan, write, visualize, paint, play, cut, morph it.

The Unknown Audience

Especially younger students are not sure who the reader of their text will be. That is why a fictive reader has to be imagined, a fact that does not promote the quality of text products. Therefore motivation and quality could be supported by the implementation of a real audience (e.g. partner school) or through communicative functions of a web page (e.g. e-mail, guestbook, form for comments, counter statistics). All students were proud to receive an e-mail with a comment from a reader and everyone revised their own hypertext afterwards. Because a homepage has to be actualize, some students still work in their leisure time on the never ending project.

Every student gave a positive judgement on the project. They emphasize the production guided innovative work with references to many subjects. The methodology of work should be find a way in the normal classroom lessons. Positive feedback was given also concerning their own roles. The chance to create a public text in an atmosphere of free ideas and cooperation gave the students a high degree of responsibility which is not typical for schools.

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Learning Environment for Integrating MOO-based Interaction and Online Local History for the Social Studies Classroom

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Social studies teachers are presented with the challenge of making both historical materials and contemporary societal issues engaging to the student audience. Students need to understand the economic, social, and political climate that shaped their community, and which continues to have an effect on how decisions are made which touch their daily lives. An interactive environment, which helps the student to understand history and the contemporary community, while at the same time allowing for alternative futures to be built, is ideal for such a task because in combines a factual knowledge-base with the opportunity for hands on development of the environment and peer-to-peer discussion.

CivicMOO is a project which links an interactive online learning environment — a MOO — with a rich historical database of local history materials. The MOO provides a text-based virtual representation of Spokane, Washington and the surrounding rural counties. It models neighborhoods, street corners, rural towns, and specific geographic and cultural features such as parks, buildings, churches, and businesses. The specific descriptions of each neighborhood or community are built gradually by the users themselves. The opportunity to describe a geographic or cultural feature in narrative form provides a rich opportunity for the writing curriculum, as well as for social studies activities.

CivicMOO will have a "transporter" which allows users to view the geographic region, its neighborhoods, and communities, in the future. Alternative futures can be built for different points in the time continuum, which express a given user or users' view of what an area might look like 20, 50, or 100 years hence. Thus, a group of students might model the small town of Chewelah with parks, and a ski resort; while a group of civic leaders might create a future with an industrial economic base and high employment. These views co-exist in the "future" and can be debated and discussed. A singular asset of CivicMOO is that it is used by community leaders for planning and discussion, thus exposing students to real-life political debate and the struggles of various stakeholder in planning for their community's future.

CivicMOO also developing a "time machine" which allows a virtual reconstruction of the geographic area at different historical periods. To enhance historical understanding, a database of historical materials is linked to CivicMOO, which can be accessed from any point in the online time continuum. Materials include primary source documents and pictures from regional museums and libraries. Many of these materials would not ordinarily be available to for classroom use. Students and others can build the historical database itself by gathering oral histories, family photographs and memorabilia which can be archived online. These activities can be part of the classroom activities planned around the use of CivicMOO. A number of issues and challenges have played a role in the development of this interactive environment:

Security

To encourage interaction, CivicMOO has seminar rooms, lecture halls, and places for casual discussion which are available at all historical, present, and future time periods. Because the MOO operates on a free, public access, community computer network, appropriate levels of security have to be designed to preserve the space for educational use and civic discussion without squelching creativity and vigorous debate. Open access, typical of the MOO environment has the potential to overwhelm our dial in capacity as casual users seek a place to "chat". (Chat is disabled on the network as a whole.) CivicMOO thus allows visitors to roam around, observe, and select items for further exploration, but venues for discussion must be reserved ahead of time. We are assigning some discussion space on an experimental basis to specific individuals and groups who will control their own times and guests as they need them.

Linkage

The text-based MOO operates in a telnet environment, while the historical materials are web-based. At this point, both sessions cannot be online simultaneously. While there are effective means of switching between the two sessions, it is easy for an individual to get "lost" while moving between.

Organization and Selection of Information

Historians often have a decidedly different notion from that of the classroom teacher as to what is the most important historical material to be put online, and how these materials should be organized. The archivist's need to have online materials catalogued by universally-accepted standards, and the historian's goal of putting significant research collections of primary data online must be balanced against the educational needs of K-12 students. Our solution is to use universal standards for cataloging, but create a front-end with an easy "who, what, where, when" search mechanism that allows the less sophisticated user to move through the materials efficiently. And, while the long-range goal of the overall historical database project is to get significant collections online, in the short-term, materials are being selected to mesh with the essential learning goals for each grade level of Washington state schools.

Historical "Truth" in an Online Environment

The issue of veracity of historical data has stimulated some of the most energetic debate in the planning process for this project. As the historians point out, there is a substantive difference in the quality of data between a diary, a treaty, and a fifth grade student's oral history collected from her great uncle. While some historian's wish to exclude student-produced data, teachers feel that its presence is critical to the growth of the database and the students' understanding of historical processes in the region. First-person narrative is intrinsically interesting to most K-12 students, who can compare their current lives to the context, manners, and morals when grandmother was a girl. Additionally, the view of what is historically "true" over time changes, as the points of view of minority and other excluded populations are incorporated into accounts derived from general's diaries and the artifacts associated with the elite. Our temporary solution is to have a cautionary statement on sections containing oral history or other less "true" materials. Long-range, we would like to have a section on historiography, geared to the understanding of various grade levels.

Teacher Involvement

Involving teachers in MOO development has been somewhat challenging. Teachers have been more comfortable with the use of the content-based database, rather than the somewhat confusing process of using and building in the MOO. To some, the text-based MOO seems "old-fashioned" when compared with current graphical interfaces and activities.

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Our Learning Environments

Shaped by Our Tools...a.k.a. McLuhan

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In the 60's Marshall McLuhan began to address how our society was changing due to the effects of technology. Many of the academics of the time guffawed at his jingle-like "gibberish" and decried his academic histrionics which made pronouncements for our future. Well, the time has come to "drop this jiggery pokery and talk straight turkey ... " (Joyce, on McLuhan & Fiore)- "the word is out - it goes without saying". The presence he saw, now surrounds us.

In this paper I'm really addressing how the instructional design approach known as 'Constructivism' is really a reflection/reaction to the changes in our societies that have been compressed into slogans by McLuhan. Could the re-discovery of McLuhanism lead to further cognitive/technological adjustments in instructional design?

"The youth today reject goals. The want roles-R-O-L-E-S. That is, total involvement. They do not want fragmented, specialized goals or jobs." *(McLuhan, & Fiore, 1967, P.100)* This paradigm shift, with roots in the 60's, is the foundation of the Constructivist 'engagement - learning' which provides learners with opportunities to self-select, plan, organize, design and monitor their own research and problem solving. Is 'constructivism' an attempt to substitute the students' interest in 'media' the tools of learning and communication for an interest in subject (Kuhns-quotes McLuhan, 1956)?

"Electric circuitry is orientalizing the West. The contained, the distinct, the separate - our Western legacy - are being replaced by the flowing, the unified, the fused." *(McLuhan, & Fiore, 1967, P.145).* Constructionsism is seeking to capitalize on diversity, emphasizing the importance of distributive expertise. The instructor mentors 'learning communities' while coordinating content experts, technologists and educational resources and students in this 'cognitive apprenticeship' (Savery, 1995). "As new technologies come into play, people are less and less convinced of the importance of self-expression. Teamwork succeeds private effort." *(McLuhan, & Fiore, 1967, P.123)* Instructional design under constructionism appears to be reciprocal, recursive, transitory in functionality and constantly calling on a variety of skill(s) and/or individual(s) to be executed, creating new all-encompasing learning environments. McLuhan said, "…nothing inherently impossible in the computer, or that type of technology, extending consciousness itself-as univeral environment. .. extension of conscious itself" (Kuhns-quotes McLuhan, 1956)

The Winn's suggestion "that what students actually learn is determined by the situation in which learning takes place (the environment)" (Winn, 1997). McLuhan has written volumes on how our new environments are the media, that technology which actually becomes our 'subconscious' that "are not just containers, but processes that change the content totally" (Kuhns-quotes McLuhan, 1956)

"The classroom is now in a vital struggle for survival with the immensely persuasive 'outside' world created by new informational media." (McLuhan, & Fiore,1967, P.119) Instruction, that Socratic basic of the University, is in a tremendous upheaval. Our passive learners, who have received the wisdom that we the dispensers and managers of knowledge deem important, are now in revolt. They are beginning to actually "shop" for instruction and learning in a worldwide market out of our control. In a similar problematic state, university instructors are being called upon to design instruction, facilitate knowledge acquisition, satisfy 'bottom-line' requirements of a 'customer' and compete with unseen cyber institutions.

As our "world tends to become a single classroom or a non-stop seminar" (McLuhan, 1969, p.37), we teach in a "global village of continuous learning and total participation in the human dialogue, the problem of settlement is to extend consciousness itself and to maximize the opportunities of learning… a community of contiuous learning, a single campus in which everybody, irrespective of age, **is involved in learning a living.**" (McLuhan, 1969, p.41)

Contrary to what you might think, McLuhan did not like the changes he observed about him, and like most of us he resisted altering his thinking and behaviour. Early recognition and adjustment to change is not seen in our 'rear-view mirror'.

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A Laurillardian CAL Design Method - Developed and Implemented

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Introduction

At ED-MEDIA '97 a paper entitled "Developing a Laurillardian CAL Design Method" was presented, discussing design methods for Computer Assisted Learning (CAL) and proposed that existing methods were based on out-of-date educational models. The paper suggested that a more suitable educational model was Laurillard's Conversational Framework. The paper then described how the model was being used to help develop a new CAL design method. This current paper discusses how the new design method was actually produced, what the new design method consists of, plan of evaluation for the method and presents preliminary evaluation results.

The Design Method in development

Schneiderman says that "Design is inherently creative and unpredictable." CAL design can be made less dependent on the particular skills and talents of a few artisans by applying some science to the design process, embodied in an explicit design process. As Schneiderman goes on to say "in every creative domain, there can also be discipline, refined techniques, wrong and right methods, and measures of success." In order to impose such a discipline, it was necessary to find some way to use Laurillard's conversational framework in an instructional design setting. The discipline comes from the imposition of the conversational framework on to a CAL design by the instructional designer. To make this a reality, it was necessary to work out when and how to use the conversational framework.

Traditional methods for capturing knowledge on the way activities, such as Instructional Design, are performed have relied on the use of observational techniques such as video recording or interviewing. Ethnographic studies common in anthropology and sociology research, combine passive observation with detailed interview data. However, since the basis for the CAL design method discussed in this paper, is an educational model that is not in established practice, these approaches to generating design methods are not possible. Scenarios have in the past been used in place of observational studies in such situations. A Scenario is "a narrative," "it is a description of context, which contains information about users, tasks and environments."

Jack Carroll says that scenarios can help to ensure that computer systems are "easy to learn/easy to use," that they "smoothly augment human activities." MacLean and McKerlie identified two distinct roles for scenarios.

1) Supporting the generation of design ideas.
2) Evaluating a proposed design.

This work adds a new use for scenarios –

3) Supporting development of new design methods.

Maclean & McKerlie call type 1) scenarios *enivisioner scenarios*. The fundamental idea behind the use of envisioner scenarios being that they "drive...and contribute to the evolving design.". Although scenarios have been used in the past to envision interactions with an implemented system, these statements seem also to apply to the creation of a design method.

The Design Method

The design method has been named *"The Practical Design Method"* due to its practical nature. The method is currently paper based and contains the following documents.

1. **The Teaching and Learning model**
   The Practical Design Method is based on the Conversational Framework developed by Diana Laurillard. The framework is described and shown how it is used in the Practical Design Method.
2. **Cost and Time issues**
   Cost and Time are extremely important issues when developing CAL. This section highlights these issues.
3. **Aims and Objectives**
   The starting point for any design is to state the aims and objectives of your intended CAL. This section explains how to write aims and objectives.
4. **Activity Implementation Chart**
   The Activity Implementation Chart provides the designer with textual descriptions of how activities from the Conversational Framework could be implemented dependent on the teaching mode chosen. The teaching mode can be human, computer or some other means e.g. via a book.
5. **CAL Case Studies**
   The Case Studies illustrate via screenshots how activities in the Conversational Framework have been implemented in existing CAL packages, providing the designer with some ideas on how to implement the activities in their own systems.
6. **The Design Method**
   A step by step guide to implementing CAL into your curriculum referring and using the other sections of the Practical Design Method Document.
7. **Design Templates**
   The method comes with a series of blank templates which the designer completes to document their design.

Evaluation of Design Method

In order to evaluate the proposition that the Practical Design Method enhances CAL design, a number of evaluations are being conducted. The evaluation techniques used come from the domain of interactive systems. A mixture of qualitative and quantitative evaluation methods are being used. A series of case study evaluations are being conducted with academic designers of CAL systems. Prompted interviews have been conducted with the designer to provide some formative feedback on the design method. Formal questionnaires have been designed for the academic designer to complete when they have reached the end of their CAL design. Quantitative design experiments are also planned to provide further evidence that the Practical Design Method has improved the CAL design.

Interim Evaluation Results

Designers from a number of academic disciplines are using the design method to design their CAL packages and associated materials. Initial interviews with developers have indicated positive experiences using the method and designers believe it is enhancing their design. The evaluations of the design method are continuing. The results of these evaluations will help to identify any difficulties designers had using the Practical Design Method and help fine tune and improve the design method.

THE ENCYCLOPEDIA OF INGREDIENTS: DEVELOPMENT AND IMPLEMENTATION

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THE PURPOSE OF THE MULTIMEDIA ENCYCLOPEDIA

Vegetables, Module 1 of the *Encyclopedia of Ingredients*, is the introductory volume in a series on ingredients generally used in the preparation of foods. Good eating and good cooking depend on the knowledge of ingredients and how to use them. Learning about these raw materials takes time and study and, in some cases, years of training. Yet, in this multimedia encyclopedia, vegetables as ingredients are graphically illustrated and described in detail, providing the learner with extensive information, not found in any other single resource.

The intent was to compile an information resource (along the lines of an encyclopedia) on vegetables available on both local and international markets. Although this information resource was initially aimed to become part of the training materials for the instruction of under graduate learners, secondary education learners and as a tool in the food industry, the following categories of users of the multimedia encyclopedia are envisaged: both under graduate residential and distance-education learners from the Departments of Home Economics, learners enrolled in various food-related courses at technicons, cookery schools and informal training institutions; food technologists, recipe developers, cuisine writers; caterers, buyers and marketers of food lines in commerce.

A TEAM APPROACH

The subject expert and educational practitioner, Seugnet Blignaut, initiated the program and the idea was proposed to the Unit for Educational Technology (now the Unit for Telematic Education), University of Pretoria. After the preliminary design of the concept for the multimedia encyclopedia, it was decided to use a team approach for the design, development and implementation. The instructional authoring task was allocated to El-Marie Mostert and the other stakeholders for this project, as indicated in the following section, were identi fied.

EDUCATIONAL PRACTITIONER

Two post graduate students from the Department of Home Economics, under the supervision of the educational practitioner, researched, gathered, and categorized the contextual aspects to be addressed in the encyclopedia, namely the identification, classification, selection, preparation, seasonal availability, storing, processing and nutritional value of vegetables. After this the subject expert evaluated and expanded the content where necessary.

INSTRUCTIONAL AUTHOR

The graphical screen layout was authored mainly on-screen using the *Quest Net Plus* multimedia authoring system. The educational practitioner and the instructional author worked closely together on a weekly basis. A graphical artist was engaged to operate in conjunction with the instructional author and educational practitioner in designing an appropriate look pertaining to the contextual aspects of vegetables and general feel of the contextual contents. The result of this collaboration, after much iteration, was the choice of an unusual green background with contrasting red navigation buttons. Although this color combination generally signals red in terms of colorblindness, no negative feedback from a wide variety of users was encountered. An additional task of the graphical artist was the scanning and preparation of the numerous graphics included in the multimedia encyclopedia. It was the total commitment of all the parties concerned that enabled the successful completion of the project. The importance of perpetual interaction between the subject expert and the instructional author of an multimedia application of this nature should be emphasized.

CHARACTERISTICS OF THE MULTIMEDIA ENCYCLOPEDIA

The main features of the multimedia encyclopedia can be described as an interactive interface with navigation buttons, enabling the learner to retrieve information regarding the description, shelf life, seasonal availability, variety, history, buying, preparation, nutritive value and processing of a large variety of local and internationally available vegetables. A search pertaining to individual vegetables can be undertaken by means of a variety of mechanisms, e.g. selecting a vegetable alphabetically by name, by typing in the name, by category, the season of availability, type of food processing and by nutritive value.

The emphasis in the multimedia encyclopedia is on the retrieval and processing of information. As there are many advantages to the use of database-type applications, learners may become disorientated within the vast amount of information whilst executing mindless search operations. Although the multimedia encyclopedia can be used as a stand-alone application, a worksheet was developed to assist both the educational practitioner and the learners to plan and facilitate effective learning.

IMPLEMENTATION OF THE MULTIMEDIA ENCYCLOPEDIA

The multimedia encyclopedia was implemented in the learning program of an introductory foods subject course (Foods 210) pertaining to the Home Economics, Dietetics and Food Service Management fields of study. The learners from two different programs, namely the residential-learner program (from the traditional population of the University of Pretoria) and the distance education learner program (from the previously disadvantaged communities), were enlisted for this mentioned subject course. The learners accessed the multimedia encyclopedia by means of a computer network. This proved not to be ideal, as twenty, or more students, simultaneously attempting to access the multimedia encyclopedia, caused severe overloading of the network.

EVALUATION OF THE MULTIMEDIA ENCYCLOPEDIA

Formative evaluation of the program was undertaken by four groups, namely (1) three instructional designers from the Unit for Educational Technology not involved in the project, (2) external education practitioners, engaged by The Institute for Educational Media of the South African Association for Research Development in Higher Education's multimedia competition, (3) the residential-learner group, and (4) the distance-learner group. The program was accepted favorably by both groups of instructional designers and educational practitioners. Within this limited scope, and due to the significance, only the crucial points of critiques will be elucidated, as these problem areas should be addressed in the designing and authoring of *Vegetables Version 2* [Table 1].

POINTS OF CRITIQUE	RECOMMENDATIONS
Lack of interaction	♦ Enable cut, copy and paste functions of both text and graphics
Lack of student control	♦ Improve means of navigation throughout the multimedia encyclopedia

TABLE 1: IMPORTANT POINTS OF CRITIQUE AND RECOMMENDATIONS REGARDING THE FORMATIVE EVALUATION OF THE MULTIMEDIA ENCYCLOPEDIA

Both learner groups were positive in their appraisal of the encyclopedia and many expressed the desire to own a copy to use at home or in the place of work. Numerous learners indicated their frustrations regarding the inadequate means of navigation and the lack of speed of the application when accessed from the computer network.

SUMMARY

Sequential development pertaining to these critiques has already been instigated. Some improvements to the mechanism of effective navigation through the encyclopedia is relatively easy to perform (e.g. the numbering of consecutive screens), and a "home button" can be added without much difficulty. However, providing learners with meaningful procedures for the exploration of information (e.g. Boolean searches), and locus of control pertaining to its retrieval and processing, proves to be more difficult. Assistance concerning this will be requested from the programmers of the authoring system used in the compilation of the multimedia encyclopedia.

Approaches to Integrating Pedagogy and Multimedia: An Expanded Definition of API

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Introduction

Improving the design of learning environments is complex. As the boundary between teachers and students is altered by multiple technologies, evaluations of interactions become more intricate. Methods developed by computer science for complex design may be useful.

Computer science defines an API as an Application Program Interface: a collection of formats for connecting disparate pieces of software. The use of this convention enables programs which were not initially designed as integrated components of a single system to be dynamically linked into functional combinations. An additional effect of this convention is that systems become more flexible. Changes made to various individual components can be more easily synchronized. Thus APIs extend the range of *ad hoc* systems, creating a single consistent interface rather than a set of incompatible and inconsistent functions.

Are there similar conventions for a Pedagogical Interface? Are the separate components of an education system consistent in their instructional goals? Do students experience a single interface, a consistent boundary layer, between themselves and the objects of instruction: teachers, textbooks, and media. Or does pedagogy appear to fluctuate inadvertently? Are academic goals and objectives reinforced in a comparable way by each component of the education system? As educational complexity increases, what heuristics exist for the integration of media and pedagogy into a coherent organic entity?

This paper will argue that, despite the complexity of systematically defining the entire model of pedagogy, a formal interface definition enables a specific environment to be more flexibly designed and evaluated. The use of an API can help identify significant variables. This process can be extended to form guidelines for coordinating changes in academic systems as increased technology use occurs over time. Systematic transformation —maintenance of a coherent pedagogy — may be the most important factor of the student–instruction–technology interface. Thus, congruent modification of teaching methods, textbooks, and media, may be more significant for learning improvement than a major change in any single artifact.

The Value of the API Metaphor

Although the meticulous vocabulary of computer science may seem inappropriate to an organic taxonomy of education, two advantages can be derived from the use of the API metaphor: a methodology for defining complex relationships can be initially implemented as a few variables at each contact layer (e.g. the student–instructor layer, student–student layer, student–technology layer, instructor–technology layer, etc.); the process of formalizing the structure of each of these boundaries improves awareness of the potential redefinition of pedagogy afforded by new modes of interaction. (i.e. if multimedia presentations assume a more central role in some instructional environments, the pedagogical side effects may become more obvious when the interactions are quantified.)

Clearly, the full implementation of such a scheme is overwhelming. Indeed, within the computer industry, arduous discussions by multiple software designers were needed to formalize API agreements. Initial program development time was often increased by using these techniques. Some programs were more complex to write this way. However, the authentic benefits created by published standards made it possible for anyone to integrate his/her work into an existing context. The academic community may benefit from similar conventions for the harmonious use of multimedia artifacts within diverse pedagogy. An evolving new API — the Adaptable Pedagogical Interface — seems valuable.

API Incentives: Distance Learning; Multimedia Tools

Increasingly, adult education is becoming asynchronous. Although the essential goals of the curriculum may remain constant, distance education and interactive learning systems may alter some essential forms of pedagogy. Several subtle changes not easily measured by current evaluation techniques influence the nature of student–teacher interactions. For example, a classroom assumes synchronized learning; Internet access, although occasionally synchronous, is primarily a method to offset time and space constraints.

Many changes of this type appear to represent movement away from a traditional teacher–centered role toward an environment in which virtually all information is mediated by computer. Although the use of technology does not inherently remove the teacher as the central focus of instruction, collateral tendencies to use computer systems as a repository for lesson plans, handouts, presentations, student work, and customized curricular material from other sources, mean that much information exchange occurs *through* a computer, and can often occur asynchronously.

The apparent effects of computer based exercises and collaborative learning techniques have relegated teachers from "the Sage on The Stage" to "the Guide on the Side." Indeed, one of the primary goals of this API methodology is to formalize what interactivity occurs at which level in terms of time, objective, and function. Such a perspective acknowledges a migration toward a technology mediated knowledge infrastructure, but seeks to avoid a belief that technology *per se* will improve instruction.

Just as the use of an API convention in the computer industry forced clear answers to questions which had traditionally been proprietary and ambiguous, the use of an Adaptable Pedagogical Interface will provide a clear definition of an iterative model of improvements in technology tools and encourage more rigorous answers to the following types of question:

Clarify how much *tool expertise* is required for teacher and student. Encourage the development of a *property list* for all objects in the learning system. Enable evaluation of hours of contact / interface by object. Document the focus of presentation / activity / reflection by object. Automate standard record keeping processes. Compute statistics which correlate learning gains with significant variables. Provide for consistent evaluation of data across environments. Provide for migration of data across classes.

Challenges:

Innovation has traditionally meant the adoption of new technology — the mechanical processes of the industrial revolution. Yet, education is not a mechanical process, rather organic responsiveness to interplay within dynamic learning environments. Part of the advocacy of an API for education is not in its potential value as a method of quantification. Rather its primary value may be as a stimulus for thought experiments:

How do we quantify the time, place and mode in which learning *really* occurs? (i.e. immediate measurable results vs. long term concept maturation.) What method correlates the observable rigor of test scores with the anecdotal evidence of the shortcomings of technology. Is the conceptual scaffolding of computer assisted instruction comparable to the mentoring of a human assistant? How different are these variables?

The supposition of this paper is that the development and attempted application of this API methodology will provide a framework to bridge the qualitative ethnography of observation with the quantification of objective metrics. The proposed API, as applied to a specific controlled environment, may provide both an extensible container for quantifiable results and a focus for the larger questions raised by the increased infusion of technology into education.

Facilitating Graduate Nurses' Transition into the Workforce with Interactive Multimedia

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Instructional problem

Current practices in the preparation of nursing students for a successful transition into the workplace is reported as being ineffective. Meanwhile, the Graduate Nursing and Preceptor Programs offered by the hospitals to facilitate the transition of graduate nurses into the workplace are under tremendous strain. It has been suggested that in order to prepare better nursing graduates for the challenges of the workplace, there must be improved collaboration between the employing organizations and the Universities which offer Nursing education programs.

Instructional solution

In attempting to address this need, we developed a learning environment which sought to present critical aspects of workplace-related issues in an interactive multimedia format for use by final year nursing students and graduate nurses on entering the workforce. The material presented on the CD-ROM attempts to simulate the complexities of life in a typical hospital, and in so doing making the education of graduate nurses and students case-based and authentic.

Learning activities incorporated in the courseware require users to make decisions about the best course of action, and source of information regarding each case or problem. Users are also able to discuss the cases presented to them in the multimedia environment and reflect on how they might have addressed the situation. This learning architecture reflects a situated cognitive model of learning where students and graduating nurses are coached in the development of their strategies for recognizing learning opportunities and critical thinking with the help of authentic cases.

We have not recommended throwing out all the textbooks and abandoning students in a welter of diverse information sources presented in this multimedia environment. On the contrary, we suggest leading students very carefully through unstructured problem situations from multiple perspectives and sources of information, providing careful instructional feedback, not only on content mastery but also on the skills of information-processing, critical thinking, and clinical decision-making.

Theoretical foundations

This project follows from the premise that if we are to prepare better nursing students and also graduating nurses for the challenges of the contemporary workplace, we must shift our focus from a content-centered to a problem-centered and case-based approach. A problem-centered and case-based approach to teaching and learning is underwritten by a "situated cognitive" model of learning, the primary propositions of which, as outlined by Savery and Duffy (1995) are as follows:

- knowledge evolves through social negotiation;
- understanding is gained through our interactions with authentic cases and *in situ*;
- cognitive conflict is the stimulus for learning, and also determines the organization and nature of what is learned.

One of the best architectures reflecting this approach to learning is *Problem Based Learning* (Barrows, H. S., 1994, Barrows, H. S., & Tamblyn, R., 1980). In this multimedia learning environment problem based learning and case based reasoning is used to improve current instructional practices in the education of nurses for their transition into the workplace (see Figure 1 below).

Implications for advances in learning

This project proceeded from the realization that current practices in the preparation of nursing students' successful transition to the workplace upon graduation are ineffective and deficient. Moreover, it was of the view that more of the same kind of education was not going to be very useful and argued for a radical shift in the approach to this component of nursing education. A shift which would combine powerful educational technologies and proven learning strategies to build a technology enhanced learning environment. This environment is innovative in two ways. First, it integrates powerful technology with problem based learning and case based reasoning in an integrated learning environment. This adds to the currently burgeoning enthusiasm in the use of interactive multimedia for enhancing learning and teaching effectiveness. Secondly, it comprises a significant shift away from current practices of teaching and learning towards one that is problem-and case-based. In this environment student assessment is situation-specific and as such authentic.

Figure 1: Technology Enhanced Case-Based Reasoning

<table>
<tr><td colspan="3">• Learners encounter cases/problem situations as they enter the learning environment.
• They explore cases/problems at two "case conferences" in the multimedia environment.
• Their goal in this environment is to develop an action plan for managing the patient situation.</td></tr>
<tr><td colspan="3">Phase I: Case encounter</td></tr>
<tr><td colspan="3">• Learners encounter the case at handover where they are explained its history and pathology.
• Their goal in the simulation is to develop an action plan for managing the situation in the given case.
• Their success is measured by reports they receive from their supervisors and peers .</td></tr>
<tr><td colspan="3">Phase II: Reflecting at case conference I</td></tr>
<tr><td>Becoming aware</td><td>Seeking solutions</td><td>Making decisions</td></tr>
<tr><td>Learners listen to the stories and experiences of expert practitioners.</td><td>They ask experts questions about their work experiences.</td><td>Learners develop a tentative action plan for feedback from supervisors.</td></tr>
<tr><td colspan="3">Phase III: Reflecting at case conference II</td></tr>
<tr><td>Raising issues</td><td>Seeking solutions</td><td>Making decisions</td></tr>
<tr><td>Learners explore new and related issues to the problem by reviewing sources of information.</td><td>They ask experts additional questions about their work experiences.</td><td>Learners develop their final action plan to submit to their supervisors to receive feedback.</td></tr>
<tr><td colspan="3">Phase IV: Developing an action plan</td></tr>
<tr><td colspan="3">• In this phase learners have their action plans accepted by supervisors and receive feedback on their decision making.</td></tr>
</table>

Development

The development of this interactive multimedia courseware product adopted a *user-oriented* approach (Goodyear, 1995) which comprises ongoing testing and formative evaluation of the prototype by experts in multimedia courseware development, content experts and a selected sample of intended users. This multimedia environment is being developed using Asymetrix's Multimedia Toolbook™, a quasi-object-oriented, event-driven development system for Microsoft Windows™. Toolbook™ combines database functionality, text manipulation, hypertext, drawing capabilities as well as a full-featured programming language called OpenScript™ which allows the developer to program object behavior. Toolbook™ offers all the advantages of a prototyping tool and is best suited in projects where user initiated changes need to be made during the development process. This prototype is currently undergoing a series of iterations of progressive development. The highly modular nature of object-oriented programming allows the developer to test each object and its behavioral characteristics.

Evaluation

Our approach to the monitoring and evaluation of the outcomes of this project is utilization focussed. As such our focus is on the use and utility of the instructional innovation for nursing students, their lecturers, graduate nurses, and other stakeholders such as the employing institutions. Formative evaluation of the courseware prototype has been carried out in a semi-structured format with individuals and small groups of people in the Multimedia Education Unit at University of Melbourne, the Department of Information Systems, Faculty of Sciences at The University of Southern Queensland, and clinical staff at St Vincent's Hospital in Toowoomba, Queensland. Comments from these sessions were noted and analyzed. Modifications and enhancements to the multimedia prototype were made on the basis of consensus from such feedback. Major modifications were carefully examined and before implementation, additional advice was sought from content experts. Final evaluation of this multimedia learning environment will involve focus groups and questionnaires to ascertain user perceptions of the efficacy of such a product.

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Faculty Development and Distance Education

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Introduction

The Information Age has provided abundant opportunities for the expansion of traditional education programs for many institutions. Distance education technologies that enhance the dissemination of knowledge are continually improving in capabilities and becoming more affordable. The new technologies have provided instructors with the technologies necessary to reach new student populations and expose traditional students to new peer groups. Distance delivery technologies have enabled the dissemination of educational opportunities to student groups who were previously geographically isolated. Although many institutions have jumped on the distance education bandwagon by purchasing the technologies necessary for distance education, few have provided for the necessary associated faculty development opportunities as an essential part of the distance education process. Faculty desiring or required to teach via distance delivery are often forced to "learn-by-doing." This method is difficult for the faculty, unfair to the students, and may be contrary to the educational mission of most institutions. In order for distance delivery to contribute to the effective education of new target populations, faculty must be trained in the use of the technologies and educated in the ramifications of the technologies for them and their students.

Course Dynamics

Distance education courses utilize technologies that are so integral to the course that they influence the course content itself. The type of technology used, lecture style, length of lecture, construction of class discussion or roundtable, type of assignment, and mode of testing can all be influenced. Knowledge of this influence is necessary in order to construct a syllabus that will work effectively, making the mode of communication a more basic part of the course structure. Without an understanding of the technology involved, the mode of communication itself becomes a hindrance to not only the classroom, but to the actual dissemination of knowledge itself.

There is some debate in the university setting concerning the adequacy of using teaching assistants to teach courses. The teaching assistant generally has an undergraduate degree in some field with little or no teaching experience, but is equipped with a teacher's manual. Asking an instructor to deliver a distance education course with essentially no training on the equipment is analogous to the teaching assistant dilemma. To effectively deliver a class via distance technology, the instructor must have both knowledge in the field being taught and knowledge about the technology being utilized. A non-trained distance education teacher may feel that he or she is being required to teach a course in a new field with only a teacher's manual and text in hand, trying to keep at least one class period ahead of the students. In addition, there are added feeling of inadequacy when the inexperience becomes obvious to the students, possibly lowering student confidence in the instructor's abilities. There is little question that this situation compromises not only the use of distance education, but the quality of the course as well.

Group Dynamics

Group dynamics are definitely impacted in a distance delivered class. For example, in a course offered via interactive video, the class "group" is generally at least two separate groups attempting to merge into one. The primary group is that which is physically with the instructor. The secondary group is that which perceptually resides in the television. Every group develops what is known as *boundary perception*. This basic phenomenon is the ability to determine who is and is not a part of the group, and is essential to the survival of the group. This perceptual division of the local and remote groups must somehow be eliminated or at least minimized to ensure effective progress in the class. The instructor needs to encourage this merging through activities and assignments in the beginning of the semester. This is difficult for the untrained faculty member to accomplish. Specific methods can be presented during faculty development to facilitate the merging of the groups.

The second area of impact regarding human interaction deals with the lack of flowing visual interaction between the groups. Although the vocal aspects of interaction via distance delivery are frequently in "real-time," allowing all students to hear what is happening as it occurs, the visual is frequently absent or involves data compression that differs significantly from face-to-face interaction. The greatest area of impact rests in turn-taking behaviors. The way an individual knows that it is his or her turn to speak in a conversation is through pause time, eye contact changes, altering the tonal pattern of the voice, and posture adjustment. Although the students can note the pause time and tonal differences in an interactive video setting, the eye contact and posture adjustment are not easily read.

As people feel uncomfortable when the pause time becomes too long in a conversation, someone will generally take over to break the pause. In the televised situation, those students in the secondary group are not given the eye contact or posture adjustment cues to read, thereby increasing the chance of the primary group monopolizing the interaction. The students in the secondary group will especially not want to interrupt or seem rude when the class is first beginning, encouraging the pattern to develop and carry through the duration of the course. The students in the primary group will be quite focused on the instructor and each other, reducing the chance that they will look to the television to try and read the other group's members to see if they have something to say. The instructor also must make an effort to specifically ask questions of the secondary group to ensure that their questions are answered, as well as to draw them into the discussion. Faculty development can address these issues to ensure that the faculty member is adequately prepared to handle these situations and facilitate meaningful interaction between groups.

Conclusion

The process of distance education has been studied and is being studied in depth. The focus is generally on improving the technologies rather than enhancing the capabilities of the instructors through formalized faculty development programs. Faculty development needs to be approached in a proactive manner with faculty learning prior to presenting a course via distance delivery, rather than solving problems associated with distance delivery in a reactive manner at the expense of the students and the faculty member. Key areas that need to be addressed in the training include use of the technology and the effects that the technology have on course dynamics and group dynamics. Careful planning for faculty development can enhance the experience for the faculty member and the students, thereby increasing the likelihood of continued effective interaction.

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An Online Digital Photography Course For High School Teachers

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1. Introduction

This report describes our experience designing and conducting two online digital photography courses for high school teachers while we were researchers with the Apple Classrooms of Tomorrow (ACOT) program and the Knowledge Management Technologies group at Apple Computer, Inc. The aim of the course was to enable teachers to incorporate new photography technologies into their classrooms effectively and explore tools and activities that advance the Internet's potential for online staff development.

2. Background

In previous research, we had studied a digital photography class at Lincoln High School in San Jose, California. We were impressed with the way sophisticated technology was being used in a high school classroom to great effect (Nardi and Reilly, 1996a, 1996b) in an ethnically and socioeconomically diverse school. The students enjoyed creating digital photos and learned about both art and computers. Computers need to be effectively integrated into the curriculum to be interesting and useful to students, and at Lincoln High, the digital photography class was an art class that used computers. The students were taught about composition, color, lighting, and other general principles of photography. They also learned skills peculiar to digital photography such as manipulating and blending images, but the focus was always on the art.

Many teachers would like to offer digital photography to their students but they don't quite know how to get started, or they may feel isolated if they are the only one in their school with such an interest. To meet these needs, we decided to design an online course in digital photography for high school teachers. We hoped this would be an effective way to reach teachers and give them access to others with shared interests.

3. Course Design and Implementation

The development of the course was a natural extension of our research model of working intensively with end users. After we had learned so much about digital photography in the ethnographic work at Lincoln, and recognized the need for education for high school teachers, the CD-ROM—created to document the classroom experience at Lincoln—became a tool in the next phase of our research. We built the online course on the scaffolding of our in-depth experience in a school as documented in the CD-ROM.

We hired a high school teacher from San Jose who teaches digital photography and whom we had worked with in the past to plan the curriculum and conduct the first course. The second course was taught by two students from the first course. We also provided the Web-based learning environment. From a research point of view, we wanted to learn whether simple tools such as chat and bulletin boards could be used effectively for staff development.

Each course ran for eight weeks and involved six assignments that had been adapted from the classroom digital photography course previously taught by the instructor (such as colorizing and manipulation). The demand for the courses was overwhelming. The first time we had 150 applications and the second time 304 (with little advertising). We were able to accommodate 15 students in the first course and 25 in the second course. One issue we tried to address through the assignments and our choice of participants was the balance between a tool emphasis (Adobe Photoshop) and a digital photography emphasis. We deliberately chose applicants who mentioned how they would apply digital photography with their students and avoided applicants who expressed an interest in learning Photoshop. We tried to steer the assignments towards photography and away from just learning the tools.

4. Web-Based Learning Environment

ACOTNet, the Web-based learning environment that was used as the vehicle for the courses, included a regular password-protected Web space that contained course content (syllabus, resources, chat transcripts, links to other Web sites); an asynchronous online conferencing system enabling course participants to post their reflections on weekly assignments, include their images, and let others read and respond to these messages at any time; and a text-based chat application with the ability to dynamically share images, documents, URLs, video and audio in a freeform work space or canvas (shared documents or images could be seen immediately by everyone participating in the live chat session).

5. Course Evaluation

What we learned, in a nutshell, was that the simple constellation of online tools we used for the course—chat, bulletin boards, email, and Web pages—worked very well to create a community of high school teachers interested in digital photography. Many online courses use the distance learning model of instruction in which content is delivered to students and they use the Internet to discuss their work and meet with an instructor and other students (Collis, 1996). We took a somewhat different approach. Rather than focus on the instructional aspects of the course and attempt to recreate the classroom experience, we decided to emphasize the differences that an online course can bring to the learning experience, especially the possibility of developing a sense of community in which sharing ideas and enthusiasms with others is the key focus.

Initially, we hoped that the postings of each student's work as well as their reflections and comments would be the key feature, which would help form a learning community among the participants. We were skeptical of the whole idea of chat based on personal experiences and even considered using chat only on a limited basis. Much to our surprise, the weekly chat became the central event each week. After the third or fourth week of the course, the students were arriving early and staying late at the chats. By the end of the course, many of the students were so attached to the chats that they asked to use the chat room on their own and continued to meet for several weeks, at which point they wrote a proposal to continue their online course experience by creating their own web pages on the ACOTNet server.

Students enjoyed most of the assignments, but were particularly enthusiastic about the last one, which involved collaborating via the Internet on a collage with another participant in the course. Here, the students shared images via email, discussed their plans using email and chat, and produced either a single image or variations based on the same set of images. One of the most exciting tools that was used in the second course was the chat application with integrated canvas. The participants immediately recognized the potential of such a tool for real collaboration over the Web.

While many participants mentioned the technical problems they encountered with the chat and discussion software, those who completed the courses were generally excited about their experience. The final assignment, which involved collaborating via the Web with at least one other student in the course, was mentioned as a particularly stimulating and challenging in several evaluations. While participants enjoyed the collaborative assignment and the way it helped them get to know others in the course, it was the last assignment, and as a result, the value of the community building that took place was short-lived. In the second course, we incorporated some suggestions to speed up the process of participants getting to know one another. These included requiring a personal web page as the first assignment (optional in the first course and done by only one student), structuring the way students comment on other students' work so that everyone's work will be reviewed each week, and splitting the class into smaller groups for two chats per week.

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Issues in the Development and Delivery of Distance Learning Classes

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Abstract: We are investigating the use of collaborative technologies, including intranets, email, audio- and videoconferencing, chats, NetMeeting, Virtual Places, and WorldsAway, to teach classes to geographically-dispersed participants. We have found that the use of multiple technologies provide an effective alternative to face-to-face instruction with rich communication and a strong sense of community. However, the use of each technology was far more complex than we had imagined at the outset. There were striking differences b e-tween distance learning and face-to-face classes including instructor preparation and le c-ture style, student interactions, and the importance of establishing protocols. We are e x-panding our investigations by developing entirely asynchronous distance learning classes.

1. Introduction

Corporate education programs are searching for ways to reduce the cost and increase the availability of education. At EDS, we taught classes on Emerging Technologies in Human-Computer Interaction (HCI) and Emerging Technologies in Collaborative Environments to EDS employees globally. Delivery technologies were selected based on cost, availability, and perceived or hoped-for (at least in the first delivery) effectiveness, and were matched to objectives in order to select and deploy the most appropriate technology for each class meeting. Feedback was used to make adjustments to the type and mix of technologies used. In the process of planning, delivering, and evaluating the classes, we learned how to match tasks to technologies and the subtleties of the technologies employed. In planning subsequent classes we incorporated many of these lessons.

2. Class Structure, Topics, And Students

The courses were structured as a four-week instructor-led seminar with guest speakers and student research projects. Guest speakers were able to lecture or lead discussions without being constrained by location. Students juggled work and class commitments. Class sessions were typically three times a week for 2 - 2 1/2 hours, which seemed to be an appropriate length of time for the students to fit into their work schedules. Extensive evaluations were conducted at the end of each class, and informal evaluations were done during the classes.

Four Emerging Technologies in HCI and Emerging Technologies in Collaborative Environments distance learning classes were taught to date by the author to approximately 80 students. These classes were interspersed with on-site face-to-face classes, which offered the author a reminder of the many differences between the two situations. Students in the distance learning classes were in many countries; the only problem we experienced delivering a class to international students was the narrower window in which classes could meet due to different time zones. Many of the enrolled students in the distance learning classes would not have been able to participate in a multiple-day class due to work commitments or travel costs.

3. Distance Learning Technologies

A variety of technologies are currently being used to replace or supplement the face-to-face classroom [1]. EDS was attracted to a hybrid approach based on the Open University's success [2]. We chose not to strictly imitate the Open University's approach since we had more distance learning methodologies available at EDS than the Open University instructors had at their disposal.

Of the technologies available at EDS, videoconferencing, audioconferencing, and a variety of Internet-based conferencing tools were selected based on cost, availability to participants, appropriateness for the course structure, and their potential to provide an interactive virtual classroom. A Web site was built that included the class schedule, syllabus, evaluation forms, RealAudio and text transcripts from class meetings, student projects, and student biographies. The initial Web site led to the development of a Virtual University, which was the repository of the materials classes and provided information not only to enrolled students but to other employees as well.

The technologies we selected varied in how easy they were to use, how comfortable their use was for the instructor and students, and the learning situation which they best facilitated. We discovered that protocols had to be established for each technology, and that the instructor played a key role in establishing and enforcing the use of protocols.

Problems with the use of individual technologies led to the combining of audioconferencing with Internet-based technologies in order to have high quality audio along with visual information and chats. Tools that were used included Virtual Places, a hybrid IRC/virtual world, which was useful for the expressiveness of the avatars, for the web-based information that could be displayed, and for the "tour buses" that avatars could "ride" to visit Web sites together. NetMeeting was added for application sharing, the electronic whiteboard, and chat; the audio and video components were not heavily used. A virtual world, WorldsAway, was used for class parties. Students gained further experience with these technologies in collaborations for projects, and many started to use the technologies during and after class as part of their work teams.

4. Conclusions

We found that the use of multiple technologies provided richer communication than any one technology alone. The use of the technologies proved, in itself, to be a valuable pedagogical experience. While none of the technologies provided the visual cues of face-to-face, the multiple technologies fostered a significant amount of interaction and students remained engaged during class sessions. The strength of the relationships students formed with the other students and the instructor is largely attributed to the mix of technologies, each of which fostered varied personal communication styles and allowed people's personalities and senses of humor to be apparent. The humor in some students' home pages and in their virtual world visits greatly increased their familiarity with each other. This led to better team projects and to the sense of community and networking that is typically a by-product of education and is especially important in a large organization [3].

Students were better able to fit classes into their work schedules when the classes required no travel and met over a longer duration with shorter sessions for each class meeting. Students reported that this schedule increased their retention of material and facilitated deeper exploration into materials since students were using their own open-ended time rather than being given a fixed block of time in the classroom for exercises and readings.

From the instructor perspective, class preparations were more time-consuming and complex than anticipated at the outset or than required for classroom teaching. Delivery was compounded by the challenges of managing technology and the greater difficulty of facilitating interactions without visual cues. It is also challenging for the student to absorb information given the abundant distractions in their office or home when taking a class..

We are now investigating the development and delivery of asynchronous distance learning classes. We are discovering the significant differences between the development of asynchronous and synchronous distance learning classes.

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Managing Self-Directed Learning in a CALL Environment

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1. Introduction

Two current concerns that language teachers have are promoting "how to learn" strategies and meeting diverse needs of learners. If we are to emphasize the importance of learner autonomy and learner diversity in our classrooms, we need to consider the possibility of designing an environment that allows learners be self-directed, that is, to manage their own learning.

The research on learner autonomy shows that learners who are actively involved and who take responsibility for their own learning process tend to develop a higher level of awareness of how to learn (Trim, 1996). At the same time, learning styles research also leads us to believe that instructional design that is aimed at meeting learners' different learning preferences helps enhance the learning process (Reid, 1995). It is no longer debatable that everyone learns differently, and the crucial issue about learning styles and autonomy is not merely about how well students learn, but how much support we can offer them in approaching learning. We believe that all language teachers should be entrusted with the obligation of helping students learn optimally, even while learning differently (Soo, 1998).

2. Principles of a Self-Directed Learning Environment

This paper discusses the design of an undergraduate ESL program in a Malaysian university where students and teachers collaborate to develop a computer-assisted language learning curriculum based on self-directed learning principles. These principles are created based on the theoretical bases of learner diversity and learner autonomy. The three principles are: (a) placing ownership, responsibility, and choice with the learners, by negotiating a learning contract between teachers and students; (b) catering to a variety of learning preferences, by exploiting a wider range of resources and learning options; and (c) driving motivation and self-efficacy in learning, by setting attainable and inspiring goals for the students.

This design is based on a learner-centered curriculum, where the teacher includes the students as far as possible in the planning and implementation of the language learning curriculum. For instance, there is continual negotiation of a learning contract concerning curricular demands and students' individual learning goals, and students are constantly encouraged to offer suggestions to enhance their learning conditions according to their learning preferences at different points of their learning process.

3. A Case in Point: The MCALL Project

This paper focuses on the design aspects of a self-directed learning environment in a study conducted to assess the effectiveness of multimedia computer-assisted language learning (MCALL) as compared to conventional teacher-taught classes (Soo and Ngeow, 1998). The experiment, which involved 188 ESL freshmen, took place at Universiti Malaysia Sarawak (Unimas), a university that was established in 1993.

Being a newly established university, Unimas had to deal with the problem of a mismatch between increasing numbers in student enrollment and resources that could not meet the demands of this increase, particularly in terms of teachers and room availability. The proposal to set up a multimedia computer-assisted language learning laboratory to offer self-access English classes attempted to deal with this problem.

To graduate from the university's ESL proficiency program, students were required to obtain a passing grade equivalent to 550 on the Test of English as a Foreign Language (TOEFL). When students first enrolled in the program, they took an entry test to determine their TOEFL scores and their corresponding proficiency level in the university's ESL program. Individual students consulted with a language teacher-manager to draw up a learning contract on individual learning goals and strategies. These strategies involved negotiating various aspects of the language learning process, for example, students' preferred times and pace of study, target levels of language achievement at various points of the semester, and types of activity involvement.

Following that, students enrolled in a multimedia computer-assisted language learning program that used the software, *English Language Learning Instruction System (ELLIS)* produced by CALI, Inc. (available at http://www.cali.com). The *ELLIS* software was a suitable program for use in a self-directed learning program because of its many features, among which are more than 200 hours of modularized video and audio clips of native-speaker interactions, students' self-checks and feedback on learning progress after completion of each language module, and modules that are set up to focus on either a grammatical or a communicative aspect of the interactions. In addition, students were given opportunities to learn from other resources such as reference materials and group discussions. The teacher-manager of the MCALL project also assigned advanced level proficiency students as mentors to groups of 5 - 6 students. The student-mentors acted as a liaison between the MCALL teacher-manager and the students, and were responsible for monitoring group members' progress and attendance records. When students completed their negotiated number of learning modules, they could then decide when they were ready to take the qualifying test for each proficiency level, and would do so after consultation with the teacher-manager about their learning progress. On attaining a level equivalent to 550 on the TOEFL, students were awarded a certificate of achievement. This certification of their language proficiency represented a significant indication of students' achievement as well as documentation of their proficiency level. Students with this certification could then move on with confidence to take higher-level language courses that are discipline-specific or job-related.

4. Implications

The implementation of self-directed learning within a multimedia computer-assisted language learning environment is significant for many reasons. With the increasing number of students enrolled in ESL programs in universities and community colleges, it is prudent and timely to consider alternatives to classroom language instruction that can provide students with optimal conditions and relevant resources for language learning. Students should not have to be reduced to a homogenous group by teachers who have neither the time nor the resources to cater to diverse learning preferences. In addition, putting students through a self-directed learning experience gives them the opportunity to view themselves as learners who are self-determined, decisive, and can be held responsible for their own learning – all of which are traits for the development of lifelong learning skills.

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DISTANCE EDUCATION and the WWW
"The Internet is being overhyped but underestimated"

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1. Distance Learning : Reasons for Change

The new social, professional and personal demands resulting from the fundamental changes introduced by the information society will have important repercussions for professional work and consequently for vocational and professional training at all levels.
This paper aims at giving an overview of the state of the art in distance learning and its recent evolution. Within this frame we will discuss the educational use of WWW, examining some theoretical and methodological aspects that seem to us of foremost importance.
Working students ought to be self-directed or autonomous and independent learners and are willing to take an increased degree of personal responsibility for their learning and working. Adult trainees like to be regarded as partners in the pedagogical process.
Open and Distance Learning are the adequate methodologies that promise greater effectiveness, more learner-centred approaches and better quality of interaction.
What we are seeing with these new learning environments is a transition from traditional models of training to completely new paradigms of learning, such as problem-solving and decision- making through the use of multimedia simulations.
This transition is technology-related.
Distance learning is changing for the following reasons:

-The economical and social contexts are different.
-The number of unemployed workers is increasing and the need to be retrained.
-Knowledge has become one of the most important economical forces.
-Knowledge is rapidly expanding and its life becoming increasingly shorter.
-Companies need to change to survive in the market.
-Investing in the human resources seem to be the only way for a sustainable development.

Distance Education evolution is due to all these changes and is considered as one of the most adequate and attractive means to face them.
We can say we are now in the third generation of Distance Learning but how can we justify this statement?
The terms first, second and third distance learning generations refer to three different models that are linked to the development of production, distribution and communication technologies.
The "first generation" is correspondence teaching, based in printed material in which trainee-trainer and trainer-trainee feedback processes are slow and sparse.
The "second generation" is called the multimedia distance teaching, developed since the late 1960's, integrating the use of print material, audio cassettes, videotape and to some degree computers. Feedback processes include telephone counselling and some face-to-face tutorials.
Communication with the trainees has been marginal and among trainees more or less non-existent. Because the technologies available up to now are one-way or two-way communication technologies but they are not yet interactive.
The "third generation" that we can call "Net/Web generation"is mainly on-line, highly interactive, supported by several on-line services.

2. Distance Learning, WWW and Communication Theory.

Communication and learning as a social process, will be the key elements in the conceptual development of the third generation models of Distance Learning. It is not possible to promote the notion of learning as a social process without access to interactive communication facilities.
So WWW appears as the implementation of the old utopian dream of the first theoreticians of communication theory among whom we find MacLuhan.
Networking enables asynchronous and synchronous communication among people wherever they may be and no matter when. It appears as a new concretization of the MacLuhan "global village"on a worldwide scale.
Jean Cloutier in his book "L'Ere d'Emerec" imagined the human being able to receive and to send messages as well. For him only self-media could improve both individual and social communication. WWW is a good example of self-media. Consultation of hypertexts on a screen incites the user to integrate reading and writing activity into one sole process.
The most important on-line facilities are:
-Electronic Mail
The advantages of e-mail are numerous: 24 hours a day accessible, easy to access, location/time independent, free open-entry and open-exit , private learning, group messages (trainees and trainers can send information), private messages and so on.
-Computer Conference
Individual trainees can join conferences on specific subjects of interest. It is asynchronous too, participants are not obliged to be present and active at the same time.
-On-line databases
Information can be stored in databases on the same host computer which is used for e-mail or computer conference system. So it is used for electronic mail or computer conferencing and it is more economic than traditional information sources.

3. Main Issues and Ideas

3.1 Educational Content for the Web

It is clear that instructional designers and distance educators can add value to technology-based training and it is particular true in what concerns the design of the learning environment specially content, that requires certain pedagogical characteristics, including facilities for: - dialogue between trainee and materials (information); between trainee and content author (tutor), between trainee and trainees, always providing feedback.
Another aspect deals with providing multiple access points to information on the Web and different ways of navigating in this medium, what makes content relevant and accessible.
As for narrative, the Web is problematic because its key features are linearity, temporality and causality), while the Web is non-linear, non-temporal and does not afford explicit representations of causality. So in narrative texts designers need to: keep hyperlinks to a minimum; avoid breaking texts down; employ media elements that can enhance or help narrative and avoid embedding interactive tasks into narrative texts.
The most successful application areas of Web training are: Communication - Research and Problem Solving.
There are different kinds of computational learning environments that can be used:
Programmed Instruction; Computer Assisted Instruction, Intelligent Computer Assisted Instruction, Cognitive Learning and Knowledge Construction among others.
The trainee must be active and interactive; the learning environment must be rich, complex and structured.

3.2 Delivering Instruction on the Web

The WWW emerges in Internet as the easiest and most popular way to access and its possibilities for training are boundless.
WWW-based courseware must not restrict itself to delivery of educational content. It must be based in some model of instruction and learning.
Why to use the Web?
It represents a new way of looking at instruction - at how it is organised and presented. It is simultaneously a delivery medium, content provider and subject matter.

When to use the Web?
The Web uses text, graphics, interactively and to a lesser extent video and audio.
It is most useful when used to explore intellectual and verbal knowledge and to a lesser extend when exploring affective learning. Due to its versatility and interconnectedness it offers one of the most effective ways to work with trainees who are spread geographically and it it is easy to update to meet the needs of changing subject matter.
The Net has two real advantages over other media. The first one is due to the fact that it conveys video and sound what a book does not, is more interactive than a videotape and unlike the CD-ROM it links people from all over the world cheaply. The second one is that it can also be a content provider and it is the largest and most complete information resource.
In what concerns the trainees and tutors they can interact with the learning materials
There are two main types of delivery: printed delivery - here the trainee decides to print out the course or part of it and interactive delivery - the trainee studies the materials from the screen interactively.

3.3 Conclusions

To achieve the most cost-effective use of the Web major changes are required in the institutions. There is a need for re-structure and for open and distance educators to re-think and re-define their roles.
"Change will be neither swift nor easy" and many educational leaders are not aware of it, while many users are rigid in their attitudes to use new technologies.
Restructuring with technology involves a shift to learner-centred instruction, cooperative learning for trainees and collaborative efforts for tutors.
The question is no longer how to use the Web to do the same thing better , but to change practice to reach new goals as a tool in creating, implementing, managing and communicating a new conception of training and learning, as well as a system to support it.
We are dealing with a new medium so we must need some humility and to up-grade our skills because it is changing very rapidly and it is almost impossible to keep up.
Global Web based courseware involves adequate content design and delivery of instructional material structured according to some pedagogical and learning strategies.
To sum up we can say that to use and explore the Web training resources implies the survival of the educator/trainer within his lifelong learning system.

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Using "Brainzone", an Assessment Tool for the World Wide Web

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Increasing enrolments at Universities have encouraged a move towards flexible delivery providing the opportunity for students to access educational materials from a distance and in their own time. Concurrent with this comes a need to manage assessment in a similar manner. "Brainzone" is an assessment tool developed by Educational Multimedia Services of The University of Queensland to enable lecturers to deliver all aspects of the assessment cycle through a web browser.

"Brainzone" allows lecturers to design a complete exam with a variety of question types including multichoice, drag and drop and short answer. Questions can be randomly selected from a pool and graphics can be displayed for any question. The student's response is marked and feedback given on completion of each question. A student report is generated enabling the progress of individual students to be checked by the lecturer and the exams can be 'formative' with the student allowed many attempts or 'summative' when the exam is available over a limited time with only one attempt allowed. Password entry is required for both staff and students and the interface is attractive and easy to use with no need for any html skills. [Strassburger, 1997], [The Staff Guide to Brainzone, 1997]

"Brainzone" was trialed in a number of Departments in this University in 1997.
Pillai-McGarry, [1997] found it a valuable teaching tool in a subject where the marking of assignments had been time consuming for staff. She recognised the need to introduce some of the students to the World Wide Web and included detailed instruction on the use of the tool in her information sheets. She concludes that "under formative conditions "Brainzone" was found to be a useful tool for student learning and self-assessment. The ability to provide feedback to students also makes it a valuable teaching tool."

Since 1994, the Department of Physiology & Pharmacology has used Computer Based Assessment for both formative and summative testing in first and second year subjects, using our departmental network and Macintosh computers. In 1997, "Brainzone" was trialed for formative tests in first and second year subjects with enrolments of 500-1400 students. The tests used to date have been simple best of five MCQ and the "Brainzone" interface enabled easy entry of questions and tracking of student performance. They were made available in the last three weeks of first semester and throughout second semester. In first semester about 25% of the students used "Brainzone", this increased to 30% in second semester with up to 55% in some of the classes.

A total of 416 first year students responded to a questionnaire about their use of computers and departmental computer facilities. Of these, at least 91 had used "Brainzone" (though 177 students left this question blank altogether) and rated it on a 1-5 scale as shown below. [Tab.1]

Very Helpful				Helpful			No use	
5	4.5	4	3.5	3	2.5	2	1.5	1
43%	6%	38%	3%	9%	0%	0%	0%	1%

Table 1: Rating of "Brainzone" by Student Survey

As anticipated, the best students used the tests most [Fig.1] which largely reflects the higher motivation levels and better study patterns of students who chose to use the tests, but, as you will see, the results are encouraging enough to promote "Brainzone" use to all students.

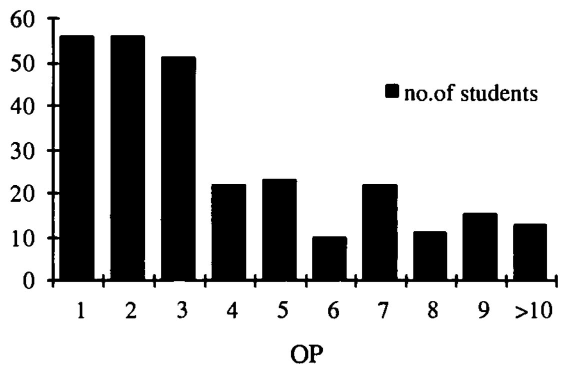

Figure 1: Relationship between number of students who used BrainZone and their OP

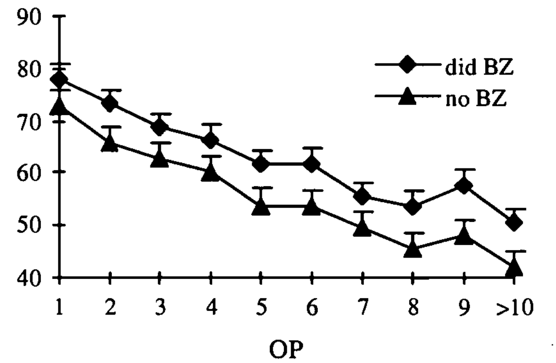

Figure 2 : Influence of BrainZone and OP on final mark (Ist year)

When a student's end of semester mark in first year was related to their OP and the end of semester mark in second year was related to the end of semester mark in first year, it was clear that the best students performed the best on the exam. This was expected. However it also revealed that *all* students that used "Brainzone" did better than their counterparts who did not, including the students with an OP >10. [Fig.2] Even when the motivational factor is excluded, there is evidence that the tests significantly improved final examination marks. "Brainzone" tests were written first for the topics typically considered most difficult by students. Consequently it is not surprising that students who did not make use of "Brainzone" did significantly worse on the exam in the topics covered in "Brainzone" tests. They also did not perform as well on the topics not covered in "Brainzone", whereas the "Brainzone" users did quite well.

If "Brainzone" tests in only a limited number of topics which are introduced very near the end of a semester can make an obvious difference to student performance, we expect "Brainzone" to be much more valuable for students when all topics are covered and the tests are available early in the semester. Data from second semester 1997 will be compiled early in 1998.

The above results confirm our expectations based on our study of use and performance by students using our Departmental Networked Computer Based Assessment. The real step forward is the use of the Web enabling much more flexible access by both staff and students. Combined with flexible delivery of lectures and bulletin board access to the lecturers, the tool takes us well into the future where students will be able to plan their learning to suit their individual needs.

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"Brainzone" is available via the World Wide Web (WWW) at http://brainzone.ems.uq.edu.au. At this site there is a demonstration of an assessment exercise as well as the access points into the system for registered staff and students.

A Network-Based Tool for Organizing Second-Language Vocabulary

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1. Theoretical Background

There has been in recent years, in both applied and theoretical linguistics, a certain shift in focus away from syntactic structure and towards the lexicon as being in a certain sense the engine of language. In many influential linguistic formalisms (including 'mainstream' Chomskian theory and unification-based frameworks such as HPSG), the syntactic rules component has had much of its complexity stripped away in favour of a more richly structured lexical component. This transfer of explanatory power in the formal domain has coincided with increasing interest in the lexical dimension of language acquisition and use, in both first and second languages. For example, [Peters 1983] has demonstrated the pivotal role of lexical units in first language acquisition, while [Pawley and Syder 1983] have argued for the importance of lexicalized sentences and sentence stems in nativelike performance. Such considerations have in turn given rise, in the field of language pedagogy, to much interest in 'lexical approaches' to language learning [e.g., Nattinger and DeCarrico 1992, Lewis 1993, Little 1994].

Given the foregoing considerations, it is clear that teachers' perpetual emphasis on the importance of learning vocabulary is not at all as wide of the mark as might have been implied by the syntactic focus of much applied linguistic research in the first two decades after the Chomskian revolution. What is more, a lexical approach to language learning dovetails with at least one precept of the communicative approach to language teaching, namely, the insistence that where learners are made to focus explicitly on form, the association between form and meaning should remain foremost in their considerations [Little 1994: 105]. Both in recent linguistic formalisms and in an intuitive sense, the interface between meaning and form occurs in the lexicon.

2. Functions of the lexical organizer

The development of the prototype Java program presented in this paper is motivated by these theoretical considerations, but also by a very practical one: it has never been obvious how learners can structure their vocabulary notes so as to make them easy to exploit as a learning resource in the future. Learners need a system that can accommodate their own, idiosyncratic, and probably frequently changing ideas of vocabulary organization, something that is very difficult to accomplish on paper. The lexical organizer presented in this paper is a tool for use in a self-access language centre. It is designed to facilitate the recording of vocabulary in a way that is flexible enough to do justice to the complex and dynamic nature of the interlanguage lexicon, meeting the learner's need to retrieve vocabulary items according to multiple taxonomies and allowing him to record various kinds of information associated with lexical items – collocations, usage registers, authentic examples of use, and so forth. The flexibility derives from the organizing principle, which is hierarchical, in conjunction with the possibility of duplicating items across categories and subcategories. A further crucial aspect of the system is the fact that its interface allows learners to visualize relations between items and categories, without predefining or implicitly favouring any particular taxonomy, provided that it can be expressed as a hierarchy. Drawing tools allow the learner to further define relations between items in a given (sub)category. The program incorporates a mechanism for self-testing of collected vocabulary items.

3. A collaborative technology

The organizer has a further possible role beyond that of recording and structuring new vocabulary; it can be used in addition, and simultaneously, as a workspace for planning written composition. For example, a top-level category might contain lexical items relevant to the chosen topic, with subcategories, nested to an appropriate depth, for sections, paragraphs, etc. In this role, and since, as a Java applet, it is Web-based, it is a potentially powerful tool for asynchronous collaboration. Multiple users, perhaps working together on a group writing project, may share an organizer, using it to co-ordinate their ideas and create a structure for their text arising out of relevant lexical items. In this way, concern with structure would arise out of a primary focus on meaning as embodied in lexis, in a manner analogous to the child's acquisition of her mother tongue [see Little 1994]. When used in this collaborative mode, the program becomes "a highly visible part of shared experience" [Roschelle 1992] and thus a truly collaborative technology.

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Algebraic semiotics and Web-based education

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1 Algebraic Semiotics

Semiotics is the theory of signs, symbols and meaning. It originated at the start of the century, and has been developed and applied to many disciplines, amongst them linguistics, media theory and educational psychology. Much of this work is imprecisely formulated, lacking rigorous mathematical foundations. This is unfortunate, because a rigorous theory of semiotics would benefit several fields, one being user-interface design.

A promising recent formulation is Goguen's algebraic semiotics [Goguen, Mori, Lin 1997], which combines ideas from algebraic specification and social semiotics. Mathematically speaking it is based on category theory. A category is a collection of *objects or mathematical structures* of the same type (such as sets, groups, or vector spaces) together with morphisms (functions or mappings) that relate one object to another while preserving its structure. The nature of the morphisms depends on the type of objects being mapped, and so morphisms contain information about the objects' structure. For example, morphisms between groups map identity elements to identity elements. Morphisms between sets do not. This is because groups have more structure than sets, identity elements being essential components of this structure.

In algebraic semiotics, the objects are ***sign systems***. Examples include alphabets, numerals, the menus and other controls used in a graphical user-interface, and Unix commands. The theory formulates the nature of sign systems and mappings between them, enabling one to discover how faithfully a mapping from one system to another preserves the structure of the first.

2 Algebraic semiotics and user interfaces

As a simple example, consider a set of files F, and two user interfaces C and M. Both C and M allow the user to print specified files. C is a command-driven interface: the user types `print` followed by a filename. M is a menu interface: the user selects a file, causing it to be printed.. Consider F, C, and M as sign systems, the signs being filenames, and consider mappings from M to F and from C to F. In M, the user can name only files that exist in F, and can name all such files: there is a 1:1 mapping between F and M. In C, the user can type any filename, whether or not that file exists: there are many filename signs in C that are not in F, so "file not found" errors can arise in C. M is therefore less error-prone, because it more faithfully reflects the structure of F.

3 Algebraic semiotics and computer-based education

The standard notation used in a course is ***one sign system; its representation on the computer is another***. We can use algebraic semiotics to reason about how faithfully the computer representation preserves the standard notation, and hence to improve the quality of teaching. We claim therefore that ***algebraic semiotics suggests a profitable methodology for interface design and notation in a way well-suited to computer-based education***.

4 Web based education

The Web is a user interface, *so algebraic semiotics can be used to improve Web-based teaching.* Goguen has done this in Web-based teaching of proofs in algebraic specification [Goguen, Mori, Lin 1997]. We believe his approach applies to a wide variety of educational topics.

We are investigating its use in conjunction with Paine's Web authoring tool *Web-O-Matic (WOM)*. WOM is based on System Limit Programming, a programming paradigm arising from the ``objects as sheaves" paradigm [Goguen 1975]. WOM is also based on category theory, and so fits particularly well with algebraic semiotics. We claim that the combination provides us with powerful tools, not only for mounting courses on the Web, but also for ensuring their quality.

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Use of Multimedia Applications in Ecological Tourism

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Abstract: "Protects the Environment," "Ecologically Designed," "Made from Recycled Paper" is the small print that we find on many products today available in the market. There is an increasing environmental awareness entering our daily lives. Computer Software is being used to highlight this consciousness. Software applications can be environmentally oriented as well as any other product. They can be designed to serve ecological purposes either directly, like in the case of computer-based applications for keeping track of energy consumption, or indirectly, in educational programs.

This paper describes the development process of multimedia software designed to educate and provide awareness of ecotourism in Costa Rica. Ecotourism is a form of nature-based travel and recreational experience that combines a respect for nature and local cultures with economic development incentives. It uses revenues from tourism for the funding of local conservation programs [Boo 1991]. While ecotourism is an educational response to problems linked to traditional tourism (overcrowding, resource depletion and degradation), this software integrates this response to an alternative method of traveling: it provides a non-destructive method of visiting ecological attractions. It also includes a training program designed for developing or enhancing an environmental appreciation by tourists desiring to visit the ecological site.

The review of the literature on educational technology shows that very few technological instruments are used to further the environmental cause, providing access to information and promoting learning of environmental issues. Multimedia technology offers the opportunity to fill the information gap and to encourage the preservation of ecological sites. Following this premise, the goal of the designers of the software is to provide a sustainable and entertaining alternative to direct visits. One reason to discourage tourism to nature-based areas is the prevention of environmental damage to endangered species or sites. This damage is often associated with uneducated tourists [Lindberg & Hawkins 1995]. In order to prevent this unnecessary destruction of the environment, an educational/training program explaining the "Do's" and "Don'ts" of ecological tourism was developed. This program provides a virtual contact with the environment while recommending alternative training options and background reference readings and videos.

Created during a Hypermedia Development course, the multimedia software, "*Ecotourism on a Computer Screen: Ecotourism in Costa Rica*," incorporates stills, graphics, videos and sound clips. Hotwords (the hyperlinks available with the authoring tool used to develop the application) enable the user to refer to text-related photographs. Since one of the endangered species in Costa Rica is the Snapper turtle, turtle-like buttons are shown frequently on the screen as navigation icons to traverse the software. The paper details lessons, applicable in a learning environment, experienced in the development of the software. Specifically, some techniques were successful, like the choice of embedding graphics over linking. Other techniques were not successful. Many of these procedures faced in the class project are repeatable, while several others should be avoided or implemented differently. In order to provide some useful hints for multimedia development both at the storyboard and programming levels, these alternatives are evaluated. Suggestions for facilitating a semester-long multimedia project are provided.

Work in progress includes testing the effectiveness of multimedia software for ecotourism. This research focuses on the assessment of users' reactions to environmental visits before-and-after exposure to the technology. To this end, on-line surveys are administered to comparable populations of MBA students attending Information Systems courses (http://www.gwu.edu/~pkatia/survey) in form of pre-test and post-test. The pre-test survey includes questions that identify respondents' environmental attitude, the post-test survey (completed after CD-viewing) includes multimedia authoring questions as well as selected pre-test questions. Although the survey is anonymous, students enter their answers through a Web Browser and a networked computer with the same IP address. Pre-test and post-test answers can be matched in one observation for the same individual to display whether the exposure to the application has altered the response pattern. Preliminary frequency data confirm a general improvement in environmental awareness, willingness to recycle, and higher acceptance of the idea of "virtual travel." Associating statistical validity to the framework expands the limited application of multimedia technology in this direction. This positive feedback can promote a more extensive application of the software and the idea represented. It can render the software even more environmentally oriented and beneficial than many other products available in the "recycled paper" market.

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Gender Differences of Favoured Multimedia Learning Interfaces

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Abstract: In this study we examined whether there are gender differences in the preferences to different designs of multimedia learning interfaces. In the study we assumed that design characteristics add to the interest in learning and we developed taxonomy of design of efficient user interfaces both for boys and girls. The research included ninety children from three kindergarten classes, who were exposed to interactive multimedia stories. The research subjects, with the help of a polymeter (Lampert 1981), answered to questionnaires which examined their overall relationship to the kindergarten, their previous experience with a computer and their level of satisfaction with the various interfaces. The research findings indicate that there is a significant difference between boys and girls in the influence of the design of the learning interfaces on their level of satisfaction with the different interfaces. The boys were more familiar with computer games and looked of for assistance through navigational buttons, whilst the girls tended to ask for help with the game. Girls preferred to include writing into the game and also preferred colourful screens full of drawings, which changed slowly. It was also found that the boys preferred green and blue colours, whilst the girls preferred red and yellow. Generally it was found that girls preferred the components of the Mise-en-scene interface, and boys preferred the components of the Montage interface.

Spatial Visualization and Multimedia

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This paper describes the research developed by the authors in their respective Ph.D. thesis, one in Computer Science and the other in Learning Technology. The objective of this work is the development of learning situations and the related multimedia resources, that will be used in the implementation of a DILE (Distributed Interactive Learning Environment) for teaching Descriptive Geometry in first grade university courses in architecture and engineering at Londrina University – Parana- Brazil.

Descriptive Geometry is a Geometry branch that allow representation of 3D objects in two dimensions by the way of double orthogonal projections. The students in this discipline think that it is very abstract and difficult to understand. The comprehension of its concepts have a fundamental importance for architects and engineers when in professional activities they need to represent ideas in a project form, to visualize an object and to transmit to the workers how to execute the tasks.

When we talk about representing the three dimensional space by only two dimensions, we talk about projections. This is the simplest way to transform space in plan. To have a projection take place, rules and conventions must be followed. Baracs notes in [Baracs 1992] that "to limit our skills only to know how to project, it is like learning how to write without being able to read" . The passage from plan to space is not a teaching object.

In the working drawings, learners use plan elementary Geometry knowledge to do all the descriptive procedures (that are algorithmic), necessary to solve the proposed problems but the learners must first visualize the situation in space (heuristic) through the reciprocal passage between the plan of the working drawing and the geometrical three dimensional space through the projections method [see Monge, 1789] conventions. On the other hand, we can solve problems more or less simple without space visualization. The projections method permits it, but to solve more complex working drawings, specially when we handle solid modeling, the spatial visualization is indispensable to reach the right solution. Permitting this practice of not visualizing, we create in the student's mind the habit of solving the working drawings only with reasoning in terms of the plan and in this way they don't develop spatial visualization, necessary to solve complex working drawings and especially modeling . Some spatial visualization capabilities are necessary to acquire the working drawing "lifting" notion.

The absence of scholar activities in projective geometry and spatial representation can be one of the reasons for which the students have difficulties when they need spatial-visual capabilities. An other reason is the absence of spatial visualization capabilities. Several authors [see Vasconcelos 1996] agreed that "the capability of spatial visualization is an individual particularity but a learning process can develop it".

Dreyfus in [Pallascio et al. 1992] relates that researches about learning had demonstrated the utility of visual resources to allow the comprehension of several mathematics concepts, and not only in geometry. Students must be prepared to understand the representations proposed to them, and that we can teach them certain specific techniques to permit spatial representation development.

What we want is to conceive a system that takes into account the "past" of students that didn't have the possibility, at the right moment, to develop:

- spatial visualization capability and
- the interpretation and representation of space through perspectives and projections.

This system will consider the whole of student difficulties to learn Descriptive Geometry, the possibility to strengthen the teaching–learning of Descriptive Geometry and to facilitate the development of spatial visualization capabilities by using technology. We create these conditions through the development of learning situations where learners will have the possibility to manipulate geometric objects and to represent them with the help of microworlds and multimedia resources to facilitate the comprehension of the more abstract concepts that are hard to visualize.

Bishop in [Bishop 1989] makes a distinction between the visualization objects and the visualization process. The visualization objects identified by Presmeg in [Presmeg 1986] are the concrete image models of kinesthetic and dynamic space forms. The visualization process is the "visual treatment" of abstract information and figural information interpretation. The visual treatment of abstract information is a process that transforms the abstract relations and the non figural information in mental images. That includes also the manipulation and transformation of visual representation in mental images. This process does not have any relation with present material stimulation.

The process of figural information interpretation is a capacity that can be explored by specific experiences. Bishop in [Bishop 1973] asserts that "structured and manipulative materials can encourage the creation of visualization capabilities and the visualization properly said".

This kind of material can be implemented with advantage in computers, by appropriate software, that allows space objects manipulation.

Conclusion

The utilization of interactive multimedia material facilitates visualization and contributes in a positive way to the understanding of Descriptive Geometry concepts. Computers is a powerful tool for graphic representation, it can permit objects visualization, representation and modeling in direct manipulation of space geometric objects when it runs specific microworlds and educational software that uses multimedia resources. The learning systems must also offer to students feedback and interactivity. In this way, the students are free from boring manual graphic operations. The change in working tools requires necessary changes in the way of teaching, not only related to the learning subject but also in terms of the didactic methods.

The learning situations developed take advantage of the following types of multimedia resources : visualization of 3D objects from working drawings representations, direct manipulation of 3D spatial forms representations that allow observation from different points of view, interactive working drawings in direct manipulation of geometric objects, interactive manipulative projections (a change in a projection causes changes in other projections), animation and video sequences.

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REMOTE LEARNING IN PARALLEL COMPUTING. DESIGN OF AN INTERACTIVE COURSE.

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1. Introduction

Parallel and scalable systems are obvious approaches to overcome the performance bottlenecks of current computing systems. However, the success of commercial systems lie well behind the expectations: one of the main reasons is the lack of automatic generation of efficient scalable code, and the others are related to the long learning curve and to the lack of integrated development environments (IDE). This communication addresses the latter issues: the design of a remote and interactive training course for parallel and scalable computing.
Current research on interactive courseware stresses the availability of facilities to experiment with - the parallel computing resources in this case study - which also improves the learning results [EPIC (1998), Cornell (1998)].
The work presented here describes a model to combine the existing tools for the development of parallel applications, in a user integrated environment with support for remote learning through a Web browser.
Two relevant functional issues were considered in the model design: the computation and the pedagogical issues. Only the computation issues are covered here: the interface and integration - of WWW facilities, operating system (host machine) and development tools (host machine) - and the tools for the target parallel machine.
This paper describes the proposed model and the prototype system currently under development. The available facilities for the project were based on a Parsytec MC parallel computer, at University of Minho, in Braga, Portugal. The resulting course will be available at the Web site of its Computer Centre (http://www.ci.uminho.pt/parcium), where a registered user will be able to follow the course.

2. The model

The proposed model follows a client-server architecture, illustrated in Figure 1. The client is the user system, while the server represents the centralised facilities at a university computer centre.
The user node contains three main modules: the Web browser, the IDE front-end and services. The Web browser is the interface to both the remote resources, and the IDE front-end. The IDE front-end integrates the existing development tools and adds access to external services, e.g. email, X.Windows server, video-conferencing. The Web browser also handles the references to URL addresses at the IDE front-end - e.g. on line help HTML pages - presenting an unified view to the user.

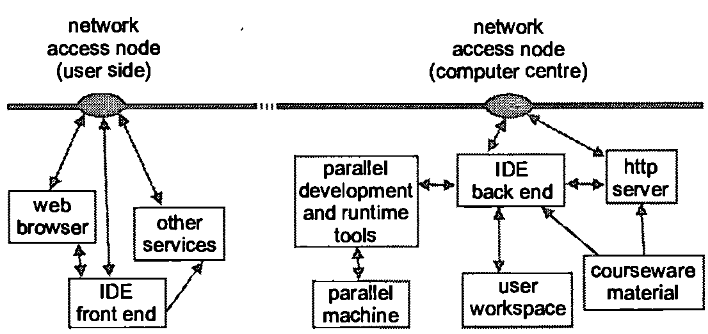

Figure 1: Model architecture.

The centralised facilities contain the parallel system and five main modules (Fig. 1). The http server launches and monitors the IDE backend, and controls the access to courseware materials, providing a more secure runtime execution environment. The IDE backend replies to the IDE front-end messages through appropriate requests to the parallel development and runtime tools, and to the user workspace modules. The parallel development and runtime tools module controls the execution on the parallel environment.

In a typical remote learning session, a registered user accesses the courseware material through a Web browser. Concepts can be better understood through programming and running examples: the user Web browser launches an IDE front-end instance, which requests the remote http server to create a corresponding instance of the IDE backend; this backend creates a copy of the requested example in the user workspace at the remote system. The user can then modify the remote coded example, and access the parallel runtime environment - including the visualisation tools - to execute the programming example with the appropriate system/configuration parameters.

The described model supports any courseware with different multimedia materials, by placing the restrictions on the Web browser capabilities/plug-ins: the approach places no media limitations on the IDE modules. However, the availability of interactive graphics and multimedia services - such as visualisation tools, video servers or videoconferencing with remote tutors - may require a high bandwidth connectivity between the client and the server.

3. Prototype system

A prototype system is under development to evaluate the model. To design a modular prototype architecture, based on the client-server approach, the object-oriented paradigm was followed [Meyer 1988, Wegner 1990, Wirsf-Brock 1989].

Java was selected to implement the IDE front-end and IDE backend modules. A relevant feature of Java is that it is based on the approach of translating the source code to a virtual machine standard code, following the approach taken already by some early Prolog compilers. This feature led to a high portability of the code, end user autonomy of the runtime environment (e.g. operating system) and higher availability of support libraries (e.g., for network programming [Elliotte 1997]). Experimentation with this prototype system will lead to the refinement of the proposed model.

4. Conclusions

The model presented in this paper led to the development of a prototype system, under tests, with reduced functionality. The work carried out so far suggests that the proposed model is well adapted to the development of an environment for remote learning, namely for the implementation of an interactive course requiring direct access to remote resources, such as in parallel programming.

More work is required to further refine the current prototype system. One possible evolution that has already been identified is the move some remote functionality towards the end user, to lessen the communication traffic and to reduce the bandwidth requirements.

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MULTIMEDIA DESIGN TO TEACHER TRAINING: GUIDE TO ANALYSE THE CONTENT OF ADVERTISING

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We are presenting a multimedia tool whish may be useful to teacher' trainning:

- This multimedia tool tries to provide them with resources and strategies in order to make them capable of using mass media in the classroom.
- It presents guides to analyse mass media.
- It shows formulas to be exploited in a didactic way: radio, comic, press, advertising, musical video clips, TV news bulletins, cartoons...

In short, it offers new methods to teachers so that they can introduce mass media in the teaching/learning process.
Nowadays, mass media have been in the National Curriculum (LOGSE, 1991) as useful tools which can represent an important help to the rest of the curriculum areas.
Moreover, it is necessary to be familiar with mass media to make it possible its understanding and be able to use it as a new means of expression.
Perhaps the most important –and the most difficult- challange, for teachers, is to identify specific school activities where technology and mass media can help them to improve existing conditions or to create important educational opportunities that did not exist without them. As part of this process, teachers decide what they need so that these changes may occurs. This process of determiminig where and how technology and mass media fit is known among users of educational technology as integration.

> "To me, it makes no sense to propose 'the media' as a separate bit of the curriculum... The media are not a separate part of our experience... They are inextricably bound up with the wole complex web of ways in wich we share understandings about the world, a web which includes gestures, jokes and hairstyles as news bulletins, opera and arquitecture; books as well as television." (Bazalgette, 1991)

The paramount aims of our proposal are:

- Make good use of the educative potencial of advertising spots.
- Analyse the formal content of advertising in a critical way.
- Discover creative formulas to transmit messages with a commercial and persuasive purpose.
- Rescue a didactic character of advertising for the different educational areas (sciences, languages, maths, geography...).

The program has been developed on CD-Rom with Visual Basic programming language. It includes text and audiovisual information including images and videoclips. It is easy to use since it follows the metaphors of a book. Its contents is accessed by clicking on an included menu.

This tool's main objetive is to facilitate the integration of mass media into the educative process. It consist of interactive sites in which advertisement.

This teaching tool includes numerous practical exemples to develop in class with students of different educative level. There are thought-provoking full of suggestions activities that can be carried out either by small groups of students or the whole class.

The approached topics are:

- Advertising stereotypes.
- Advertisement structure.
- Expressive resorces: color, music and sound.
- Languaje and vocabulary used in advertisements.
- The cultural message transmitted.
- Advertising characters: their roles and meaning.
- Real and fictitions advertising styles.

To sum up, this multimedia program can become a useful tool for teachers who are concerned about bringing up to date and innovative tasks into the classroom, and exploring the impact of mass media and particularly advertising in our current society.
Teachers cannot ignore the influence of mass media.

Presenting Educational Contents in Nonlinear Narrative Structures by Conversational Virtual Actors

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Abstract: This paper applies the autonomous animation of a conversational virtual actor for presenting educational contents. The scenario of a virtual educationalist is combined with nonlinear storytelling. Our research in autonomous virtual actors focuses on multimodal conversation that combines verbal-vocal with nonverbal-nonvocal natural language generating synchronised speech, facial movements, gesture and body posture of a 3D character. This scenario combines findings from computer science, linguistics and psychology.

Introduction

In media such as the book, television, film, video, etc. narrative and pragmatic contents are mediated mainly in a linear manner. Even in new interactive on- and off-line media, an active participation of the recipient is limited to the activation of hyperlinks by mouseclicking.

By the use of a conversational virtual actor we want to put a computer-generated 3D-figure at the interface between the recipient and the content that is to be mediated. The virtual actor's facial expressions, gesture and body posture should complete its verbal-auditive utterances. The aim of this research project is to introduce natural interpersonal communication structures to computerbased education media. The limitations and possibilities of nonlinear conversational and dialogue structures should be explored in combination with the nonverbal behaviour of the virtual actor. Some of the scientific question formulations resulting from this task are:

- In what way is the reception behaviour influenced by the 3D-figure and the nonverbal communication in comparison to a pure auditive or textual reception?
- What is the impact of the interactivity of the dialogue form to the communication - compared to a mere linear reception of a conventional spoken or written text?
- Which nonlinear narrative and conversational structures are suitable for this scenario?
- How does the degree of interactivity influence the educational results?

Concerning the investigation of socio-emotional effects of computer-simulated nonverbal behaviour ([Bente, Feist, and Elder 96], [Bente and Otto 96]) we cooperate with the institute of *Differential Psychology and Communication Research* at the University of Cologne. [Bente 96] distinguishes three „degrees of immediateness of contact between recipient and screen person" ([Bente 96], S.9). Our research intention is to be classified on the third level: „Direct interaction with mutual contingency between media user and screen person".

Autonomous Animation of Virtual Actors

This research project is build on top of the work ([Actor 97], [Fleischmann, Opalla, and Mähler 96], [Piesk 97]) of the character animation group - an interdisciplinary group of computer scientists, animators and designers headed by Prof. Dr. Trogemann. Our current implementations of autonomous 3D-characters are a *Virtual Storyteller* and a *Virtual Educationalist*. The interaction scenario realised by these conversational virtual actors comprises the users textual input, natural language processing, emotion-based triggering of a textual response and its audio-visual performance by the 3D-character's facial expressions, gesture, body posture and voice. The speech synthesiser Hadifix [Portele, Krämer, and Stock 94] is integrated in our implementations.

Nonlinear Dialogue Structures

In the first prototype (VISTA - Virtual Storytelling Actor) a conversational cactus is used to tell its user the story of *Alice's adventures in wonderland* [Carroll 89]. Originally this story was told to a school girl who made questions and raised objections. The book is therefore a linearisation of an originally nonlinear dialogue structure. [Piesk and Trogemann 97a] describes the implementation of the *Virtual Storyteller*.

Virtual Education

[Piesk and Trogemann 97b] describes an additional implementation of a conversational virtual actor as emotion-based learning environment - the *Virtual Educationalist* [Fig. 1]. Here the 3D-figures verbal repertoire does not consist of a story. Educational contents are mediated instead. The 3D-character *cactus* has been designed for the german children and youth program of the WDR (a german TV-station). The autonomous version in the shape of the *Virtual Educationalist* should take advantage of the emotional relationship that a member of the target group (children) develops for mediating educational contents. Emotions displayed by the figure's facial expressions, gesture and body posture serve different functions in form of motive, feedback, and intermittent accentuation of effect (see [Piesk and Trogemann 97b]). An online-connection adds the knowledge of online-databases (e.g. language dictionary [Jung et al. 97]) to the virtual educationalist's verbal repertoire.

Current Research

The research project in this paper is the symbiosis of the two concepts of the *Virtual Storyteller* and the *Virtual Educationalist* described above. The idea is mediating educational contents via entertaining story lines. The young recipient can approach the core of a topic on multiple paths via different story lines. The story is presented during a natural language dialogue with the child using the characters nonverbal behaviour for enhanced communication. In our current research in this field we focus on two areas: nonlinear dialogue structures and the synchronisation of the 3D-figure's verbal and nonverbal behaviour.

Figure 1: „A conversational cactus is teaching geography“

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Cross-Campus and Cross-Platform Language Learning
Concept - Challeges - Solutions

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I Introduction

In 1998 and 1999, the Sprachenzentrum (language centre) at the Fachhochschule Gelsenkirchen will be setting-up three new multimedia language laboratories at campuses in Gelsenkirchen, Bocholt and Recklinghausen. Special emphasis is being placed upon:

- the implementation of new media in language instruction
- the development of both traditional and multimedia self-access language learning facilities
- the provision of further education in languages for specific purposes

In each lab, up to twenty learners will have access to a broad range of interactive multimedia language learning resources. Additionally, access to satellite television broadcasts from six satellites will be provided, along with language learning materials on video cassette. In order to support cross-campus team learning, the three language labs will be networked.

II Concept
Software for Language Teaching and Learning: English, French, Spanish, Dutch.

Software products for teaching and learning all four languages will be introduced. The software will address the demands of learners of different abilities and interests both in terms of level and content. In order to provide learners with a flexible learning environment, the software will be introduced in a number of different ways, including the use of programmes:

- in seminars (in which an instructor is present)
- for self-access
- for language reference (dictionaries, encyclopedias etc.)

Initially, a total of 80 programmes of this nature will be provided. An increase in this number is expected, however, as new products become available.

III Challenges

The multimedia language learning software will be both Mac (HFS) and PC (ISO 9660) compatible. Learners will be able to work interactively with either format from the same workstation. Learners may also choose to interact with one another using desktop video cameras, which will form part of the standard user interface.

The language labs at each of the three campuses will be networked, so that learners can communicate cross-campus with one another. This will enable cross-campus project work, either in pairs or in teams.

IV Solutions

Software Administration

The language learning software will be administered centrally using a RAID-system, a CD-ROM server and CD-ROM jukeboxes. Some programmes will have to be made available locally at each workstation. Use of the software will, however, be possible from all 21 workstations.

Server

Pentium servers will be installed running Windows NT as the network operating system. The use of Windows NT will allow both Macintosh and PC 'clients' access to the programmes in ISO and HFS formats.

Workstations

Each language lab will provide twenty learner-workstations and one instructor-workstation. Apple PowerPCs will be used throughout. As extras, the PowerPCs will also include PC-cards (Pentium processor) and MiroMotion video-cards; they will each have desktop video cameras (FlexCam) and an additional headset connected. The integrated network-card can also be used by the Pentium PC-card. The operating systems will be MacOS8 (Macintosh) and Windows 95 (PC). Using a simple macro, learners can switch between the two operating systems. In this way, both Mac and Windows software can be accessed from each workstation.

Visual User Interface

The visual user interface for the workstations will be designed using Macromedia Authorware. Via a system of menus, the learner will be guided to the language learning programmes of his or her choice. In so doing, the learner will asked to choose materials for one of the four languages on offer, orienting themselves toward the programme type of their choice. An introduction to each of the programmes available will be given in order to help the learner to determine if the software is appropriate to their needs.

Network

The language labs will be networked using Ethernet and a switching-hub. This will provide each workstation with a band width of 4 Mbit/s. The advantage of this over fast-Ethernet or FDDI is that standard components can be used, for example, the Macintosh network-card present in the PowerPC.

Communication

Via the network, each workstation will have access to all of the software available in the language lab in both formats (HFS / ISO). This will allow each of the workstations to work with the same programme simultaneously. Using communication software (TimbuktuPro for Mac and PC) and a conferencing software (Skopeo for Mac), learners and instructors will be able to communicate with each other and use the same language learning software. This will also be made possible cross-campus. A permanent network connection between the three language labs will be available for this purpose.

Satellite and Video Equipment

Learners will be able to access twenty-seven satellite channels via six satellites (Astra1A, Astra1B, Eutelsat II F1, Eutelsat II F3, Hispasat, Panamsat). In addition, language learning materials on video cassette will be provided, including commercial materials and video broadcasts of particular interest saved to video. Five video recorders will be available to learners to enable further broadcasts to be recorded. Access to broadcast television programmes and to video materials will be possible from five television sets. In order that all five television viewing stations have simultaneous access to all the channels available, two satellite dishes will be installed which will each receive the signals from three satellites.

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The Three Little Pigs in a Postmodern World

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Abstract Education in a postmodern world will have to change its stripes dramatically. Otherwise, it will be an impediment to the actualization of our potential; an absurdity when you consider that the recognition and pursuit of possibility is the business of education. The diffuse but intensifying sentiment that we must go beyond the constraints of the modern perspective is one that we educators must comprehend ourselves, learn to explain to others, and, most importantly, act upon. Our profession is challenged to assist in the birth and development of this new world view and determine how its own metaphors and methodologies perpetuate the modern perspective and frustrate the emergence of the postmodern era.

How is computer technology going to contribute to the development of postmodern education? We are increasingly recognizing the importance of narrative learning to the educational process. The power of metaphor to guide and transform knowing is also an integral facet of our changing perspectives on curriculum. The computer, however, is most easily applied to modernist approaches to instruction. This presentation illustrates how multimedia can be used to integrate technology with changing notions regarding teaching and learning.

The postmodern perspective, still forming, yet amorphous, will characterize our new approaches to cultural definition and life. The old is on the way out, but the new is still unformed. Nonetheless, we can't stay the way we are, and we can't go back to a simpler age. We have to design and build a "new home."

Education in a postmodern world will have to change its stripes dramatically. Otherwise, it will be an impediment to the actualization of our potential; an absurdity when you consider that the recognition and pursuit of possibility is the business of education. The diffuse but intensifying sentiment that we must go beyond the constraints of the modern perspective is one that we educators must comprehend ourselves, learn to explain to others, and, most importantly, act upon. Our profession is challenged to assist in the birth and development of this new world view and determine how its own metaphors and methodologies perpetuate the modern perspective and frustrate the emergence of the postmodern era.

Postmodern education will be characterized by the understanding that the best form of learning is active, the forging of understandings and meanings on the part of learners. The formulaic installation of factoids into passive, quiet minds is *not* good schooling, regardless of how convenient it is behaviorally or measurably. Schools in the postmodern era will increasingly recognize the idiosyncratic, constructivist, and intrinsic nature of learning that promotes capable, thinking, responsible, and active citizens.

Evidence is mounting that learning requires active participation. Knowledge can be acquired passively, but then it is knowledge that will not thrive; it will be weak and anemic knowledge, and the mind will be quick to discard it as irrelevant. It does not take on the "aliveness" of knowledge that the learner mulls over and ponders, seeking to fit it into his or her developing intellect.

A hopeful indicator of the emerging shift in our cultural perceptions regarding the educational endeavor is the growing recognition of brain-based education. Our present pedagogical practices don't mesh with the brain's biology. Psychologists and brain biologists essentially agree that the human brain learns actively, and in context. The passive reception of congealed knowledges (separated from the flow of learning) does not make biological sense.

The mind actively searches for meaning in its natural, ever-evolving context. The biochemical function of the brain is to somehow make sense out of nonsense. Brain-based education refers to the development of the capacity to understand. This process is one where threads (of knowledge) change the web (of understanding) and then the changed web alters the kind of threads it incorporates. Passive learning, which too often includes that which is computer-assisted, impedes this kind of mental development.

Passively acquired—or injected—knowledge is either stillborn or soon withers and dies; it does not become fused into the life of the mind. Thinking and knowing are an interdependent dynamic. They give the tension and resolution of rhythm to each other.

It is thinking that breathes life into knowledge, and it is the gaining of knowledge that keeps thinking from stewing within itself. Acquired knowledge provides thought with new foundations from which to expand. It is thinking that gives learning the element of active participation. Thinking constructs new understandings from the acquisition of new knowledges, for, as knowledge is born, it must be fused into developing intellects.

These are just a few of the changing perspectives on the interactive/emergent nature of teaching and learning. The postmodern education movement is increasingly constructivist in its understanding of how the best learning occurs. The most vital and democratically healthy learning is something that is initiated in the minds of learners themselves. It is not crowded out by instructional techniques that are excessively focused on training. Self-directed thinking should not be suppressed by schooling-imposed knowing.

Can computer technology integrate with these changing notions regarding the educational process? It will mean the incorporation of narrative learning, illustration by metaphor, and the idiosyncratic inspiration of learner-initiated thinking. These are questions that must be answered if the evolution of computer education is to contribute to the emergence of postmodern instruction.

A particular postmodern concern—the spirit of democracy within the process of schooling—could be assisted enormously by instructional technology. But there is a seductiveness that pulls the opposite way, the application of computers to further the traditional, modernist theories and practices of education, where teachers are curriculum implementation specialists and students are recipients of programmed knowledge.

A touchstone story for postmodern teaching is *The Three Little Pigs.* It helps introduce an ongoing dialogue about the development of integrity and the phenomenon of gaining experience. In our revised version, the houses represent *integrity* and the wolf represents *bad circumstances*, as in "the wolf at the door." The story is about how we develop the personal strength and responsibility necessary for the gaining of experience—as well as education for integrity and initiative. The narrative weaves in well with discussions regarding the thinking of John Dewey, Erik Erikson, and Alfred North Whitehead.

Using presentation software, we created a multimedia presentation of our rendition of the story. The visual narrative provides technological assistance to a postmodern way of teaching, where storytelling is blended in with theoretical and practical discussion. The story of *The Three Little Pigs* itself communicates the importance of identity construction, personal ownership, and the phenomenon of experience.

An Investigation of the Use and Impact of the Internet in Coping with an HIV-Positive Diagnosis

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Introduction

Since its emergence in 1981, the human immunodeficiency virus (HIV) has posed one of the greatest health threats the world has ever known. This incurable virus and precursor of acquired immune deficiency syndrome (AIDS) continues to exact a staggering human toll. As of December 1996, AIDS has claimed the lives of 6,400,000 individuals worldwide. While the spread of HIV beyond the boundaries of the gay community weakened some prejudicial barriers, it did not completely eradicate the epidemic of bigotry and blame that often accompanies HIV infection. Consequently, coping with HIV has never been merely an issue of dealing with the physical consequences of the disease. There are myriad social, emotional, and psychological issues with which HIV-positive individuals must also contend.

For individuals infected with HIV, social support is a critical factor in coping with their medical condition. Obtaining and sustaining the support of others is usually accomplished through a network of friends, family, and community-based service organizations. The circumstances of some individuals, however, may preclude the use of one or more of these sources of support. For example, a newly diagnosed individual, fearful of discriminatory action by an employer should word "get out" about her/his positive status, may be reluctant to seek assistance from a local service organization. Further, lack of proximity to family and close friends is an often-cited reason for insufficient social support, as is progression of the disease itself; it is not uncommon for late-stage HIV infection to render an individual homebound. For these reasons and numerous others the Internet, with its wide array of services, provides a viable alternative for individuals who cannot or who elect not to pursue traditional avenues of support. Electronic mailing lists, bulletin board services, computer-based support groups, and World Wide Web sites devoted to every conceivable disease are among the online resources that have turned the Internet into a treasure trove of information for individuals coping with life-threatening illnesses. The Internet has arrived as a force in our lives, and medical information and support constitute two of its more important uses [Mayer and Till, 1996].

The Internet "will affect adult learning in ways that we can only dream about" [Fleischman, 1996, p. 18]. It provides an especially fertile context for informal learning -- the type of learning most commonly employed by individuals coping with a life-threatening illness. Informal learning is a loosely structured learning activity undertaken by individuals without institutional direction and is both reflective and active [Eastmond, 1995]. Informal learning is the primary means by which adults learn at work and at play and is characterized by "involvement with other people, real problems and authentic tools and resources" [Johnson, 1996, p. 7]. Heuer found that the online discussion opportunities afforded by the Internet provide a "rich, flexible environment that serves as a context for informal learning" [Heuer, 1997, p. 122]. Schrum and Berenfeld likewise underscore the capacity of the Internet to provide informal online educational opportunities [Schrum and Berenfeld, 1997]. The Internet also provides a natural venue for self-directed learning. Self-directed learning embraces the notion that the individual learner is "capable of assuming considerable responsibility for and control of learning activities when such opportunities are provided" [Hiemstra and Sisco, 1990, p. 283]. In fact, "the world of electronic communication assumes and demands that people take initiative for their own learning and growth" [Schrum, 1993, p. 193].

Although anecdotal accounts of the usefulness of the Internet in coping with a life-threatening illness have been regular features in the popular press, the ability of the Internet to facilitate informal learning has not been systematically investigated. The purpose of this study was to investigate the use and impact of the Internet in coping with an HIV-positive diagnosis. For what purposes do adults report using the

Internet in coping with their illness? What is the impact of Internet use on their self-reported ability to cope with HIV infection?

Research Design and Findings

This study, doctoral dissertation research that is a work-in-progress, employed a qualitative design to study the use and impact of the Internet in coping with an HIV-positive diagnosis. The sample selection of respondents was purposive, and the following criteria were used for inclusion: (a) participants were at least twenty-one years of age, (b) they have been seropositive for HIV for at least six months, (c) they have utilized the Internet in coping with HIV for at least six months, (d) they were at a sufficient level of physical functioning to comfortably endure a 90 minute face-to-face interview and agreed to a brief follow-up interview (by telephone or email, their preference) if a review of the transcription of the first interview revealed a need for clarification or further discussion, and (e) they live in the Southeastern USA. A semi-structured interview format was used to interview ten respondents (six males, four females), most of whom were located through the AIDS Survival Project, an AIDS service organization in Atlanta, Georgia. The respondents ranged from 27 to 47 years of age; eight are Caucasian, one is African American, and one is Hispanic. Level of educational attainment spanned high school to Master's Degree. Data are being analyzed inductively using the constant comparative method [Glaser and Strauss, 1967]. Because this research is a work-in-progress, only tentative findings can be presented in this short paper. (The research will be completed in May 1998, and a more complete report will be given at the ED-MEDIA/ED-TELECOM '98 conference.) A preliminary analysis of the data reveals that HIV-positive adults are using the Internet to find a range of information (general to condition/situation-specific), for social communication with other HIV-positive individuals, to engage in advocacy, and for "escapism" from HIV-related stresses. In addition, the research indicates that Internet use has impacted the participants' ability to cope with HIV by augmenting social support, promoting empowerment, and facilitating their ability to help others.

Significance of Study and Implications

Although the use of the Internet in promoting *formal* opportunities for learning (e.g., for the delivery of instruction) is a much investigated phenomenon, little attention has been given to its potential to advance opportunities for *informal* learning. Substantive information in the form of interpretivist research that provides a rich description of the use of the Internet is needed if the Internet is to be considered a viable resource for addressing the psychosocial needs of individuals coping with life-threatening illnesses. The findings of this study will be useful to HIV-positive individuals engaged in the ongoing struggle to cope with their illness. It will also be helpful to individuals coping with other life-threatening illnesses, as well as to instructional designers and program planners who serve the resource and learning needs of online constituencies.

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Distance Education Courses about Interactive Multimedia: Problems and Solutions

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Introduction

Increasingly, university teaching and learning experiences are being replicated independently of time and place via appropriate combinations of technology-based resources (the Internet, the Web, CD-ROM, etc) and conventional teaching and learning resources. As part of this world wide trend, the author is currently involved in trialling the delivery of selected distance education units in Interactive Multimedia (IMM). The resources for these units are being delivered in multiple formats: Internet/Web, CD-ROM and paper. Like many other educational researchers and practitioners around the world, the author is searching for ways to increase the educational gains possible from using the Internet and CD-ROM technologies while continuing to seek to optimise the integration of other learning media and resources. This paper focuses on the unique issues and problems encountered when the educational content involved is IMM.

While ECU has used a range of technologies to support distance education courses for several years, it was not until 1997 that IMM units were first offered to off-campus students via electronic delivery. The delay in offering these courses was partly due to the belief that the delivery of in-depth courses with IMM content posed unique and significant (if not insurmountable) problems. The author perceived a need to evaluate the initial experience of delivering IMM content to off-campus students electronically and did so in a qualitative manner through the eyes of the developers, tutors and students. The evaluation was a pilot study for more formal evaluation studies to come.

Description of Pilot Project

The project looked at the process of development and implementation of two multimedia units, IMM 4102 Digital Resources and IMM 4103 Interface Design, for delivery to off-campus students. IMM 4102 was developed initially as a Web site supported by conventional paper-based resources (a CD-ROM was later produced when students were having problems downloading large files). IMM 4103 was initially developed as a "Web site on CD" with most of its software running "locally" under a Netscape browser, although software demonstrations, examples and utilities were also included on the CD-ROM (an actual Web-site was subsequently established). The URL for IMM 4102 is: http://liswww.fste.ac.cowan.edu.au/Courseware/IMM4102/
and the URL for IMM 4103 is: http://malt.ed.ac.cowan.edu.au/exunits/imm4103/. The implementation of the units was examined from the perspective of the tutor and the students. Questionnaires and follow-up interviews were used to gather data from the developers and tutors while phone interviews were used to get the inputs from students.

Observations from the Pilot Project

1. A range of practical problems became evident early in the study. The major problems were: difficulties in submitting large Interactive Multimedia (IMM) assignment files as email attachments (an ftp site has now been established); lack of access to full versions of IMM applications software (trial versions were too limiting); learning problems with students who had no manuals or tutorials for IMM applications software (presumably, they lacked a legal copy!); problems in submitting assignments because files couldn't be saved in trial versions; and computing infrastructure hassles of various kinds. The existence of all these problems was clearly impeding the capacity of course designers to focus

more on pedagogical issues. Nevertheless, the developers did remark on the importance of social interaction, the provision of concrete experiences, improved content interactivity and relevant and contextual assessment - all aspects in keeping with cognitive and/or constructivist views of learning.

2. Course developers and tutors clearly need to be aware of the computing facilities available to the students and the nature of their Internet connection. This is more difficult for off-campus students because tutors can't see their students' systems. This problem was further exacerbated for the IMM students in the pilot study because they required computing systems with greater capabilities than students in "non-computing" fields. IMM courses require students to have access to relatively powerful personal computer environments and relatively fast Internet connectivity. Even if these requirements are met, however, current bandwidth limitations of the Internet also mean that CD-ROM based resources are usually necessary (as well as conventional distance education resources).
3. The students in the pilot study appeared unwilling to embrace the electronic forum opportunities provided for communication. This problem appeared to be far greater than that previously experienced with electronically delivered units for "non-computing" students. This issue warrants further investigation.
4. Copyright problems were heightened by the nature of the subject matter. One tutor wanted to illustrate the content with examples of work done by others (2D and 3D graphics, video, sound, sections of multimedia applications) and yet could not do so unless the copyright was cleared - a time consuming process. Courseware development teams could resolve this issue by having a media developer who can create original media. There is also a case to be made for a well structured process for obtaining clearances from the copyright holders.
5. Units which require the learning of specific multimedia software packages face the issue of students not having access to all of the expensive software packages required. To some extent this can be alleviated by providing the students with "demo" versions which are usually available on the Internet at no charge, but the restricted capabilities of many of these are often too limiting. Attempts to negotiate site licence rights for ECU students for study purposes have been largely unsuccessful. Unfortunately, it may be necessary to require students to purchase this expensive IMM software as a course requirement in the future.
6. Student feedback for one of the units indicated a desire to see a range of examples of typical assignment work (multimedia software files) on the unit Web-site, a deficiency that is already being addressed. The CD-ROM for the other unit did contain a wide range of examples of past student work.

Conclusion

The face-to-face interaction experienced by the majority of today's on-campus students plays a key role in sharing ideas and experiences and generally adding a social dimension to the learning environment. While it has been argued that most students prefer face-to-face interaction (Simonsen, 1995), for many of them, the convenience of "on-demand" access from any location will often outweigh the limitations placed on personal interactions. For off-campus students in IMM courses, however, the availability *and* usage of multiple and reliable communication channels with their tutor and their peers appears to be the most effective single means of overcoming many of the problems brought about by the unique nature of the content involved. It seems likely that a variety of approaches to personal interactions within learning environments will emerge over the next decade and that many will provide the best of both worlds as they attempt to balance virtual and direct interaction. In the long term all learning environments will have some of the attributes of technology-mediated learning and it will always be important to strike an appropriate balance between virtual interaction and face-to-face interaction.

In the prevailing climate of economic rationalism within which many of the world's educational institutions must survive, economic reasons are frequently given for using technology-mediated learning approaches, particularly the Web, for the delivery of instructional materials. It is important for educators to ensure Web delivery occurs in order to achieve sound educational goals, not simply because it may offer practical and economic advantages. While the author believes that for this to be achieved we need to base design for the electronic delivery of curriculum on a sound theoretical base, searching for such a theoretical base has been the subject of other papers (eg Ring and McMahon, 1997). Nevertheless, it is hoped that the documenting and reporting of qualitative data concerning the electronic delivery of IMM content, as given in this paper, will be of assistance to educational researchers in their pursuit of such a theoretical base, whether it be for the Web as a sole learning medium or whether it be for the use of the wide mix of technologies likely to be necessary for the provision of optimal learning experiences in the 21st Century.

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A Theoretical Framework for Creating Webscapes: Educational Information Landscapes on the Web

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The design, development, and delivery of educational materials is undergoing a remarkable evolution from a traditional lecture format to a media-rich information landscape delivered via the World Wide Web. As an alternative model to the traditional, linear presentation of information, instructional designers have sought new methods for structuring and representing relationships between widely diverse ideas and concepts. The term "information landscapes" was first used by Florin [Florin 1990] who visualized "virtual towns" or "intellectual amusement parks" where abstract concepts could be brought together within a single metaphor.

With the explosive growth of the Web, the potential for the development and widespread use of information landscapes becomes more apparent and meaningful. This is due to the fact that the Web is now considered to be an essential information-gathering tool found on an increasing number of desktops. However, this growing access to new information has created significant problems for users who must navigate through vast amounts of data to locate desired resources. At first, hypertext seemed to provide a solution to navigation problems but as more and more resources have been developed based on hyperlinked information, users face a staggering number of navigational choices. There has been no unified framework that helps bring information together and reveals the multi-layered relationships and connections that are not always apparent.

MacNeil [MacNeil 1998] proposes one possible solution by emphasizing the distinction between hypertext resources and information landscapes:

> In contrast to the discontinuous jumps between flat pages provided by the ubiquitous hyperlinked Web browser, an information landscape provides a continuum of paths from place to place, conserving context by allowing loose, but spatially meaningful, relationships between information objects. Navigation of such spaces should not only reveal needed and appropriate information, but should do so in such a way that the journey itself has meaning.

The paradigm shift from a static, paper-based structure to the interactive electronic experience of an information landscape offers exciting new ways to engage users by providing a supportive climate filled with educational content. In this context, students with widely different backgrounds and learning styles can explore multiple pathways designed to encourage active exploration and analysis. A framework provided by Jonassen [Jonassen 1994] proposes that a learning environment should provide multiple representations of reality, focus on knowledge construction, not reproduction, and support collaborative construction of knowledge.

We have designed a Web-based information landscape, what we are calling a "Webscape," that supports this framework by including a rich variety of content; challenging, cognitive explorations; intuitive navigation structures and user-oriented interfaces. This Webscape model presents a theoretical foundation for the development of a comprehensive educational Web site with a large database of information, interactive components and a variety of multimedia resources.

In the Webscape model, educational content specialists work with both instructional and graphic designers as well as technical specialists in a collaborative team environment to create interactive experiences for users and develop a wide assortment of online materials. Using both standard hypertext markup language and a variety of emerging technologies such as Adobe's Portable Document Format, Javascript and Dynamic HTML, the

Webscape can incorporate many different interactive experiences ranging from simple point-and-click interaction to more sophisticated examples such as data manipulation and analysis, problem solving, and reflective discussion. Rather than just presenting lists of hypertext links on a given topic, the design team's role is to create multiple paths for the student to navigate through the information. The Webscape should contain an interesting and significant set of electronic experiences that have been pre-screened, organized and presented in a way that gives it meaning and synthesizes the most important details from the overwhelming amount of data that is available on the Web.

In education, these electronic interactions may be used by instructors and students to explore course content through the use of hypertext, interactive graphics, multimedia elements, and collaborative areas where asynchronous discussion takes place and assignments may be uploaded and viewed by the entire class. The collaborative discussion is managed through Hypergroups, a Web-based interface for traditional listservs. Through this mechanism, students and the instructor are able to post questions and comments that are then automatically generated as Web pages and threaded by date, subject and author. This Web structure facilitates sharing of ideas in an intuitive, user-friendly format that is already familiar to the students.

Management tools are used to create interactive quizzes and examinations, individual student pages for feedback and progress in the course, and final course evaluation forms. Additionally, in some educational projects, the option for users to provide their own stories and viewpoints is incorporated into the design. Many different forms of data are collected through these resources and returned to the design team through e-mail and data files that may then be collated, analyzed and used in the ongoing development of the project.

One example of an educational Webscape is the Untold Stories project (http://www.coe.uh.edu/untold-stories), developed by a team of University of Houston faculty members and graduate students working closely with content experts and an advisory panel. This site grew out of a book and video documentary that recounts the events that led up to the desegregation of public spaces in Houston, Texas during the late 1950s and early 1960s. Through more than 12 years of research, the book and film development teams gathered a great deal of information that was used in the production of both the print and film media and will now be shared as Web resources.

The Web site is being designed to facilitate the navigation and exploration of a multifaceted collection of research on Houston's desegregation. Users may choose how to navigate through the information in three different ways: by a timeline, by people involved and by accessing multimedia resources. Multiple perspectives of each event are provided; these enable users to see many sides of the same story and draw their own conclusions about what took place. For example, when one of the leaders of the desegregation movement is arrested, the Web interface allows users to investigate this episode from several different viewpoints: the person being arrested, the police who made the arrest, the political leaders in Houston, and the news media. In addition to text versions of transcripts from participants who took part in the actual events, both audio and video materials are also available that help tell the story in a clear and interesting manner. Oral histories are also being collected which will added to the Web site and extend the scope of the project.

As the Web continues to transform the way information is shared, developers must gain the skills needed to create meaningful electronic information landscapes. It is imperative that these Webscapes be filled with useful, and easy-to-navigate resources that allow users to create their own knowledge structures. The major challenge that designers and developers face is creating their own framework or structure through which appropriate information may be located and the exploration of new information becomes possible.

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The 24-hour Language Lab: Extending Traditional Media Services with Digital Streaming Technology

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1. Introduction

This paper will describe the background and first phases of a two-year program to apply the new digital streaming technologies to traditional academic media center services in support of foreign language teaching and learning at New York University.

The project was begun in the summer of 1997, when it was determined that the development of streaming media by such companies as Progressive Networks (now RealNetworks) could deliver acceptable-quality digital audio using TCP/IP connections. It was also deemed important that the technology had reached a commercial "critical mass" of acceptance by World Wide Web content providers, so that media materials converted to these formats would continue to be commercially supported. A server was purchased and configured to deliver multiple streams of live and encoded streaming audio.

Phase Two began in the winter of 1998. A key faculty member in the College of Arts and Science was contacted and a pilot project designed to convert to digital streaming audio targeted sections of each chapter of the audio cassette tapes used in the teaching of Introductory French to undergraduates. The publisher provided a standard agreement allowing unlimited duplication of the tapes for students in the class. Sample files were created and technical considerations of storage and bandwidth noted.

In spring and summer 1998, a selected group of students and instructors will work with the files to determine the ways that audio prepared and delivered in this way can be used by students and teachers to *enhance access and interactivity without the creation of new audio content.*

In fall 1998 the project will be extended to support undergraduate Spanish and Italian audio materials. Only NYU students will have access to the streamed files. This will be accomplished by configuring the media server to restrict access by domain (nyu.edu). Workstations will be installed in the Media Center for access to the files. Students will also be able to access the files via TCP/IP using T1 networks installed in dormitories and in computer labs on campus, or via modems off-campus by means of passworded Internet accounts supplied by NYU.

2. Background: The Instructional Environment

At NYU, a traditional language lab equipped with audio cassette recording and playback equipment serves English-speaking students of other languages and students of English as a second language (ESL). The language lab is located in the Avery Fisher Center for Music & Media in NYU's Bobst Library. Bobst Library is the main library for the University, and is centrally located at NYU's main Washington Square Campus. The Media Center is open only 70 hours per week. Most language instruction courses require the use of extensive sets of audio cassettes, which are far too expensive for the students to buy (the textbook and workbook set, without the tapes, costs $80.00). One master copy of the entire tape set is purchased for the Media Center by the instructional department. According to agreements with publishers free duplication of the tapes for students is done by Media Center staff using a high-speed duplicator and tape stock provided by the student. Turn-around time is 48 hours and only one chapter may be duplicated at a time. The student also has the option of listening to the master tapes in the Language Lab. To use the tapes in the Media Center, the student has to compete with language students and others using extensive tape-based audio reserves.

3. New Web-based Models for Instruction

While "traditional" teacher-operated language lab operations have fallen into complete disuse, instructors still consider intensive audio and speaking practice highly effective. Instructors are already experimenting with web-based instructional models, using e-mail and listervs to enhance interactivity, and linking students to foreign language newspapers and information services. In addition to extending Media Center access off-site, the preparation of digital versions of audio materials will provide "raw materials" for instructors to create computer-based instruction and present it on class web pages without having to learn complex authoring programs. No proprietary software is necessary beyond the freely distributed RealPlayer, which works in conjunction with standard web browsers.

4. What Is Streaming Audio?

Good quality compressed digital audio over TCP/IP connections is now available. Low-cost encoding techniques and players that allow the listener to play audio (and video) while simultaneously downloading it. Using a process called buffering, the player downloads into the memory of the listener's computer a small portion of the sound before beginning playback. As the audio plays, the player continues to put some of the file in memory. Most streaming audio files do not require that special software be loaded on the host web server. Because the project requires archived audio be served to more than one listener at a time, RealNetworks Easy Start server software was installed on a Dell 6200 dual 200MHz server running Windows NT with Microsoft Information Internet (IIS) Web server.

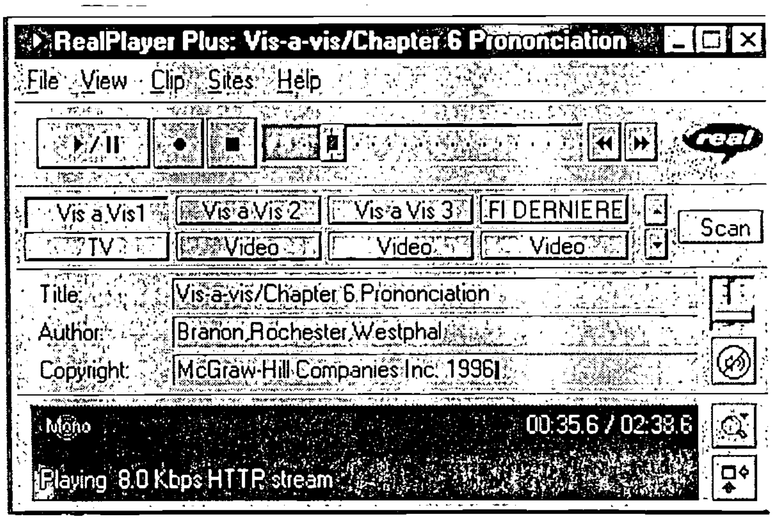

Figure 1: The RealNetworks' RealPlayer playing a test file of French instructional audio.

5. A Procedure for Producing Streamed Files from Audio Cassettes

Each chapter of the text is accompanied by an audio cassette of about 30 minutes. In the test phase, the analog audio cassette was digitized using SoundEdit 16 V.2 (with the free RealAudio plugin) on an Apple Power Macintosh 9500 with 32MB of RAM and a 2GB hard drive. Files were initially digitized at 44KHz and a sample size of 16 bits. "Master" SoundEdit files require 5MB of disk space for each minute sampled, resulting in a file size of 148MB for a 26-minute chapter. When this master file was converted to RealAudio at 8Kbps (suitable for 14.4bps modems), the resulting compressed streaming file was reduced to 851K (a 10:1 ratio).

The Impact of Electronic Publishing

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Introduction

The number of pages published each year is steadily increasing. The American Chemical Society, for example, published 135 pages in one journal in 1900. By 1935, pages had increased to 4,500 in three journals. In 1995, ACS published 125,000 typeset pages of research and 80,000 pages of supporting information. The number of journals had increased to 24.

With Springer, in comparison, since its foundation in 1842, the number of journal titles published has grown to 34 in chemistry out of a total of over 400. By the year 2000, all journals of the international Springer publishing group will be available online, in addition to their printed versions. Right now, 200 (27 in chemistry) are online and 1,000 libraries are registered users of the new Internet information service LINK. [LINK]

History

The idea of an information highway is not new. In 1937 H.G. Wells [Wells 1994] promoted the concept of a "world brain" based on a "permanent world encyclopaedia" as a social good through which universal access to all of human knowledge is given. It was not until the 1990s and the advent of the World Wide Web that a system with many of the attributes of Wells' "world brain" came into being. The web makes available linked and indexed interactive multimedia documents so that it emulates the printed publication medium but also goes beyond it in offering sound, video and interactivity.

The Internet and the World Wide Web both typify technologies that came into being through serendipity rather than design in that the informations and aspirations of their originators had little relation to what they have become. The beginning of the Internet was the ARPANET with 23 computers connected in 1971. At the beginning of 1988 some 28 thousand computers were connected through the Internet. The number has grown to over 16 million in 1997 and an end of the expansion is not in sight.

The World Wide Web was conceived by Tim Berners-Lee in March 1989 as a "hypertext project" to organize documents at CERN in an information retrieval system. The design involved: a simple hypertext markup language that authors could enter through a word processor; distributed servers running on machines anywhere on the network; and access through any terminal, even line mode browsers. The web today still conforms to this basis model. However, major usage only began to grow with the February 1993 release of Mosaic for X-Windows. The growth rate of overall Internet traffic is some 100% a year. Web traffic, when last accurately measurable in 1994, was growing at some 1,000% a year.

Science Publishing

General

As already mentioned, the number of pages and title published is increasing constantly. At the same time the quantity of research continues to expand, therefore publication times of printed journals are not able to keep pace with the advances of science. In a world of rapid communication the scientist is slowed down by long publication times.

On the other hand science journals are part of the permanent, scientific record. Only quality science that

passes the critical review of experts in the field and falls within the scope of the journals' coverage should be published. The peer review process of a manuscript is time consuming, but necessary to guarantee the high level of a scientific journal. Like the refereeing, a number of steps had to be passed during the publication process to prevent errors from being introduced in the final publication. The solution at hand to achieve short publication times in a high quality scientific publication is to use electronic technologies in every step of the publication process.
Electronic publication also offer the possibility to publish information enhanced papers. Supplemantary material like 3D coordinates, videos, spectral data etc. can be linked directly to the paper. Electronic journals that are available via the World Wide Web can be accessed from almost every computer all over the world. The scientist does not have to go to the library, but can retrieve the information directly from his desk in the lab.

Journal of Molecular Modeling

The Journal of Molecular Modeling [Clark 1996] has started as an idea at the Fall ACS National Meeting in 1994. In the beginning, not being aware of the World Wide Web, it was planned to distribute the articles as wordprocessor files via FTP. To guarantee longevity of the published material a CD-ROM and print version should be issued once a year.
When the project started in Spring 1995 with the publication of four articles, the WWW had become common knowledge. With this new hypermedia system an electronic journal could be presented in a way we never dreamed of. The limitations of the HTM language became clear when we tried to format our first article. Greek letter and mathematical formulae could only be introduced trough tiny little images. Tables could not be typeset and page numbering was not available. The last one was the point of trouble. Being the first fully electronic journal in chemistry the abstract services were willing to include the Journal of Molecular Modeling as long as it could be cited just like a printed journal. The solution was to publish the articles in PDF-format. This makes the journal in the beginning more "book-like", but has the advantage that Greek letter, mathematical and chemical formulae can be included, pages are numbered and the manuscript is save in a format that cannot be easily tempered with. Authors and readers have the guaranty that the publication remains unchanged.
The Journal of Molecular Modeling has been developing over the years and still is. The primer aim is to be a good scientific publication, therefore every article must pass through all steps of a thorough publication process to control quality. Every manuscript is reviewed by at least two referees, experts in their field. The paper is revised by the author and after resubmission corrected by our copy editor. The layout of the corrected article is done by the desk editor, who will send the galley proof back to the author. After transfer of the authors' corrections to the original the paper is ready to be published. In principle this procedure is the same for printed and electronic journals. The difference is in the implementation: Papers are submitted and refereed electronically. The galley proof also is send back to the authors via email. Since an electronic journal must not adhere to a fixed publication schedule, papers are published as soon as they are proofread by the authors and double checked by the production department. Abstracting of papers published in an electronic journal is extremely fast. Abstracting services can either copy the graphical abstracts to their own server or link directly to the journals pages.
The first volume of the Journal of Molecular Modeling had 201 typeset pages, some of them showing color graphics, and the only multimedia component used were 3D structures provided in PDB- or XYZ-format. The number of pages has increased to 477 in 1996. Authors made widely use of color graphics. In addition to 3D structures multimedia material like VRML-scenes and video sequences were incorporated. In 1997 we expect to publish some 800 pages. Three new features are launched this year.
For the first time, the 1997 edition of the Journal of Molecular Modeling will feature enhanced abstracts, these are short (up to 6 slides) HTML-slide shows outlining the contents of the full paper that convey the message of the paper as effectively as possible.
The implementation of electronic technologies in every step of the publication process did cut down the publication times considerably. However, for urgent communications of up to three pages we will issue the Journal of Molecular Modeling Communications that are intended to provide unprecedentedly short publication times of less than 20 days.
Invited reviews of unlimited length will be presented as Journal of Molecular Modeling Reviews and Open Discussions. Reviews will be available for three months after the publication date for email comments from other researchers and replies from the authors. This discussion will then become part of the final published

version of the review.
The Journal of Molecular Modeling is always in development to adapt to the needs of authors and the wishes of readers. We cannot build up today the framework for tomorrows publishing. In theory there are much more multimedia applications that could be incorporated in an electronic science publication. The question that always arises is, does it help the author to present the results and does it lead to a better understanding? The aim of the Journal of Molecular Modeling is to communicate chemistry in a sophisticated way, not to make chemistry publishing to a new science of its own.

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Simulations for Learning: An Inquiry-Based Approach to Biology

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Introduction

BioBLAST® is a multimedia curriculum supplement for high school biology classes. In the *BioBLAST* scenario, students use simulations based on USA National Aeronautics and Space Administration (NASA) life sciences research data to develop and test their own designs for a biological life-support system that could support humans in space. The primary goal of the *BioBLAST* program is to get students involved in critical analysis and problem solving processes associated with scientific inquiry. The interactive adventure/simulation framework includes computer-based tools and resources, telecommunications events, and hands-on experiments that are all presented within a graphically rich QuickTime™ Virtual Reality (QTVR) interface. [Figure 1] provides an illustration of the three-dimensional lunar base model used in the QTVR user interface to the interactive simulations. The software is designed to draw students into a futuristic, problem-solving scenario in which teams of students are sent to a simulated lunar research facility. There, students use graphical simulation tools and resources to prepare for their mission goal: to design and test a model for a plant-based life-support system that can support a crew of six for three years.

Features of Simulations

The laboratory-based Plant Production [Figure 2], Human Requirements, and Resource Recycling simulators enable students to perform investigations not possible in real time or within the facilities of a high school lab. In addition, the interactive, simulation/modeling tools give students hands-on experience with the technology tools that scientists use to collect, analyze, and display complex sets of data. The three lab-based simulations are designed to accompany each of the three research strands within the BLiSS (Bioregenerative Life Support System) problem that students will address. A fourth simulation called BaBS (**B**uild **a** **BLiSS** Simulator) [Figure 2] is used to pull all three topical areas together to construct an idealized model of plant-based life-support system. Students refer to the research database provided within the main simulator to generate their numeric entries regarding crop growth, human diet, energy requirements, resource recycling parameters, the number and gender of crew members, and duration of the test. All four of these simulations utilize NASA data and make it easy for students to export the database and the results of their simulation runs. Students are encouraged to further analyze their results in a spreadsheet program. Through the process of selecting and testing features to include in their simulation run, students apply, synthesize, and expand their understanding of such principles as: (1) how energy flows through living systems; (2) the role of plants in recycling air and water cycle for human use; (3) how various environmental factors affect the rate of photosynthesis; and (4) why photosynthesis and cellular respiration form a continuous cycle. As prescribed in the National Science Education Standards (NSES) [NSTA, 1996], student work with the simulations leads up to a design model that the student must explain and defend in a written report and/or verbal presentation. The final BaBS run, analysis, and report is one of the culminating activities in *BioBLAST*.

Teacher Involvement

Early on in the development of this program, high school science teachers representing a variety of cultural and socio-economic communities and geographic regions of the United States were selected to participate in the design, testing, and evaluation of this software. Two primary criteria were used to select teachers to join the extended design team: (1) access to the computer technology required to run the software; and (2) demonstration of a clear desire to use an inquiry-based approach that emphasizes problem-based learning. This study describes how early involvement of teachers in the design, development, and formative evaluation process helped identify the goals for teaching and learning that the simulations in this software most effectively address. Teachers used the initial list of goals that we designed this software to address as a planning document.

Based on teacher reports regarding the process of integrating the simulations and related materials, student use and analysis of outcomes of the *BioBLAST* simulations fulfill the NSES [NSTA, 1996] through activities that ask students to: (1) Trace energy transformation and/or apply the principles of mass/energy conservation to physical and biological systems; (2) Relate the effect of light and other factors on various aspects of plant life and growth, including photosynthesis and respiration, germination, and tropisms; (3) Predict the effect on an ecosystem due to a given or proposed environmental change; (4) Formulate an experimental design to test a given hypothesis; and, (5) Relate the effects of biotic and abiotic factors to animal life including growth, reproduction, and behavior.

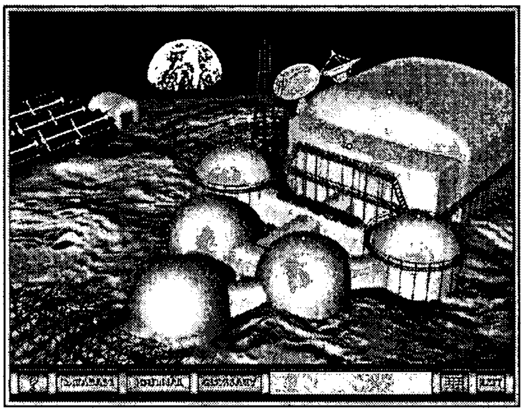

Figure 1. This screen capture shows the graphical interface for one of the *BioBLAST* simulators.

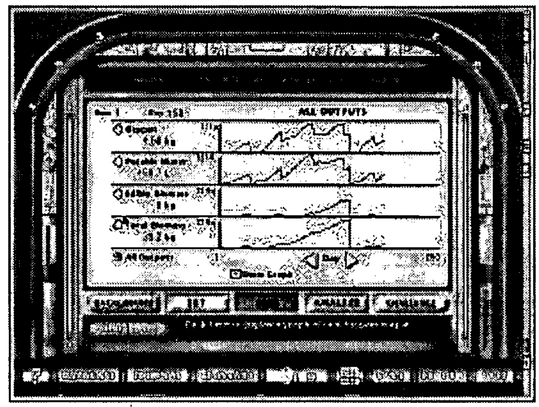

Figure 2. This screen capture illustrates the dynamic graphing available in the *BioBLAST* simulators.

Summary of Results

The formative evaluation of the *BioBLAST* software included data from pre- post-tests, student reports, teacher observations, and student work. Teachers developed unique ways to integrate this program into their curriculumin that suited their school curriculum and course offerings. BioBLAST has been incorporated into introductory, general and advanced biology, advanced technology, student research electives, and math classes. Teachers reported that they had to change their teaching style to integrate this program and found that students needed the following skill-building activities prior to beginning the computer simulations: (a) cooperative learning and team building activities; (b) introduction to the use of spreadsheets for organizing and analyzing data; (c) concept mapping to tie together concepts and connect ideas; (d) building and interpreting graphs to represent data; and (e) conversion to and use of metric units of measure. Further analysis of pre- and post-tests will show whether our selection of ninth grade as the target population for *BioBLAST* is consistent with the findings of [Friedler & McFarlane 1997] and [Burkam, Lee, & Smerdon 1997] who determined that data logging and analysis can significantly improve student graphing and interpretation skills if conducted prior to age 16. Analysis of student portfolios provide descriptive indicators of student motivation and effort and, as [Hickey 1997] suggests, will provide ways to document teacher reports of increased student motivation and effort associated with the interactive media tools and approach to teaching that encourages inquiry-based learning.

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Introducing a Media Production Course into the Middle School: Don't Reinvent the Wheel

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As schools continue to add classes involving multimedia integration, teachers without production training are being asked to implement these courses. Usually an innovative instructor covering a traditional subject area will be asked to take on this new challenge. In other cases, a risk-taking teacher may volunteer to teach the new class. In either circumstance, teachers are left with the challenge of implementing a new course covering a subject area where there are few curriculum guides, few sample lesson plans, and even fewer teacher training materials.

One middle school near Charleston, South Carolina, successfully implemented such a class. Not wanting other teachers to "reinvent the wheel", the instructor created an online compilation of her teaching objectives, lesson plans, hand-outs, and resources called The Media Production Homepage. The web site contains practical information for a teacher with limited resources and limited training. Educators from across the globe have visited the web site that receives approximately 140 hits a month and have responded positively. From the Media Awareness Network in Ottawa, Ontario, Cathy Wing asked for permission to adapt the lessons for use in Canadian schools. Mark Dobbins, a member of the Education faculty at the University of Melbourne commented, "Your site is terrific! I can see many teachers wanting to try out your course. And you have supplied them with just about everything they would need. Thanks for putting such a wonderful resource in the public domain for teachers everywhere." Linda Cossel, a K-12 teacher from Michigan said, "I do a daily, live, morning news broadcast for our junior high school, or actually the kids do it. I stand around and pray. It is wonderful and the most stress I have ever endured. Anyway, I love your site and am in the process of reading every word. Five stars!"

The nine week middle school course taught students how to create short animations, write news articles, and how to take a broadcast news topic from idea to video. Students worked in teams to produce a segment of a final news show that was broadcast throughout the school.

The course was implemented with a very limited budget. Basic materials needed to follow the online lesson plans include a videocamcorder, tripod, copystand, microphone, typical classroom supplies such as scissors, tape, construction paper, computer running desktop publishing software, laser printer, TV, and two VCRs for editing.

The course ran for nine weeks. It began with an ice breaker on day one and the initiation of a collaborating partnership with an overseas classroom on day two. For the following three weeks, students worked on animations. Next, for one and a half weeks, articles for the school newspaper were created. Students then spent two to four weeks on video production. They wrote T-scripts, created sets and props, and then videotaped their segments. The Media Production Homepage gives several suggestions of how to fill any remaining time. The teacher may want to provide instruction on the Internet, spend more time collaborating with the partner school, teach a unit on advertising, or utilize Tom Snyder's One Computer Classroom Kit, *Violence in the Media.*

Handouts for the class included a letter to parents telling them about the new course, Animation Guidelines, Steps in Creating a Newspaper, Formula for a Well-Written News Article, TV News Evaluation, What Are We Doing? Worksheet to help students with their video production planning, and an Occupations Related Worksheet to give students a chance to research careers related to media production.

By viewing the curriculum materials from a successful hands-on middle school course, teachers of media production will have an easier task of adapting the class to meet the needs of their schools. The Media Production Homepage, authored by Stephanie Rusnak, is located on the World Wide Web at www.geocities.com/Hollywood/Hills/1902.

Tela: an Authoring Tool for the Instructional Design on the Internet

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Abstract: We want to promote teachers' collective work on the World Wide Web, through the definition of the architecture of a standardized network system for the integration of the operating cycles of the learning process. The integrated system is composed of an authoring tool (Tela) for the design of instructional material to be used on the Internet, of a distributed data base management system (Component Warehouse) and of a fruition module (Bùxis). In this paper we will describe our current research work on that part of the integrated system which is used to create and modify the lessons: the Tela authoring tool. We will also describe the way chosen to represent the learning architectures thus tailored.

Introduction

The ideation of an integrated system and the development of its prototype are the most important phases through which we want to promote teachers' collective work on the World Wide Web. Our main objectives are:

- to define the architecture of a standardized network system for the integration of the operating cycles of the learning process
- to define how to store and use didactic components
- to define how to elaborate a training course dealing with the corresponding theorical and practical approaches for teachers.

The integrated system is composed of an authoring tool (Tela) for the design of instructional material to be used on the Internet, of a distributed data base management system (Component Warehouse) and of a fruition module (Bùxis). The system will be tested by a small group of secondary schools (25) in the first phase of our project. Its main caracteristics are related to:

- the "ideation space" which will consent teachers to organize in a structured way the conceptual nodes they want to elaborate;
- the "filling of nodes", which will be processed by either a querying activity to the common data base or by the personal edition of content;
- a serie of guidelines, based on the instructional system design principles. The guidelines will orientate the design of material and the selection of media for knowledge representation;
- the navigational strategies through a new browser, called Bùxis. We focus on a new mechanism for the visualization and the access of specific concepts integrated in a large cognitive map.

In this paper we will describe our current research work on that part of the integrated system which is used to create and modify the lessons: the Tela authoring tool. We will also describe the way chosen to represent the learning architectures thus tailored.

We will develop the system prototype according to the following actions:

- automating the identified methodology for Instructional System Design (ISD);
- implementing Tela's advanced GUI;
- structuring the Component Warehouse using a distributed OODBMS;
- defining syntax and extension of the Lesson Document as a SGML application;
- developing the Bùxis navigator that offers the neccessary browsing and visualization tools.

The Learning Architecture

Concepts pertaining a particular topic, which is investigated in one or more lessons, are represented through a map of the corresponding cognitive area. This map consists in a hybrid structure with peculiarities of a tree as well as of a non-oriented graph, where every single concept, idea or task constitutes a node (labelled with a title).

In particular, ascendent and descendent links (associative connections) among concepts are represented with a hyerarchical structure (tree), while referential links consitute further non-oriented archs among the nodes of the previously constructed tree.

First of all, the tree is designed and secondly, the learning architecture is completed with the referential links, thus generating a graph (reticular structure) which is the final result seen by the user, who, however, still keeps traces of the underlying tree structure. The latter allows the use of implicit different Levels of Detail (LoDs) while visualizing the didactic material. On the underlying learning architecture, the teacher tailors the various lessons using instructional design techniques. In the graph, which represents the map, the lessons are shown as groups of nodes of different colours.

Every node of the map contains some material describing the concept dealt with in the node or, for instance, the development of a proposed exercise. This material may consist of one or more mediatic representations, for instance a concept may be better described with written text and an image. Generally, a node should not contain more than one element being represented with the same medium (for example two images). However, when this is necessary, it is better to further structure the map inserting two other subnodes under the main one, each of them containing an image. Still, the support of representations similar to each other may be useful when describing a concept, as in the case of a node describing a tree by showing two pictures of it.

In this way, the distribution of concepts is always organized in the graph whereas at a node level they are only codified. This makes it easier for the user to choose between verbal or non-verbal encoding depending on the topic being described. Finally, it is better not to leave a node empty (i.e. when structuring a topic in various subnodes): every node should contain at least an overview of the topics dealt with in the subnodes in order to facilitate the use of LoDs.

The Authoring Tool Tela

The system includes activities based on the conceptualization and development of learning architectures for teaching, distributing, accessing and differential processing of knowledge. All this will involve three specific, interdependent phases. The first one is concerned with the whole of the procedures defining and structuring didactic material. The second one regards the planning of the teaching strategies and the last one sees the development of the material, that is the attribution of contents to the nodes previously described. The latter activity becomes effective through the sorting of the media operating by means of a search system in the Component Warehouse.

Tela is new in its introduction of a set of techno-pedagogical functions which can place the user within a mixed environment, so that he/she can be guided by some principles of the pedagogical design but is not forced to follow its sequential organization. The user, moreover, is able to edit or create material from within the system itself. The idea of recalling information components in various formats from the Component Warehouse created for the project implies that it is possible to start operations of total or partial construction as well as to collect didactic activities carried out by the other participants to the project.

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Connecting Educational WWW Pages With Curriculum Materials

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Abstract: The main goal of the present investigation was to evaluate the relevant method of teaching in computerized science classes. Furthermore, we tried to estimate the impact of computerized biology lessons on students' motivation and their attitudes to the problems of environment protection and Estonian nature. The teaching method developed in our department was fully supported by the expert group of science teachers. The analysis of students' worksheets and questionnaires refers to the suitability of the relevant methodology to enhance students' ability to analyze and synthesize. The questionnaires revealed students' increased interest in school-biology.

Estonia is currently undertaking reforms in its educational system. The implementation of the new State Curriculum in Estonian schools began in autumn 1997. The reform is taking into account Estonian aim of integrating into structures of European Union. Estonian educational reform covers pre-school education in kindergartens, general basic schools, upper-secondary general schools and vocational education. Following from the curriculum, different subjects are integrated by common themes. "Informatics and Infotechnology" is one these.

At the present time about 200 out of 350 secondary schools in Estonia have their own computer classes with the direct or dial-up Internet connection. Therefore at first we were interested in how our science teachers had used computers in their everyday activities. 85 science teachers of different secondary schools filled out questionnaires about their previous experiences, opinions and suggestions in using computers for teaching their own subject.

It appears that only 6% of teachers use computer every day and 37% of them have never used it. The most common areas of using computers are the following: typing texts (54%), various Internet services (31%), playing games (16%), creating databases together with statistical analyses (8%), and using educational software (8%). Nobody has used computers in teaching science.

One may ask whether Estonian teachers don't like to teach science in computer class. Our Department conducted several computerized biology lessons in different secondary schools. Teachers of those schools had an opportunity to observe these lessons. We were interested in their opinions. Nearly half of the teachers were willing to teach science using computers and only 4 % of them declared that by no means. The students who participated in the lesson also liked it. More than 64% of students found that it would be nice to have more such kind of lessons. They also mentioned that the biology lesson carried out in computer class increased their interest in school biology.

Another problem is lack of educational software, in particular, in Estonian. Our students are not ready to use software in English or in other languages, except in Estonian. Of course, in some subjects, for example, in teaching languages the software is immediately applicable. In other subjects, the computer programs can be translated. But in the field of natural sciences every country must compile its own original educational software introducing their own unique nature.

Therefore our department has started the project "Estonian Plants and Animals". As the result of two-year project we will create Web materials applicable in teaching various themes of school biology, integrated science and environmental study according to the new Estonian State Curriculum. The materials consist of two distinguishable parts - the database about 500 most common species of Estonian plants and animals, and appropriate computerized educational tasks for both basic and secondary school students. All the opportunities of multimedia will be accounted for - texts, visuals and sound. "Estonian Vertebrates" (*http://sunsite.ee/animals/*) and "Estonian Plants" (*http://sunsite.ee/taimed/*) available on Internet are the first examples of this project. These WWW materials are applicable in several out-of-class activities, for example, in writing and compiling students' research papers, reports, essays, etc. Computerized educational tasks composed on the basis of "Estonian Plants and Animals" enable students to learn the particular themes independently to develop their memory, comprehend, analyze and apply the facts. Various tests added to the package will provide teachers with necessary feedback of students' knowledge and abilities.

On the other hand, it is impossible to create the computerized tasks satisfying all the teachers' needs and adaptable to all the appropriate themes in curriculum. Therefore, we have also compiled various students' worksheets. They can be used without any changes or might serve as examples for teachers to work out theirs own ones. It is essential to compile the worksheets not only for finding and memorizing facts, but also for developing students' higher order thinking skills.

According to the methodology developed for computerized biology class the first 10 minutes at the beginning of the lesson students should get acquainted with the new software. It is essential for both beginners and advanced users of computers - it speeds up work later on. A special printed instruction for students about the principles of layout and help information together with simple tasks was compiled.

Next, after the introductory part of the lesson students had 35 minutes to work independently to fill out the printed worksheets [Adojaan & Sarapuu, 1997]. Since the purpose of the educational tasks was to develop students' higher order thinking skills, the worksheets were composed not only for finding, memorizing and reproducing facts. Students had to find information on different WWW pages of "Estonian Vertebrates" or "Estonian Plants", to analyze, synthesize, make conclusions and find plausible reasons in order to fill out worksheets. Two versions of worksheets with different tasks were used in the pilot lessons. Solving both tasks was connected with all the categories of thinking: knowledge, comprehension, application, analysis, synthesis and evaluation [Bloom et al., 1956]. In case of all the tasks students' abilities to analyze, synthesize and evaluate were connected with acquiring knowledge and comprehending the presented material. Students' ability to find electronic information was also of interest.

Three teachers conducted nine pilot lessons in the computer classes of different schools. 27 basic school students of the ninth grade and 59 secondary school students of the 10^{th} - 12^{th} forms participated in these lessons. Immediately after the lesson students filled out questionnaires about their previous experiences in using computers, ways of using and interests. Students were asked to evaluate the software, worksheets and to express their opinions of possible application of the program in the biology lessons and its relevance to everyday life. Both formative and summative methods of evaluation were used [e.g. Thornton & Phillips, 1997]. Another aim of "Estonian Plants and Animals" is to motivate students to become more interested in school-biology, Estonian nature and the problems of environment protection. 19% of students claimed that it made them be more interested in biology lessons and 35% of students thought that "Estonian Vertebrates" together with the educational tasks made them be more interested in Estonian nature and its protection. Increased interest in these areas is the greatest success in the educational software and methodology.

Teachers of pilot schools formed an expert group. They were interviewed about the educational content of "Estonian Vertebrates" and "Estonian Plants" together with teaching method used in the pilot lessons. Almost all the teachers fully agreed the teaching methodology used in computerized biology lesson. Every educational database with understandable vocabulary is applicable with additional printed worksheets to promote students' knowledge, comprehension, analysis, synthesis and evaluation. Therefore, the relevant method of teaching science in computer class developed in our Department is applicable not only with "Estonian Plants and Animals" but with any electronic database consisting of appropriate information.

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Evaluating Impact of Video and Web-Based Distance Learning Courses

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Universities and colleges are increasingly delivering courses via various modes of distance delivery. This paper briefly describes the results of evaluations conducted on two types of courses which used distance learning methods. In one evaluation an outcomes-based education course for preservice teachers was adapted for television delivery. One section of this course also included a three-week computer-based self-instructional module to teach development of competency-based instruction, and students had access to an "electronic forum."

The other evaluation was conducted to determine the impact of a set of a prototype World-Wide Web-based tutorials for two university engineering courses. This evaluation is currently being completed and full results will be included in the presentation.

The presentation will compare both the evaluation methods and results in these two types of evaluations of two types of distance learning courses.

Introduction to the Evaluation of the Televised Course with Computer-Based Module

The Televised Course: First Course Offering, Fall, 1996

During the fall semester of 1996 a two-credit course, "Learning and Motivation," was taught for the first time via television. Forty-five on-campus students enrolled in one section of the course which was taught in a specially-equipped video classroom. Four students enrolled in the off-campus version of the course. (Another 160 students enrolled in other sections of the course.)

As did students in the other sections, the television-section students met for one hour once a week for the class lecture, followed by another hour of discussion section taught by a graduate-student discussion leader. All 49 television students (45 on campus, four off-campus) participated in the one-hour video lecture, taught by the first author. Then students were divided into three small discussion sections. Sixteen students in one of these, taught by the second author, participated in the televised discussion section, with twelve on-campus and four off-campus.

Both instructors taught the video course using an available graphics pad as well as computer graphics. The class was designed to be broadcast via cable to off-campus students enrolled in their homes or dorms and at various educational and employment sites in the metropolitan area. The classroom was equipped for live two-way audio interaction. On the instructor's podium was a telephone which rang when an off-campus student called in with a question or comment. The video classroom was equipped with microphones, which campus students activated with a button when they wished to ask or respond to questions or make comments.

This semester, however, the four off-campus students enrolled in the course did not subscribe to the cable company, and chose to make copies of the class sessions and pick up materials when they came to campus for other classes later in the week. They watched the tapes at times convenient to them, and instead of using the telephone system to interact with the classes live, used either the electronic forum, email or phone to contact the instructors at other times. These four students were told they would not have the benefit, therefore, of live classroom interaction, but would need to be more active in interacting at times outside of class. They indicated they understood this, but felt it was worthwhile for the convenience of not coming to campus, and/or watching tapes at other times. (Off-campus students were required to come to campus three times during the semester to complete exams.)

The Learning and Motivation Course

The Learning and Motivation course has been taught for over nine years at this university. Over 200 students per semester enroll in the course and we are told students consider it one of their more relevant and enjoyable courses.

The course was initially developed over several years by James D. Klein as an outcomes-based course. We have made changes in the course and in 1996 chose this course for televised delivery, primarily because of its systematically designed, objectives-based nature and relevance for students.

The course is divided into 11 units in three topic areas, namely: applying learning theory in the classroom, developing competency-based instruction, and motivating students. During the first eight weeks of the course this semester students learned about learning theories, how to classify learning outcomes and the conditions for learning. During the next three weeks students worked on their own to complete the self-instructional computer program about developing competency-based instruction. During the last part of the course, students met together again, reviewed the elements of effective instruction and learned about motivation.

Students earned up to 200 points in the course by completing a midterm and final exam, the course computer project, in-class activities and section assignments.

Method

Data Sources

Mid-Semester Formative Evaluation Survey. Students completed a mid-semester survey to assess their attitudes toward the course and television delivery, as well as to enable the instructors to make improvements in the course. The survey consisted of 25 questions. Students were asked the name of their discussion leader and whether and how they had used the class videotapes. Then they responded to eight forced-choice items on which they rated aspects of the televised lecture section. Following this, students answered 12 items rating their discussion section (one of which was televised, two of which were not.) Finally they answered three open-ended questions about the course.

Electronic Forum Logs. About mid-semester students in the television sections of the course were offered the opportunity to communicate with their classmates and all four instructors through an electronic forum somewhat like an electronic bulletin board. Students were told this represented a new aspect of the course that we hoped would work well for them and, if so, that we'd be incorporating in all other sections of the course. As an incentive students were offered up to seven extra-credit points for using the system. They could earn the maximum points by writing at least one original entry about a critical issue in education, replying to another person's entry, and writing one comment about any aspect of the TV delivery of the course.

The system kept a log of all participants' entries. Students' entries were analyzed for frequency and content of participation and results will be presented below.

End-of-Semester Formative Evaluation Survey. As is customary in the course, a brief end-of-semester survey was administered to all students. Students were asked the same questions as on the mid-semester survey, and were also asked questions about their overall rating of the course compared with others, their opinions about the self-instructional, computer-based unit, and whether or not they would again take a course via television. (Highlights of the results of this survey only will be included in the presentation.)

Course Performance. Students could earn a total of 200 points in the course. Mean numbers of points students earned were compared by section.

Results

Mid-Semester Formative Evaluation Survey

The results will be presented by section. Thirty-three of the forty-five on-campus students and three of the four off-campus students rated the televised lecture section of the course. Twelve on-campus and three off-campus students rated the televised discussion section of the course. For comparison purposes ten and eleven students respectively rated their non-televised discussion sections taught by the two other discussion leaders.

Results are summarized on a copy of the student survey in Table 1 and will be discussed in detail in the presentation. Key results were that the audio system was problematic for both in-class and remote students, and that students even in the classroom felt somewhat hampered in interacting in class due to the television system.

Electronic Forum Logs

Sixy-one entries were made in the electronic forum during the final six weeks of the course. Forty entries were made by students, while 21 were made by the two TV instructors. Only nine (18%) of the 49 students used the electronic forum. Four students made three entries each about an issue in education, a reply and a comment about the televised course delivery. These four students made their entries consecutively, thus participating the minimum amount to earn all the extra credit points. Three students made one entry each; each of these chose to describe their view of a critical issue in education.

Two students conducted undirected interactive discussion, beyond what was required to earn points; these two students made seven and five entries, respectively. The first student was an off-campus student taking the course via videotape. This student was the first to begin the discussion on the forum with an entry about a critical issue. This student followed by asking three questions about course delivery and made two entries communicating with the instructors. The second student who participated more than was required was an on-campus student who used the forum for longer discussions with fellow students and the instructors. This student made only one entry commenting about the course, but made four entries which commented about issues in education and replied to other students' entries.

End-of-Semester Formative Evaluation Survey

A brief summary of key results will be presented. Most students rated the course highly when compared with other education and general college courses. Most said they would take another television course. Most said that we should retain the computer-based unit of instruction, however that it should allow students to go back and to print out screens. Some also suggested it should be supplemented with written material, or produced in both Macintosh and PC formats.

Course Performance

Students could earn a total of 200 points in the course. The mean overall course grade for the 213 students across all eleven sections of the course was 178.75. The mean score for the 16 students in the completely televised section was 182.93, including the mean score of 182.96 for the twelve on-campus students and 182.85 for the four who took the course via tape. Five students in this section, four on-campus and one off-campus, earned some extra-credit points by participating in the electronic forum.

Scores were 181.1 and 178.23 for the 24 students who saw the televised lecture, but participated in the non-televised discussion sections. Four students in the first section earned extra credit points, while no students in the last section chose to participate in the electronic forum to earn bonus points. Thus scores across sections did not differ greatly.

Discussion Regarding the Televised Course

Modifications to the audio system are being suggested. In addition, future versions of the course will encourage students to interact with off-campus students who are enrolled via cable, thus taking the course come "alive." In future courses, we intend to foster increased student interaction within the class by using brief motivational exercises early in the semester to get students presenting to their colleagues informally from the start of the course.

Course grades did not differ greatly among televised and non-televised sections of the course. This would be expected in that most of television students participated in the on-campus video classroom. It may be that the slightly higher scores could be attributed to the fact that the television lectures included better visuals, such as full-color PowerPoint graphics, than did the overhead-equipped regular lectures. Also students in the three television sections could choose to earn extra credit points by taking part in the electronic forum.

However, the television sections of the course were also smaller than the regular class sections, as they usually are for our evening sections. They ranged from 11 to 16 students compared with 18 to 27 for the day sections. Students in the surveys also indicated that they enjoyed taking the evening, television class because it was smaller than the day class, with 49 students in lecture, compared with 164 in the day lecture.

Finally, we have noticed a pattern in past years in course grades per discussion leader by section. Each instructor teaches each topic three times, usually beginning with the day classes and ending with the evening section, so evening section grades have tended to be higher.

We have concluded that the fact that scores did not differ greatly bodes well for at least on-campus students in televised classes. This is consistent with results of earlier evaluations of televised classes at this university. It is hoped that in the future increased numbers of students will enroll in distance learning versions of this course. Grades will be continue to be examined to monitor the performance of on- and off-campus students.

The Evaluation of the Web-Based Engineering Tutorials

The Web-Based Modules: Pilot Course Use, Fall, 1997

During the fall semester of 1997 a team of engineering professors and students received a grant to develop four prototype tutorials for graduate education in semiconductor processing and manufacturing. Each tutorial was designed specifically for each course to provide an interactive self-paced and very visual learning environment. An education professor assisted each development team in improving the effectiveness of these prototype tutorials as part of the process of developing an expanded set of tutorials for the following year.

During the latter part of the fall semester, the impact of the first two tutorials was assessed in graduate courses in the engineering program. These tutorials were for an electrical engineering course and a chemical engineering course.

The results of these evaluations are currently beingThe proposed presentation will describe the methods and results of the formative evaluation study conducted to determine the impact of these prototype web-based tutorials.

Method

A short survey, based on those used in our previous evaluations of distance-learning courses and multimedia programs, was developed. The survey consisted of 21 items, with most being forced-choice, followed by three open-ended items. The survey items required students to provide us their perceptions in such areas as the value the tutorial added to the course, whether they'd used such web-based tutorials in other courses, how easily they were able to use the tutorials and their features, opinions about the design of the tutorials, their least-liked and most-liked features, and their suggestions for future iterations of the tutorials.

Nineteen students evaluated the CHE, chemical engineering tutorial and 56 students evaluated the EEE, electrical engineering tutorials. The students were either upper-division undergraduates or graduate students.

Results

Most students had not encountered web-based tutorials before, with 84% in the EEE course and 95% in the CHE course indicating they had not used such materials before. Students in the EEE course rated their tutorial more highly, with 89% indicating that the tutorial added value to their course, compared with 63% of the CHE students who said their tutorial added value. Similarly, 91% of the EEE students said more tutorials like this would help students learn. On this question, the CHE students were also positive, with 89% of the them agreeing that more tutorials like this would help students learn.

Students' responses to the question regarding where they accessed the tutorial provides insight into other attitudes toward the materials. Most of the EEE students (71%) accessed the tutorials from university computing sites, at which the computers were already set up with such necessary software as Shockwave. In contrast, only 28% of the CHE students accessed their tutorial from university sites, with one-third each indicating they used the materials at their home or their job. Using the tutorials at these other locations proved problematic for some students. Half of the EEE students, who mostly used the materials at the university, said they did not have to download Shockwave, while 23% said they had to download Shockwave and it did not work. Of the CHE students, 81% said they had to download Shockwave and it worked, but took a long time.

Students' open-ended comments about the course amplified and explained the previous results. For example, many students in the CHE course indicated they felt the graphics and animations helped them learn and they liked them. However, students described many problems downloading Shockwave preparatory to viewing the animations. They also indicated that there were some bugs in the program, so they could not view all pieces and that they would have preferred more textual explanations of the graphics.

Students who used the EEE tutorial wrote such comments as that they were "revolutionary," and helpful, especially for exams. Many of these students said they wished there were more tutorials or tutorials to accompany every topic in the course. They, too, described some problems with downloading fonts and Shockwave. These students were very sophisticated in their critique of the design of the tutorial. They suggested adding, for instance, more examples, more solutions and hints for solving problem sets, enhanced color contrast between text and background, less busy screens, a "page down" feature instead of scrolling, an index, added sound, and enhanced navigational aids.

(This paper provides a summary of results. Complete results will be included in the presentation.)

Conclusion

The presentation will conclude first with suggestions for adapting a course for televised delivery. Suggestions include ways to enhance the interactions of students and instructors, improve the systematic nature of the course, and use the visual power of the television medium.

Next will be discussed suggestions from the evaluation of the web-based engineering tutorials for improving the effectiveness of such tutorials.

Finally, the presentation will include a discussion comparing the methods used in the two sets of studies, as well as recommendations for evaluations of various types of single and mixed-mode distance learning systems.

Learning Strategies in Hypermedia Environments

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Most studies regarding learning strategies are based on information from learning strategy questionnaires. One disadvantage of the questionnaire method is that it is not possible to conclude what learners actually do in a given learning situation. A study by Artelt and Schellhas [see Artelt & Schellhas 1996] shows that considerable discrepancies can occur between the strategies which learners report using and the strategies they actually use in a specific learning context. The presented study therefore emphasizes the need for analyzing the use of learning strategies in action.

Learning strategies are the result of the interplay between the cognitive competence and the situated experiences of a person. Furthermore, learning strategies are used to reach learning goals. We choose hypermedia learning/studying environments as a research context for analyzing learning strategies in action because they allow us to examine how students go about reaching a specific learning goal (in the sense of the constructivsm view: self-regulated and self-determinated learning and exploring, so called "free learning"). By analyzing what contents they choose to learn, how they proceed and why they made particular choices, we can observe from multiple indicators how students structure the learning process (self-regulation) and construct a new knowledge entity.

In this study, 50 10th grade students studied a learning unit in History about the First World War in order to draw a personal conclusion. They were guided by a content question which was given to them at the beginning of the hypermedia session. Students were given considerable freedom in defining the task in their own terms and exploring the learning environment at their own pace with their specific questions in mind.

While studying the hypermedia materials, all learner-computer interactions were recorded in a computer log-file. This protocol thus contains data about reading-times, chosen cards, navigational data, etc. At the end of each session, the trace was displayed step-by-step. With the help of this display, students were interviewed about their intentions, goals, their thoughts and the strategies they employed while moving through and exploring the hypermedia learning environment.

Data were thus collected with three different methods: a) questionnaire data was collected concerning learning strategies, cognitive abilities, motivation (general and proces-specific), anxiety, attitudes towards computers, school subject preferences etc., b) behavioral data was gathered concerning navigational and content choices in form of a computer log-file, and c) qualitative interviews were conducted about learners' thoughts and intentions during the hypermedia learning session.

The main research interest was focused on the use of individual learning strategies, specifically, the use of deep and surface learning strategies and the use of metacognitive aspects of learning strategies such as resource management. We found that students who preferred surface strategies did not structure information in an elaborated knowledge system. They were not interested in getting further information for a deeper understanding of the subject. On the behavioral data level, we found a rather sequential orientation in using the hypermedia material. Also, students with a surface-strategy orientation were more extrinsically motivated and more affected by test anxiety than students with a deep-strategy orientation. On the other hand, students with a deep-strategy orientation showed more nonsequential or linked processing and more frequent use of content maps indicating better metacognitive resource management in the behavioral data. Navigational behavior could be interpreted mostly in terms of self-regulated learning.

It could be shown, that learning strategies and exploratory styles (linear or nonlinear navigational patterns) were relatively independent factors in the learning process. In pursuing learning goals, the exploratory mode is controlled by some other factors, e.g. motivation, prior knowledge or cognitive style preferences. A lot of students who had a rich prior knowledge base regarding the History topic, preferred a more direct (or linear) way of information seeking. The interviews which were conducted after the session, showed that these students had a deep-strategy orientation although the trace of the behavioral record showed more surface-strategies indications (e.g. linear proceedings). This fact shows that qualitative interview data are necessary to reach valid conclusions about behavioral learning strategy data.

We also compared learning questionnaire data with behavioral data gathered in actual learning situations. The results indicate significant gender effects in attitudes towards the computer. Generally, students who are more familiar with computers rated the task more positively. Our findings suggest also, that the learning strategies identified for learning with traditional texts are also manifested in hypermedia environments. Furthermore, we found that students approach a task in very different ways, depending on prior knowledge, abilities, motivation and learning style. The implications of our findings are discussed with regard to improving the design of hypermedia learning environments.

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Internet-Based Telelearning: Architectural Support and Experiences

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1. Introduction

With the evolution of Internet services and distributed multimedia technology new tele-education facilities become feasible. This enables numerous new opportunities for students and universities: Courses can be designed in a more interactive way, lectures of specialists from abroad can be integrated into a regular curriculum, solutions to exercises can be submitted and be corrected online, and interdisciplinary work can be stimulated.

This paper first presents experiences with a teleteaching project between the Universities of Technology of Saxony, Germany, in Dresden and Freiberg. To enable flexible teleteaching support, three major scenarios are being implemented: (1) Broadcast of lectures: First, lectures can be broadcast online or batch-oriented to remote locations via the Internet. In addition to the audio and video of the lecturer, the teaching materials are displayed via shared applications. Internet tools such as mbone, and wb (whiteboard) serve as an experimental basis. (2) Interactive exercises: Secondly, exercises can be accessed via World Wide Web in an asynchronous way, and solutions can be sent back by the students (also from dormitories) via HTML forms, recently also augmented with animations based on Java applets. Some exercises can be corrected automatically using solution masks (e.g. for multiple choice questions), but most are corrected interactively. Feedback is given to the students by MIME (Multipurpose Internet Mail Extension) mail. (3) CSCW (Computer Supported Cooperative Work) in small groups: Thirdly, we offer seminars to small groups of students. The students cooperate performing special exercises, for example designing web pages for a virtual company.

2. Java Based Teleteaching Kit (JaTeK)

Based on our experiences gathered in our previous project, an integrated infrastructure based on Java has been developed recently for more systematic development and more runtime support of such scenarios. In this part, the paper presents the major characteristics of this „Java Based Teleteaching Kit" (JaTeK).

The usage of the programming language Java makes it easy to develop platform independent software that is able to run with various Internet browsers. The installation effort of such a system may be kept quite low. Java enhances the functionality of the Internet in such a way that makes it possible to use this language for such complex teaching scenarios as the ones listed above that mostly can be supported by the JaTeK system: (1) Creation of online teaching material: JaTeK offers utilities for structuring the teaching material in chapters and subchapters, inserting the lecturing material into these chapters, creation of interactive exercises, and for glossaries etc. (2) Offering teaching material: JaTeK supports teaching material in various forms such as scripts, video and audio sequences, simulations animations, and links to important literature etc. They are structured into various chapters and subchapters and combined with hyperlinks. (3) Online interactive exercises: Students have the possibility to access exercises in an asynchronous way. Solutions can be sent back via E-Mail, HTML forms, and recently also augmented with Java Applets depending on the representation of the exercise. (4) Workgroup support: The system offers the possibility to work in groups over larger distances by using such functionalities like e-mail, and newsgroups that are used for asynchronous communication, and chat, audio and video conferencing, and whiteboard for synchronous communication. (5) Evaluation of the teaching process: The system offers two major viewpoints: the evaluation of teaching material by logging and monitoring various access data and the evaluation by gathering data from questionnaires.

3. Architectural Aspects

JaTeK combines three main modules that interact with each other and realize the mentioned features of the system: JaTeK as the core module implements integration of multimedia lecturing material, user administration, management of user groups, and several auxiliary tools. This module consists of two modes: the student's mode is for learning using the lecturing material, and with the tutor's mode it is possible to edit this lecturing material. JaWoS (Java Based Workgroup Support) offers various multimedia-based CSCW tools for interaction within small learning groups. Finally, Javal (Java-based Evaluation) implements tools and techniques for evaluating learning success, especially with respect to online exercises. The architecture of JaTeK represents a Client/Server architecture, e.g. as the basis component serves a JaTeK server that interacts with JaWoS servers, the Javal server, and all JaTeK clients running in the context of a browser on the student's or turtor's side. On data request from a client the JaTeK server connects to a database, retrieves the according material objects, and extracts the requested data. In the database all lecturing material and glossary items are saved as well as all exercise parameters.

4. Conclusions

In summary, it is obvious that today's multimedia facilities, network infrastructures and Internet services already enable rather sophisticated, interdisciplinary teleteaching scenarios. In particular, we often discovered that didactic questions and issues of presentation and user interaction are as challenging as the basic technological problems. The results of a questionnaire-based evaluation have shown that the acceptance under the students for such a Java based teleteaching system is quite high. This is mainly based on the independance of time and location of studying We also recognized the important potential of user interaction within exercises and practical online courses: The system gives students the possibility of interactive exercises in form of special Java applets. These exercises allow students to solve problems by playing different situations (experiments) or trying sample solutions (online exercises). In this case the solutions are automaticly corrected online. It has shown that the availability of interactivity intensely increases the learning achievements of the students. The presentation of the lecturing material also crucially affects learning motivation. So we became aware of the importance of layouting the user interface, of colors, fonts, font sizes, and structuring texts. Especially the student's remarks in the free-form sections of this questionnaire caused us to set more sensitive store by those points during the realisation of the user interface.

Our further work will concentrate on the realization of more interactivity in exercises and on tools that support the user interaction within working groups. Moreover the evaluation of the JaTeK system and the presentation of lecturing material will continue being an important area in our work.

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The Freiburg Medical CD-ROM On-line Library

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1. Introduction

The number of medical CD-ROM releases such as electronic databases, computer based training and multimedia systems, textbooks and conference proceedings is continuously growing. Therefore these media should be considered important information sources besides traditional library services [Graham 95, Schatz 97]. They are especially important for students in Health sciences and for the continuing education of Health professionals [Barnett 95, Klar 92, Schulz 97a]. An outstanding added value of electronic media is the independence from time and space through on-line access. But only a minor part of these publications (mostly literature databases) are really designed for on-line access or multi-user operation on the basis of terminal emulation or client-server architecture. Besides HTML and JAVA™ based Internet-resident free publications that will not be discussed in this paper, virtually all commercial medical *multimedia* programs are developed for stand-alone microcomputer (today chiefly Windows™-PC) usage. A possible network installation – if ever planned – generally requires time-consuming client installation and maintenance and is mostly restricted to one platform architecture.

2. Methods

In the Freiburg University Hospital with more than 3500 PCs connected to the local network we installed hundreds of different PC software titles on a high-performance Netware™ file server, called INFOSERVER [Schulz 97b, Schulz 98]. In order to use it, only once a Windows™ based client must be installed. This menu client cares for the necessary modifications to the local configuration, the mounting of server volumes and the license metering, as agreed with publishers. This unorthodox approach of keeping all program and library files on the server and avoiding local registration and installation of the programs was possible with more than 90 % of all acquired software titles. The rest was installed on a central Citrix Winframe™ server [Schulz 98] with sessions delivered to the end users via the ICA protocol. INFOSERVER is however limited to the University Hospital's network with a homogeneous PC / Windows™ platform basis. Due to the great demand for medical programs from outside this subnet access to medical software will be provided within the campus network in near future. As here different platforms (PC, UNIX, MAC, OS/2) must be supported, we decided to migrate totally to the new Windows NT terminal server technology that makes Windows NT sessions exportable through the network using platform independent JAVA clients. This campus-wide implementation of INFOSERVER, called INFOSERVER+, will be based on the technology [Winterer 98] developed at the Freiburg Computing Center. INFOBASE+ uses the NTrigue™ server technology and the Keoke™ Java Clients. It is already routinely used for the platform independent distribution of Windows™ and DOS™ based databases [1].

3. Results

[1] The present situation is complicated by the purchase of the NTrigue™ technology by Citrix Systems Inc. and the licensing of the WinFrame™ multi-user technology by Microsoft. We will therefore wait for a definite solution in this process before putting the INFOSERVER+ project into practise.

Besides the routine experience with WinFrame within the running INFOSERVER project, we performed test installation of medical multimedia CD-ROMs in the INFOBASE+ environment. The results are promising, but multimedia performance is still a week point, due to the limitations of network bandwidth and the performance of the JAVA clients. Sound is not yet supported. Printing on local printers can be realized by the transfer of PostScript files to the user. The following table shows a first comparison between the two approaches:

	INFOSERVER (Netware™-Fileserver with specialized Windows™ clients)	INFOBASE+ (NT-NTrigue™ application server, InfoBase+ solutions and Keoke™ Java Clients, in future InfoServer+, probably based on the future Citrix platform)
Stability of Server	+ + +	+ +
Stability of Clients	+	+ +
Scalability of Server	+ +	+ + +
Platform-independence	– –	+ +
Printing	+ +	+
Software installation on server	+ –	+ +
Client maintenance	+ –	+ +
access to large files	–	+ +
video performance	+	+ –
storing of individual user settings	+ +	–

Table 1: comparison INFOSERVER / INFOBASE+

4. Conclusion

The personal computer paradigm that may be outlined by "one CD-ROM, one program, one user, one machine" must be considered obsolete in corporate and campus networks, where a user-friendly on-line access to all electronic media should be taken for granted. We demonstrated the feasibility of delivering Windows based CD-ROM titles from remote application servers to multiple platforms. Compared to the traditional LAN approach with shared file systems the new terminal server technology seems to be more promising because clients are platform independent, there is no interference with the local machine and the file system is more protected against unauthorized access. Without any doubt, distributed client/server solutions might be preferable, but nothing indicates that commercial multimedia publishers will adopt this technology in near future. We expect that the present deficiencies in NT™ terminal server technology will be overcome due to future improvements in bandwidth and JAVA performance.

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Professional Taxonomies and Instructional in Information Systems: Linking Educational Practice to Student Goals

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1. Introduction

The University of Auckland with an enrolment of 25 000 students shares with other tertiary educational institutions the vision of providing life-long learning for its students while attempting to deal with the current restraints on budget and a lack of progress toward optimal use of technology in teaching and learning. The Dearing Report (Dearing 1997), a comprehensive, 1700 page document laying out the situation of tertiary educational institutions in the United Kingdom, has been carefully examined here and its recommendations for expenditures on resource base learning (RBL) and increased use of technology noted with optimism.

The School of Commerce at the University of Auckland has developed a computer-supported learning system (CSL) that is now in its third year of operation and delivers browser-based assessments and other learning materials to more than 10, 000 students in business, and the sciences. On a weekly basis CSL generates many thousand unique practice sessions and quizzes, sends out hundreds of diagnostic email messages and at times is processing more than 300 transactions per second. We have been asking ourselves how we can use technology like CSL to forward our goal to provide life-long learning.

The model curriculum for information systems, IS97[Davis, et al, 1997], is the culmination of more than twenty years of work by world experts and could be adapted to represent our student's goals, our curriculum, the model curriculum and the IS profession.

This paper will report on our research efforts to make IS97 a live link to courses of study, and papers (a single class). Our initial work using Apple's Project X (Hot Sauce) and its attendant graphical representation will be compared with a conventional database solution using Access an implementation of IS97 in Hyperwave™ and a consideration of Th!nkmap™ as an alternative method of representing the taxonomy.

2. Bodies of Knowledge

The body of knowledge (BoK) for information systems, IS97, is made up of 209 knowledge elements classified under 3 topics and 27 subtopics. The depth of knowledge expected of a student for each knowledge element is stated using a system similar to Blooms Taxonomy of Educational Objectives (Bloom 1956). The depth of knowledge varies with the course level and course content. Aggregations of knowledge elements form learning goals and learning units. Learning units are grouped to form 11 separate courses that make up the model curriculum.

Thirty-five Diploma in Business students (first year MBA equivalents with a mean of five years IT experience) were surveyed to determine what value they might ascribe to a body of knowledge in IT. The results were a very positive endorsement of a BoK to assist them in bench marking their courses of study with current job descriptions, the goals of professional IT organisations, and their current personal skills and knowledge in their profession.

One hundred seventy first year business undergraduates were surveyed to determine the value they might place on accessing a BoK in IT. This group strongly endorsed using a BoK to ascertain the relevance of course content and examination questions, as well as for planing their course of study and assisting them in comparing the university's offerings with a professional association's recommendation for a course of study.

Both student groups perceived a long-term advantage to having a personal BoK, and access to a BoK based upon the university's IT curriculum and a BoK maintained by practising professionals. Given these various taxonomies an alumnus could determine what developments in the field indicated a need for professional upgrading by comparing their BoK with the university's BoK. Universities that maintained links with their alumni could proactively identify areas where short courses could be of benefit to former students. Practitioners who had developed niche specialisations or who received corporate training could build new knowledge elements into their BoK.

3. CSL + BoK

The computer supported learning system (CSL) used at Auckland University is based upon a database of more than 200 tables and 800 attributes. Access is via an Internet browser whether at home, work or at the university. CSL delivers active pages generated by MS ASP + COM objects from an SQL database engine mounted on an NT Server (Sequent NTX 2000). All students enrolled in the university are automatically loaded into CSL and have access through a universal ID and PIN, the same used for telephony services. CSL is used by a number of faculties and departments to provide access to teaching resources, on-line assessments with diagnostic feedback and course marks. Many academics use just the Gradebook feature since it can be loaded by tutors marking at home while on the Internet, or batch loaded from OMR sources.

IS97 has been converted to an MS Access environment and links to the CSL SQL database (questions, reference texts, and courses of study) explored. Portions of IS97 have been created in Hyperwave to exploit its multi-collection hierarchy. The greatest challenge is the representation of the inter-relationships among knowledge elements whether within a single course, a curriculum or the professional taxonomy. To this end Thinkmap and other graphical representations of a networked database appear to have potential.

Thinkmap has attracted out attention in particular since it allows one to visualise complex interdependent information without carrying with it the overhead of a major quantitative compute engine. Being able to evaluate the data from multiple perspectives and use standard SQL is a substantial advantage for us. Since Thinkmap maplets are Java applets that interface directly with the data in real time, navigating the curriculum results in the display changing dynamically.

This paper will report on the status of our research into providing a visualisation of the model curriculum, IS97, in the context of a computer-supported learning environment that contains an institutional curriculum complete with student achievement data.

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Dynamic Generation of Customised Documents

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1 The Customising Problem

In many training and education applications of hypermedia, it is desirable to present material at different levels, and in different styles, matched to the learning styles of users [Skillicorn 1996]. Doing this by explicitly preparing multiple versions of the content is tedious, and creates consistency problems.

We present an approach, based on a two-stage filter, that allows a single copy of each document element to be maintained. The first stage is a generative filter. It uses both inclusion and automatic generation to transform a base document into a version that includes many different optional pieces. The second stage is a selective filter. It makes a choice from among the many different presentations implied by the document constructed by the generative filter, delivering the one selected by the user at that moment. The advantage of using a two-stage process is that the boundary between generation and selection need not be statically defined. Moreover, users select the presentation they desire dynamically for each page, and they can therefore adjust it based on their understanding at the moment of encountering the material.

2 Two-Stage Filtering

An important requirement for practical construction of courseware is that there should only be one copy of each element. For example, program code is often included in the courseware for programming courses. The easiest way to check that it has been correctly written is to compile it. Existing systems typically require the program to be embedded in an HTML page, from which it is clumsy to extract it for compilation. Two presentations of the same content pitched at different levels may contain substantial common text. It is hard in existing systems to avoid replicating this text.

The first stage of the filtering process is a *generative filter* which provides a general inclusion mechanism, and automatically generates semantically-placed tags.

Existing systems take two different approaches to tagging, neither of which is completely satisfactory. Closed systems, such as Hyperwave [Kappe et al. 1993][Maurer 1996], keep documents under their control, removing tags to separate linkbases whenever documents are created or edited. This makes it possible to be clever about which links are rendered, checking, for example, if the destination exists. However, documents can only be created or edited in ways sanctioned by the hypermedia system, which is restrictive. Open systems, such as Microcosm [Davis et al. 1993], permit users to control their own documents. However, it is then impossible to be sure that linkbases are consistent with documents.

The best of both of these approaches can be achieved for tags that can be generated *semantically*, that is whose positions can be inferred each time the document is served. There is no need for linkbases, and hence no need for the filter to know if the document has been altered since it was last served. A tag at the beginning of each document informs the generative filter which operations it should apply to the document.

Some of the semantic tagging possibilities that we have investigated are:

Automatic linking to glossaries. It is common, in presenting technical material, to provide definitions of terms, by making each occurrence of the term an anchor to a definition. Inserting all of these anchors manually is extremely cumbersome. The generative filter inserts such links automatically. A list of appropriate words, URLs of definition files, and priority levels for each one are provided to the filter separately. As the generative filter processes each page, it inserts an anchor around each occurrence of a word on the list, labels it with a priority, and links the anchor to the appropriate definition file.

Automatic Table of Contents. Especially in large documents it is useful to have a means of getting an overview. The generative filter produces tables of contents automatically by looking through the document for text enclosed in header tags, copying it into a hierarchically nested list at the beginning of the document, and making it a source anchor, pointing to the occurrence of the header within the document.

The second stage of the filtering process is a *selective filter*. In the present implementation, this uses a simple linear threshold to remove elements from the document it receives from the generative filter. Any element of a document can be optionally labelled with a priority. Each user defines the current priority threshold, and the selective filter removes elements whose priorities are below the current threshold (and their descendants) before serving the document.

There are two distinct types of priority attribute that may be included in any structure tag. Both allow the structure to be assigned a priority between 1 and 10, where 1 represents the most detailed information and 10 the least. The priorities differ in what they imply about structures that fall below the threshold. *Content priority* structures are removed from the document entirely (together with any substructure they contain) if their priority is below the current threshold. *Tag priority* structures have their tags removed but the content between them remains in the document.

For example, glossary words can be labelled with priorities in different ways.

- The first occurrence has high priority, and subsequent ones have low priority. Using a high threshold means seeing definitions only once.
- The first occurrence has high priority, and subsequent ones have priorities that steadily decrease. Using a high threshold means seeing the first few occurrences of the definition.
- The first occurrence has high priority, and subsequent ones have priorities that begin low, but increase steadily with distance in the text, cyclically. Using a high threshold means seeing the definition at equally-spaced intervals in the document.

The selective filter inserts a set of buttons in each page that it serves. Clicking these buttons generates URLs that are intercepted by the selective filter and interpreted as requests to change the current priority threshold. Of course, structures without priority tags are always displayed.

3 Discussion

We have achieved the goal of only having one occurrence of each distinct element, which can be included wherever appropriate. This significantly reduce the overhead of generating courseware. Much of the structure that is pedagogically useful, but tedious to insert by hand, is inserted automatically. Such structure is inserted independently of other changes to documents, so that courseware can be freely altered without requiring subsequent consistency checking.

Decoupling the process into two stages gives more flexibility. It is possible, for example, to experiment with generation techniques that are overly verbose, because the downstream effects can be removed by the subsequent filter. For example, generating all-to-all links between occurrences of a key term produces too much information to be useful *in the majority of cases*. Our system makes it possible to tag forward links with one priority and backward links with another, so that users may see some or all of the possible connections, and alter their view depending on the results for a particular document.

A linear ordering of thresholds means that we can customise documents on a continuum from novice to expert. We cannot yet customise for different learning styles. This is not technically difficult given our approach. It is possible that structures, all of whose substructures have been filtered out, will still be rendered even though they are 'empty'. There is no easy solution to this. For example, it would be easy to detect a list all of whose elements had been filtered. It is much less easy to detect the paragraph preceding the list which contains only a simple introductory sentence ("Some examples are:") - and in this case removing the list but leaving the paragraph is arguably worse than leaving the empty list.

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From Video-Conferencing to the Cybercafé: Membership, Performance and Online Learning

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In the Spring 1996 semester, Malaspina University-College offered its first distance education courses using video-conferencing technology. Four courses were offered to participants in Nanaimo, on Vancouver Island, and a satellite campus in Powell River on the British Columbia mainland. We employed switched-56, compressed video-conferencing technology (PictureTel PCS 100 from Adcom) in a Windows environment. The compressed video and audio signals posed on-going challenges for instructors and course participants when it came to such subtleties of communication as facial expression, body language and gestures, and a sense of timing in discussions. These challenges were compounded by occasional instability in the application sharing software (LiveShare), and instructors began to build redundancy into their methods of delivery. I learned to use web-based methods to provide lecture notes, resources, demonstrations, and a discussion forum for both remote and local course participants. This was especially important for the remote students, who expressed their desire to be given as rich an educational experience as the students in the source classroom.

The four courses were extensively evaluated by Norm Dolan, an external evaluator, in *Interactive Television Course Delivery* (1996), and the results were summarized in my *Enhancing Capacity with Video Conferencing* (Soules 1996). One of the significant conclusions of our research is the importance of establishing a sense of membership for participants in distance courses. Evaluation made it abundantly clear what common sense might lead us to expect: that students in the remote site "appear to have greater difficulty establishing a strong sense of membership in the experience, than do students in the host site" (Dolan 1996). What might not be as obvious is the discovery that student satisfaction and success are highly dependent on this sense of membership, or engagement by the learner in the educational process. Our research found, for example, that unlike the membership construct, the technology itself does not lead to high satisfaction rates: once the purpose of establishing clear and reliable communication has been met, further efforts to develop more sophisticated systems are not likely to result in more student satisfaction. Similarly, once basic student support services have been provided, more elaborate administrative functions do not significantly increase student satisfaction or success.

After considerable discussion between instructors, project coordinators, and the evaluation team, we formulated the following broad parameters designed to promote membership in distance learning, especially as it relates to video-conferencing technology (Soules 1996):

1. Course materials should be prepared to take into account not only the constraints and characteristics of the medium, but also to engage students successfully at the remote site. The level of structure and preparation required for distance delivery generally exceed that required in face-to-face settings where the instructor can rely on spontaneous interaction to enhance the learner's degree of engagement.

2. Learners should be able to communicate easily and reliably with the instructor and the students at the other site. The instructor should take active measures to communicate personally with each student and subsequently to confirm the communication with the student. We established guidelines, or protocols of communication, which tended to formalize interactions until all course participants, including the instructors, found that the guidelines actually contributed to greater confidence and spontaneity.

3. The instructor should develop a learning environment in which individual students develop a sense of working cooperatively with peers in a meaningful activity. Engaging students in the active use of the medium of delivery will help them overcome their reticence and increase their confidence.

Besides our discoveries showing the important correlation of membership with student satisfaction and success, as instructors we found ourselves in a new performance medium: the distance education "classroom." I use the word "performance" here advisedly because the presence and demands of the technology tend to shift the instructor's focus toward delivery concerns and an acute awareness of the needs of the audience. The confidence we may have in addressing and reaching our audience in the traditional classroom is de-centered in distance delivery. Our presence is mediated by the human-technology interface which provides a new kind of performance medium, and not necessarily the stage we are used to.

Since the original video conferencing project, I have continuously offered web-based, online courses in Media Studies and Computer-Mediated Communication (see http://www.mala.bc.ca/~soules/). In the delivery and content of these courses, I continue to explore the performative aspects of participation in this learning environment, and how performance relates to membership. In *Protocols of Improvisation and Online Communication* (available online at http://www.mala.bc.ca/~soules/improv1.htm), I describe how the particular performance style associated with improvisation has many points of reference to online learning. Following Laurel's analysis in *Computers as Theater* (Laurel 1992), I suggest that the human-computer interface is not only essentially dramatic, but also requires a considerable degree of improvisation for its successful negotiation. A study of cross-cultural practices shows that the play of improvisation occurs within a matrix of constraints, or limitations, and these limitations can be considered "protocols of improvisation" (Soules 1997).

In the design and delivery of my online courses, I encourage learners to explore the medium of interaction by researching its history and writing about is as a medium of communication. Assignments have precise parameters regarding method of presentation, but they require learners to solve problems that they help formulate. Students are encouraged to learn computing applications from one another as well as from me. I have had most success in promoting membership, however, with a series of online journals featuring the writing of course participants. It has been extremely gratifying to see the improvements in writing quality when students write for one another, and for publication on the WWW. The traditional one-to-one writing relationship between student and instructor is redefined to become one-to-many, and this shift in broadcast model has, in my experience, a profound effect on the performance of learners in online communication.

In June 1997, my proposal for the Cybercafé Project at Malaspina University-College was funded to provide an alternative model of support for students and community members wishing to learn about computing, especially online applications. Unlike conventional computer labs in many post-secondary institutions, the Cybercafé encourages interaction between participants, experimentation in the learning process, and the networking of expertise in a "learning community." We use drop-in fees to regulate access to one of the institution's networked computer labs. Student facilitators are available to help users with their computing questions, to suggest alternate resources, and to foster the development of a non-hierarchical, stimulating, and safe learning community. The Cybercafé Project attempts, in short, to model constructivist learning principles.

The Cybercafé Project provides more than an alternate model of support for educational technology—something learners need when they begin to go online to accomplish their instructional goals; it also reflects on such institutional protocols as access to labs and the policies used to regulate them. This project attempts to address the interrelated issues of membership and performance in the context of computer-mediated instruction and online learning.

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An Instructional Design Framework for System Dynamics Based Learning Environments

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Abstract: System dynamics provides a powerful framework for the development of highly interactive learning environments for complex domains [Forrester 85; Sterman 88]. There is significant potential for improved learning in and about complex systems using system dynamics due to the ability to represent complexity in a visual form, to link that representation to visual and quantitative behavioral descriptions of complex systems, and to engage learners in the re-design of the underlying model based on a process of hypothesis formulation, experimentation, and validation.

Traditionally, system dynamics based learning environments have been called management flight simulators and contain three types of learning activities: preparatory tutorials and explanations, interactions with the simulation, and debriefing sessions [Richmond 93; Sterman 88]. The basic idea contained in this structure implies a particular approach to learning with some elements drawn from a constructivist perspective and some from an instructivist perspective. The designers of these learning environments are not generally aware of having adopted a particular learning theory or design perspective, yet they are inclined to make strong claims about potential learning outcomes [Sterman 88]. The evidence is mostly anecdotal, however. The learning effectiveness of these environments is not well documented nor well established [Mandinach & Cline 94]. As a consequence, there is not a well established methodology to guide design and implementation.

There are two missing links in the design of effective system dynamics learning environments: a firm and explicit foundation in learning theory, and a tight coupling of that theoretical perspective with the disciplined practice of instructional design. These deficiencies have resulted in the following kinds of problems: (1) inadequate attention given to preliminary learning and to learning transfer activities; (2) high variability in the preliminary learning environment, during the group interactions, and in the transfer activities; (3) lack of integration of the various learning activities; (4) inaccessiblity of the underlying model without sufficient elaboration; and/or (5) inadequate preparation for the complexity of the underlying when provided.

The hypothesis of this research stream is that learning in complex and dynamic domains can be facilitated by the adoption of a version of cognitive apprenticeship [Collins, Brown, & Newman 89] which integrates a socio-historical perspective [Spector 1994]. This emphasis on cognitive apprenticeship in a collaborative learning environment, implies an instructional design framework well suited for the management of complexity. Specifically, a process of graduated complexity consistent with elaboration theory [Reigeluth 83] is useful in developing an overall macro-level sequence to help learners come to grips with the various kinds of complexity in these domains and systems.

In addition, the design model provides computer-based preliminary tutorials to eliminate the variability of human tutors as we explore the learning effects associated with various versions of the interactive simulation experience. Some versions include an elaboration scheme which gradually elaborates a single case in increasing levels of complexity, focusing first on selected model components and the manipulation of a single variable and later on the entire model and its re-construction according to alternative conceptualizations. An alternative line of elaboration introduces many different cases before proceeding on to more demanding forms of interaction. Within these major sequences, we have placed versions which support small group collaborations and others which engage learners in isolated learning experiences.

The primary change within the system dynamics based portion of the learning environment is that learners are allowed to see the underlying model as they reason about the behavior of the system and its responses to various changes in variables. Because these models are depicted visually, learners are provided early scaffolding with regard to the various feedback loops and delays in the system. With the simpler cases, it happens that identification of the dominating feedback loops and associated delays is crucial in formulating reasonable decision policies.

As learners become more sophisticated in their reasoning, the notion of learner immersion is introduced. Immersion in these environments comes about by having learners play various decision-making roles, eventually empowering learners to re-design key portions of the complex system. For example, a particular decision policy with regard to hunting in a predator-prey model may alter the nature of a feedback loop or it may introduce an entirely new feedback loop. Small groups are formed within classes, sometimes at a distance, since these environments can be deployed in internet settings. The small group interactions between simulation runs appear to be crucial to learning effectiveness in these environments. When learners are denied opportunities to discuss the simulation results, they report significantly more difficulty in formulating explanations for the observed results and they do not score as well on simple posttest exercises.

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Teaching Web Site Design + Development on the Web

Creating an Educational Paradigm to Empower Student Centered Learning Utilizing the WWW

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There are several difficulties to be overcome in preparing to teach a class about the Web, utilizing the Web. First is the changibility of the Web itself. Class preparation requires prior planning, however, by the time the instructor gets to a specific unit, that information may have changed. Second is the student's expectation of a "class" and their role as a "student". Finally, the role of the teacher or instructor is different. The instructor can no longer be responsible to be the technical "expert". There are simply too many different sets of knowledge required. It is equally inappropriate to ask an instructor to learn the material one week ahead of the class; this creates a very tense situation.

The solution to dealing with these issues is to change the expectations and definitions of a "student", a "teacher" and a "class". We created a class where the students became their own teachers, I call them learners, and the instructor directed, or facilitated, the individual research. The learners entered the class understanding that the answers today may not be the answers tomorrow. Each learner was helped to set up an individual system for seeking out and discovering innovations in hardware and software. Learners were then required to bring that information to the class. To teach the class with the idea that the teacher had all of the answers, indeed to allude to the notion that there was a "right" answer, would have been dishonest. The result of this process was that the students entered the experience expecting things to change rather than becoming upset by change. In addition, when the students left the class they were prepared to continue learning without the instructor.

At the onset the Web is very effective at helping to dispel the traditional teacher/student paradigm. The Web allows each student to develop a different "answer" to a common question. This creates a unique situation for discussions and insights about content and the effect of presentation on the interpretation or meaning of information.

To begin, we created a Web site to serve as a template to teach the class. The site was divided into conceptual and concrete information areas. The first area of the site housed concrete information: a class list, links to student pages, tutorials and the resources section which contained links to other resource sites. The second area housed the conceptual component including discussion topics, class feedback and a critic forum for outsider imput.

Some of the issues that we addressed in the design of the teaching site include:

. . . the information presentation. Information was organized to be helpful to non web literate students and to build upon their previous educational experiences. We hoped this would build confidence.

. . . the site design itself. We thought the design needed to reflect good design practices without being "over" designed. The site was engineered to load fast. The primary screen allows the user to choose from a site outline and this outline is available from any point in the site. This was to prevent the user from getting lost and frustrated.

. . . the tutorials were designed to be printed and bound as a resource, not to be read on screen.

From the beginning the class had two diverse goals. For learners interested in becoming proficient in Web design, the class would introduce them to the skills that they needed to develop and expose them to the design issues that related to communication on the Web. For learners interested in becoming literate about the Web, but not interested in production issues, the class would provide them with insight about the possibilities and limitations as they related to Web design, as well as give them a vocabulary and a frame of reference to work with Web designers.

For this project we encouraged the learners to address issues that would be relevant to the study of design and professional designers. We created the problem of how to encourage visual designers (practicing print professionals) to work on the Web. Because the Web is such a dynamic media, many designers have not had the concentrated time necessary to become literate about Web design restrictions. And when they do, the restrictions change. In the process of learning to design for the Web, the students created a site that attempted to educate professional designers about design for the Web. The site became a documentation of the creative process as it relates to design.

The site outline existed at the beginning of the class and acted as a template for the actual research. We broke the experience of learning about the Web into three levels. First we asked the learners to redesign an existing site. Second, we asked the learners to design a Web site for an existing data set not currently represented on the web. Learners were asked to research existing music sites as well as the recording artist(s) and design a site that created a visual experience that paralleled the music experience. Finally we gave the learners a conceptual design problem about legibility. This created a discussion about typographic issues and information visualization on the Web.

Several of the issues that we hoped to encounter included:

Even though the learners were working in an entirely new medium, they were still able to apply the design principles that they had learned in previous classes.

Several of the learners made major errors as they were working and their classmates supported them and helped them to recover.

The learners were willing to try to find their own answers to programming questions before asking the instructors.

The learners gained respect for their ability to learn on their own and saw the value in developing a working style that included constant learning.

Several unexpected issues that we encountered included:

The learners gained respect for the complexities involved in getting a design project to print and became more willing to view the production process as creative.

The learners gained confidence in their own ability to teach and relate to professionals, in addition to respect for the place they can occupy in the design community.

Due to this professional insight, the learners gained respect for the accomplishments of the practicing designers.

Class projects were critiqued in a traditional classroom manner. Critique insights were posted to allow visitors access to the designer thought process. Projects include a site map in addition to a design brief. This was meant to help visitors see the difference between intention and reality. Concluding insights were also posted to allow viewers to understand the analysis aspect of the design process. Outside reviewers were invited to critique the student work and offer additional observations. We hope, in the future, critiques will be able to be carried out on line in a more dynamic environment.

Another feature that was built into each "project" on the site was a timer that would disclose the amount of time each designer has spent creating that particular site. This will help practicing designers, as well as prospective clients, estimate the amount of time necessary to generate a project.

The tutorials were lectured about in class and general programming concepts were addressed. The learners were expected to post their work and check the site and their e.mail for information and feedback. While this class was not designed to occur entirely on the Web, that is the obvious next step. The dynamic discussion that occurred during the critiques was very informative and never could have been pre determined. If this were to become a totally electronic class, a system to facilitate the face to face dynamic of the critique would need to be incorporated.

By changing the role of the teacher from information giver to learning facilitator two things happen. First, the responsibility of having to know all of the information is removed from the instructor and second, the students learn how to learn as opposed to learning "the" information.

Multimedia-Based Environmental Science Education: From Local Use to Broad Dissemination

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Multimedia-Based Environmental Science Education in a Planetarium

In the last 30 years, the image of the whole earth as seen from outer space has served as a cross-cultural symbol for the uniqueness and fragility of our home planet. Based on this image of our home planet, the planetarium in Freiburg is currently developing multimedia shows about global environmental issues. The pilot project aims to convey scientific information that fascinate and hopefully provoke interest and a fresh perspective on environmental issues. Particularly suitable environmental education topics are those of global scale, which are based on solar-terrestrial relations. Some examples include the ozone layer and its depletion, the greenhouse effect and global warming, the role of the sun's radiation in the development of life on earth, and modern uses of solar power.
As a setting for science education, communication and entertainment, a planetarium has many advantages:

- It is an unusual and fascinating place to visit [Marshall, 1997].
- With a plethora of special video and audio effects, including the projection of a bigger-than-life starry night, planetaria shows are both deeply moving and highly informative.
- People expect science education in a planetariumn and are, therefore, more willing to be exposed to science.

Creative, well-designed multimedia presentations (in a planetarium) grasp audience interest, thereby easing the learning process, and providing motivation for further learning [Apel 1997; Gräsel and Mandl 1997; Weidenmann 1995]. A survey study indicates that environmental multimedia shows at the Freiburg planetarium sparked audience interest in the topics that extended beyond the show. Unfortunately, planetaria only reach a limited, mostly-local audience. It would be beneficial if the time-consuming intermediary steps in the production of a multimedia show could be re-used to impact a broader audience. At the Freiburg planetarium we explored the various means of disseminating information broadly with little additional manpower. Two productions have provided the thematic content and the media for (i) two article series, (ii) four radio broadcasts, (iii) a CD-ROM, and (iv) an internet presentation. The following discussions describe the four types of media in terms of the ease and effectiveness with which they re-use multimedia material originally created for the planetarium shows.

Authoring Systems in Science Education: a User's Perspective

The Radio Broadcast

Broadcasts that directly incorporate the shows soundtrack with minor editing have been successfull. The advantages of a radio show are: (i) little technology involved, (ii) minimal production time, (iii) a potentially wide audience. The disadvantages are: (i) particularly complex issues are difficult to convey as visual aids are missing, (ii) people need to listen closely if they want to follow the show, (iii) lengthy radio shows are difficult to place into the broadcasting system.

The Article Series

Only minor revisions are necessary to create free-standing text from the script of a planetarium show, and graphics from the show can be directly imported to complement the text. However, video clips and computer animations need to be replaced with stills. Advantages are the ease of production and the wide use and availablity of print. However, placing articles on environmental science written for a lay audience is difficult.

Electronic Publishing

This section compares a traditional style CD-ROM production, which uses the Windows 95 based authoring system *Toolbook* with a Whiteboard authoring sytem called *Authoring on the Fly* [Bacher et al., 1997] that electronically records a lecture and its respective visual aids. Both authoring systems have the following features in common:

- They combine sound, text, pictures, video, and animation to convey information in a multicodal and multimodal way.
- They require far more time and effort to produce than either an article series or a radio broadcast.
- They are less readily available to a potentially interested audience (computer technology is necessary).
- Given the up-front investment in computer technology, both are relatively expensive to access.

Traditionel Style CD-ROM Production

Text and visual aids from two planetarium shows provided the CD-ROM material. The product was certainly the most appealing of all four dissemination types, yet:

- Adapting the text from linear storyboard to hypertext, reformatting the media material and the design of the CD-ROM itself were time consuming.
- The Editing and revisions necessary to produce the final version took up considerable time of the author.
- Close cooperation of collaborating content specialists and technical specialists was necessary, as the media designers who designed the CD-ROM had limited understanding of the content (as the case often is).

The advantages of a CD-ROM production are apparent:

- The final product is easy to use, well designed and appealing to students and lay audiences alike.
- The CD-ROM can be run on any Windows-based computer with a CD-ROM drive and a soundcard.
- Given all the color graphics, video clips, and computer animation, the CD-ROM is closer to the original multimedia presentation and, therefore, generates more of the original fascination.
- The contents of the CD-ROM can easily be placed on the internet.
- Like other types of electronic publishing, all charts, graphics, photographs, animations, and video-clips on the CD-ROM can be made available as teaching material.

Authoring on the Fly

Authoring on the fly (AoF) enables an educator to produce independently an electronic version of the work. The Whiteboard system has a range of advantages over the traditional style CD-ROM production:

- Little additional effort goes into preparation of the electronic presentation (a lecture held on a computer); production is therefore extremely fast.
- The author has total control over the product.
- Spoken words (the text) and visual aids are perfectly synchronized, even during scolling.
- The recording can function as the backbone of a traditional style CD-ROM production: AoF-based presentations can be used to complement a traditional style CD-ROM by hyperlinking the presentation with written text and vice versa.

The AoF sytem is ideal to record a complex lecture for teleteaching, and unlike a CD-ROM production it requires almost no technical expertise. However, this authoring-on-the-fly system is still in the experimental stage and, therefore, not yet commercially available. So far, it requires a UNIX-system to operate and run (a Windows NT version is currently in preparation). The sheer size of a single AoF document (can be more than 100 Megabytes) makes internet transfer difficult at the moment. Still, from a user's perspective it is an extremely promising method for future science education.

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Guidance and Personal Guides in Learning with Hypermedia

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Abstract: The contents of many computer assisted multimedia learning environments realized on CD-ROM or the Internet is arranged in a hypermedia structure. It can be expected that particularly through the growth of Internet (WWW) based telearning applications hypermedia becomes increasingly an important platform to deliver content and to be used as a cognitive tool. Hypermedia seems to be suitable for supporting the new constructivistic way of active and selfregulated learning. However, recent results of research in the hypermedia area have revealed some problems regarding to the use of hypermedia for learning purposes. In particular novices in the subject matter area who don't have adequate knowledge structures in that field as well as learners without advanced learning techniques have difficulties during the learning process with hypermedia. These problems are mainly known as 'loss of orientation', 'cognitive overload' and the lack of appropriate competence in dealing with hypermedia and for constructive selfdirected learning. This paper will discuss the use of 'personal guides' as a possible help and coach function to reduce the mentioned hypermedia problems.

Hypermedia as a constructive learning environmet

Hypertext and hypermedia were originally created to handle large amounts of information in a flexible and dynamic way. Only later they were adapted for the use of computer based learning. The Internet and World Wide Web as the biggest hypermedia system today were not developed for learning purposes either, but for fast information exchange between the users. Several experiences and investigations have shown that hypermedia is more suitable to be used as an associative multimedia database or as a cognitive and learning tool than as course software with clear defined learning goals like computer based training or tutorial systems. Therefore hypermedia is an appropriate media and tool for supporting constructivistic learning environments. The possible activities in hypermedia environmets could be browsing and searching for wanted information, collecting information, constructing own subdocuments or new hypermedia documents, exploring a topic from different points of view and learning from different authors in an associative web.The use of hypermedia learning environments is convenient if the subject matter is very broad and has no clear structure, like History, Medicine or Physics. The hypermedia program "THE WORLD FORMULA", which we have created at our research unit as an experimental platform is a physics program and deals with the topic of four basic forces, and with the atemmpt to describe these forces using only one mathematical formula. In the program are integreted the common hypertext functions like index, map, history function etc. and a notepad which is also a small cognitive tool and allows the students to gather text and pictures from the main program, modify the textes and to build an own small hyper-subdocument of this material.

What are the Problems of learning with hypermedia?

The experts in the particular subject matter are able to take advantage of direct and associative access to the information in hypermedia. They can enlarge and modify their knowledge base effectively. Many studies on learning with hypermedia report that novices - both in the subject matter area as well as in the use of hypermedia systems - have encountered manifold cognitive and ergonomic problems when using these systems for the first time. One of the central tasks during learning with a hypermedia system is the process of making a decision about the next step and the next action in the hypermedia environment. This decision-making process and the freedom of choice were seen in the early days of hypertext and hypermedia as an important pedagogical factor and advantage for an active and explorative learning process. Meanwhile numerous investigations have shown that this freedom of choice can also be an obstacle in such learning process. The reason is that the learner invests a lot of cognitive capacity for such strategic considerations instead of using it for the assimilation of new information. Conklin [Conklin 1987] subdivided these problems as Cognitive Overload and Disorientation. Cognitive Overload is the result of the three following aspects: the informational myopia, the serenedipity effect and the context partition (dilution).

Learner control, learning strategies and hypermedia-Literacy

Hypermedia is a learning environment that is very strongly learner control oriented. The large extent of learner control requires a high level of self-regulation and metacognitive abilities in the learning process because the learner has to make decisions by himself during this process. Numerous studies have shown that students with a low level of metacognitive skills have more problems resolving problem oriented tasks and also in learning with hypermedia systems in general [Hammond 1993].The hypermedia tasks require a certain level of hypertext literacy. Therefore it is important for the user and in particular for novices to acquire learning strategies for hypermedia environments. There are prerequisites for learning with hypermedia:

- competence for effective use of hypermedia documents and environments (hypermedia literacy)
- competence for creative and constructive learning
- competence for selfregulated learning (effecitive learning techniques and metacognitive strategies)
- competence of content
- competence for team work in online environments

Tergan [Tergan, 1997] argue, that most students cannot use effective the complexity of hypermedia systems and need explicit modelling and scaffolding support as well as more experience in using hypertext-based technologies for constructive learning.

Personal Guide as a possible help for hypermedia-problems

In my research, I've chosen to examine the potential of personal guides to help reduce the above-mentioned problems in the hypertext and hypermedia learning environments and to enhance the motivation and acceptance by using such learning systems. One of the main functions is to support the user by building competences for effective use of the hypermedia program (e.g. effective use of the notepad as a cognitive tool) and for effective learning strategies. The guide is an anthropomorphic character as a help function. It can be called by the learner at any time in order to provide answers to a variety of questions. The guide can also carry out a variety of tasks, totally related to the learner's interests and approach of working his way through the hypermedia program. The main idea is to combine a trace, a database and content-support functions with a lot of different appearance forms of the guide. This way the user has the feeling of different, situation related reactions of the guide figure and the outward appearance does not repeat. There is no claim to make the guide an 'intelligent' one like an agent. However, it is interesting to see if the combination of the functions scope and the way of appearance form wiill give the user the impression, there is some form of 'intelligence' behind the guide.

These are the desirable and partly realized functions of the guide:

- a consultant who helps in the development of a learning strategy by giving tips and examples of efficient ways to use the program,
- a presenter who summarizes the highlights of the content, both of the program in general, and of the specific pages,
- a navigator who gives orientational aid to the learner as she or he works through the program, and provides glimpses of topics related to the current subject contained elsewhere in it

- a coach who - after tracing and recording the learner's steps - proposes alternatives for how to proceed, and - if the learner appears to be staying away from the chosen route - provides a gentle nudge to go back in the right direction.

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Evaluating Software Ease of Use based on Speed, Memory, Effort,Comfort

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INTRODUCTION

As training costs to companies increase, the issues surrounding evaluation of the various business software solutions available to them become more and more critical. The problem is that the basis on which to make this assessment is not straightforward. There are two main subjective approaches which may be used when trying to assess the effectiveness of various package design factors in achieving ease of use. These can be based on:
a) characteristics of the package - degree to which package has or does not have the characteristics considered essential (Doll and Torkzadeh, 1988; Davis, Bagozzi and Warshaw , 1989; Ives, Olson and Baroudi, 1983; Khalifa, 1990);
b) on general reactions to the package - degree to which users like or do not like the package (Scriven, 1990; Teng and Jamison, 1990; Roberts and Moran, 1983; Holcomb and Tharp, 1993; Ravden and Johnson, 1989).

In this paper, it is proposed that ease of use may be evaluated based on the support provided by features in a package for certain learning dimensions, namely, user performance speed, memory, effort and comfort.

BACKGROUND

In this paper, learning is viewed as the stages of transition required to achieve mastery learning and ease of use as relevant to the entire spectrum of usage, regardless of level of expertise. This view is adopted because it accounts for the fact that the learning of a package is, essentially, never complete. The user is usually at a mix of levels of expertise, depending on the mastery attained on the various functions. The user is always in a process of learning new functions or finding new and better ways of performing ones already learned, whereby the user may be novice in some functions, intermediate in others, and advanced in others. To classify ease of learning as being applicable to novice users exclusively and ease of use as applicable to expert users would, therefore, not take into account the user's knowledge of the current package as a whole, or of other packages. Ease of use, therefore, should be concerned with this `harmony' which a package design creates for all user categories.

It is suggested that ease of use of a package will be determined by the extent to which it supports the learning dimensions of speed, memory, effort and comfort. A software package will be considered easy to use if it is able to reduce performance time (**speed**), reduce memory load or not require it because of the simplicity of operation or the nature of assistance provided (**memory**), reduce mental effort thereby reducing errors made (**effort**) and is deemed comfortable to use (**comfort**). Evidently, what contributes to reducing the strain imposed on memory and mental effort should also contribute to the psychological comfort felt when using the package, all of which, in turn, should contribute to reduced performance time. The speed with which the task is accomplished is also likely to affect the user's perceived comfort when using the package. The arguments for suggesting these components are supported by the Learning literature and the Human Factors literature. (Thomas, 1994).

The factors comprising ease of use and learning have found support in the varied views of different researchers on the concept. Roberts and Moran (1983) consideered ease of use to be a function of speed and functionality, while Davis (1989) looked at it from the perspective of physical effort, mental effort and memory. This is similar to the Keystroke Level Model proposed by Card, Moran and Newell (1983) which is based on physical effort, mental effort, system response time and memory. Murphy (1990) looked at the effect of speed and effort on ease of learning, while Khalifa (1990) considered ease of use as a function of recall, recognition and cognitive complexity.

Studies which support consideration of these dimensions include Shneiderman (1982) whose studies of menu structures and message tones and specificity indicated that users' performance speed, memory and comfort levels were impacted by these factors. The well known studies by Miller (1956) which point to the human memory limitations suggest that the memory dimension is a critical one requiring support. Studies by Burns, et.al., (1986) and Gray, et. al. (1994) suggest that greater memory and mental stain will be tolerated if the outcome is sufficiently desirable. Waern (1985) fournd that users relied on memory rather than read unless the effort required to read was minimal. This has considerable import for the design of assistive material. Bigge (1982) identifies cognitive strain as being a block to learning and Todd and Benbasat (1991) found that strategies requiring the least effort were the ones most often adopted. Stephenson (1990) found that student's frustrations, that is, comfort with a statistical package lead to lowered perceptions of the package's value for the future.

Given this support, the notion of ease of use as a function of support for speed, memory, effort and comfort offered by various package features seems reasonable.

PROPOSED STUDY

A study is proposed wherein users will be asked to evaluate various software design features for ease of use based on their support for the dimensions identified as performance speed, memory, effort and comfort. It is suggested that this view of ease of use may provide a potential basis on which to make a multi-dimensional evaluation of packages. For instance, a package design which offers greater support of these dimensions is likely to be easier to use than one offering less support. Secondly, this approach may be valuable in pinpointing more clearly those areas of design in need of being rectified. A package feature rated low in user performance speed or effort may indicate deficiencies in the number of operations required to perform a task while a low rating on memory may indicate deficiencies in the assistance provided for the feature. A low rating in comfort may point to poor screen design, confusing wording, or unclear conceptual models.

CONCLUSION

In general, business software evaluation instruments which do exist, address only the degree of existence or non-existence of a particular design feature, and often includes ease of use and/or ease of learning as one on a list of attributes to be assessed. The evaluation is usually one-dimensional, and not based on the multiple underlying factors which promote learning and/or ease of use - memory, speed, effort, comfort, as is being advocated in this paper. It is hoped that this view of ease of use, and the study of it, will aid in deepening our understanding of the concept and to the development of appropriate instruments for measurement.

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Use of Multimedia Technology to Complement Active Learning Strategies

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One of the primary components of most nursing curricula is the inclusion of basic science courses in the first or second year of the program. Because these science courses are fact based, teaching methods tend towards the traditional lecture format. The problem with this approach is twofold. The passive learning environment tends to fosters memorization. As a result, students are left to synthesize concepts on their own. Not all students are motivated to do this nor does this come naturally to all students. In addition, even those students who are able to synthesize the material, will not have the opportunity to apply their learning until they graduate in two to three years. This calls into question how much will retained by that time. To address the problems created by teaching basic science through the traditional approach, a course was redesigned around the use of an interactive multimedia program in combination with active learning strategies.

The multimedia program, which is based on real life clinical scenarios requires students to apply concepts and problem solve. The key feature of this process lies in the interactive nature of the technology. Fundamental to the problem solving exercises is the incorporation into the program of an easily accessible database of detailed information. Multimedia tools such as animation, video, audio, and images used to present the information, created a more inviting learning environment. In addition students were able to use the technology in accordance with their own preferred approach to learning. By using the multimedia program outside of the classroom, in class time was used to reinforce key concepts. This was accomplished through the use of varied active learning strategies and tools.

Anticipating that this would be an initial step towards implementing further change, a number of tools were developed to evaluate the impact of this approach on learning: 1. A questionnaire was used to determine the level of student satisfaction with the use of technology, 2. Interviews were conducted with individual students to explore the impact of the technology on their approach to learning and 3. A classroom observation tool was developed to assess the impact of the changes on the learning environment. This tool was used to monitor factors such as instructional method, teaching style and engagement of students. A key feature was the categorization of the interaction between the students and instructor.

It was felt that for the impact on the learning environment to be significant and permanent, further changes would need to be incorporated gradually over a number of years. Consequently it was difficult to draw concrete conclusions from the data gathered to date. However, it can be said that based on the results of the questionnaire, students had a high degree of satisfaction with the use of the technology. With respect to learning strategies, it appeared that the use of interactive multimedia technology fostered students to explore beyond the material that presented in class. This was based on individual interests and approaches to learning. The extent to which students made comments on the differences between using a textbook versus multimedia also seemed to have an impact on how they used the technology. Results from the classroom observation tool suggested that students were asking questions based on an understanding of the material, not just memorization of facts. Additional analysis of this ongoing research will be used to expand the use of multimedia in the further development of an active learning environment.

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Building and Evaluating an Automatic Search Method for Pre-Answered Questions in an On-line Classroom

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Introduction

In on-line classrooms, i.e. "distance learning," questions from students to teachers are designed to be sent via e-mail. However, it takes a lot of time for teachers to write appropriate answers for each e-mail question. And very often, two or more e-mail questions are the same. Reading for the same questions many times, and writing the same answers many times becomes boring work for teachers who of course would like to process such work more efficiently.

We have been giving a lecture of computer literacy at Kyushu Teikyo Junior College. In this class, we have recommended students to ask questions via e-mail as in an on-line classroom. This report introduces our automatic search method for pre-answered questions and describes its evaluation in our classes.

Background

Our premise consists of pairing questions asked by students with the answers supplied by a teacher. These pairs are stored in a database called "Questions Database."

There are two current methods for reducing teachers' work in replying to students' questions. The first is by using a database system. Since it is so complex and difficult for students to use formal language like SQL as database access languages, a natural language interface for database systems are being developed. However,

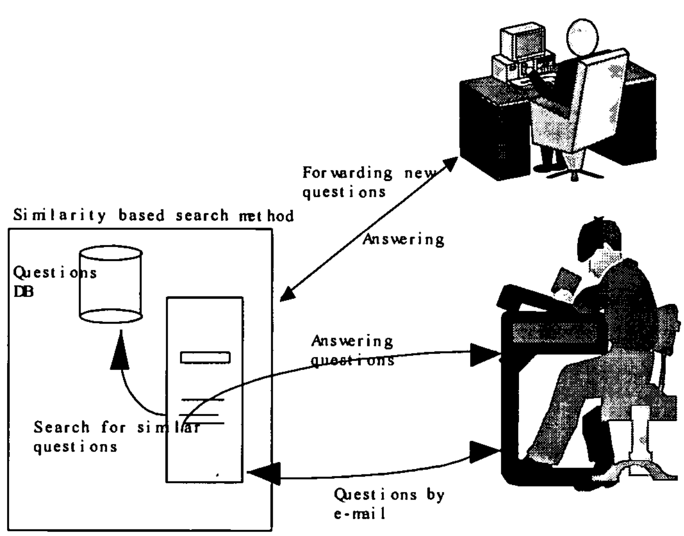

Figure 1: Overall System

this approach still has the problem that students cannot write questions in normal, natural language.

The second method is a natural language processing approach, where we analyze question sentences, search for knowledge using a knowledge base, and then generate answers. This method has the following problems:

(1) The knowledge base is required to be perfect and consistent. But building it is very difficult.
(2) Domain specific knowledge is required. It means a knowledge base can be made only by a person who is familiar with the domain.

Both approaches do not suit our needs. Instead, we use a Similarity-based method of searching for sentences in a Question Database. This process is light.

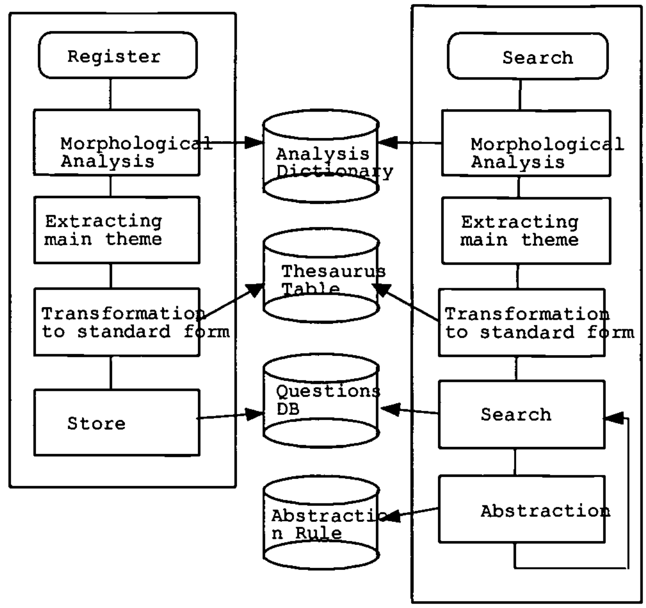

Figure 2: Similarity-Based Search

Similarity Based Search Method

Figure 1 shows the overall system. Students can ask questions via e-mail whenever they have problems. The question will be sent to the similarity-based search system, and if the system finds a similar question in the pre-answered Questions Database, the student will receive the pair of both the question and the answer from the system. However, if the system cannot find such a similar question, then the e-mail will be forwarded to the teacher, who must read the question, and write an answer.

Figure 2 shows the flowchart of the similarity-based search system. The idea of this system is based on our previous research for syntax matching of natural language sentences [Sumita & Tsutsumi 88]. As shown, the process consists of two phases. First is Register and the second is Search. They share the morphological analysis, extraction of question sentence, extraction of main theme, and transformation to standard format. In the Japanese language, parts of speech for each word in a sentence can be determined by morphological analysis. After morphological analysis, the main theme of a question will be extracted by word-order patterns. Next, the main theme will be searched for in similar sentences in the Questions Database. If one or more sentences are found, they will be sent out. If nothing is found, a specified part in abstraction rule will be reduced to make it easier to search for similar sentences. The abstraction rule consists of six "primitive rules," such as the reduction of pronouns, changing the past tense to present tense, etc. We determined the rule order

Table 1: Abstraction rules

Order to apply	Rule
(1)	Omit function words, i.e., RENTAISHI (noun modifiers), SHIJISHI (demonstratives), SETSUBIJI (suffixes)
(2)	Omit pronouns
(3)	Omit verb modifiers
(4)	Omit all noun modifiers
(5)	Omit place holder nouns
(6)	Change A NO B to B, except B means "method", where A and B are noun.

Table 2: Result of Experiment

Quest'n #	Success	Failure	Total	Success ratio
1	44	9	53	83%
2	26	28	54	48%
3	32	21	53	60%
4	32	21	53	60%
5	32	21	53	60%
6	18	8	26	69%
7	29	24	53	55%
8	41	13	54	76%
9	28	24	52	54%
10	34	11	45	76%
11	34	14	48	71%
12	35	15	50	70%
13	27	24	51	53%
Total	412	233	645	64%

in order to search for the most similar sentence by heuristics. Table 1 shows primitive rules and order to apply them.

Experiment and Evaluation

We experimented with our similarity-based search method in order to test this method in actual classes. We tested with 55 students, asking them to send a question via e-mail in actual class. Every question was searched for in the Questions Database. After searching, each question was stored into the Questions Database. When the search result found one or more question and answer pairs, we count it as a success.

Table 3: Causes of Failures

Cause	Occurrence
Morphological Analysis	82
Sentence is too complex	52
Data shortage	46
Failure in abstraction	28
Question is consisted of two sentences	24
Total	233

Table 2 shows the experiment result. As shown in Table 2, it is clear that half or more of the students' questions were automatically answered by our system. It is anticipated that teachers will be able to save considerable time by using our system.

Table 3 shows the reason of failure. As shown in Table3, one third of the failures were morphological analysis.

Advantages and Aspects

In this section, we will discuss the advantages and the aspects of our approach.

(1) Preparation
Our system does not require any preparation unlike the AI based QA system which needs a large amount of the logical form of questions and answers.

(2) Easy-to-use
Students can ask a question via e-mail, which they can write in Japanese. It is very easy for them to use.

(3) Maintenance
Our system is almost maintenance free. If our system cannot find any similar sentences with a Database, it is automatically forwarded to a teacher, as well as stored into the database with the answer, as a new entry.

(4) Morphological analysis
It is important that more powerful morphological analysis technology is developed, since e-mail includes spoken language expressions, miss-typed words, and long sentences.

(5) Technique for asking a question
As described above, the ideal e-mail question consists of a situation description, a main theme, and a request to answer. We think it is important for students to describe these three parts firmly and simply, to communicate between their teacher by e-mail, as well as off-line.

Conclusion

We have described our similarity-based search method for e-mail questions. We believe that our system will help teachers answer more e-mail questions by students more efficiently. Additionally, by storing such e-mail questions into a Questions Database, teachers are provided with student feedback relating exactly to the point which they are having difficulty learning. In the future, we plan to develop a more powerful search method and on-line classroom environment, and we also plan to evaluate in actual on-line classroom.

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"NeuroAssistant" -
A Computer Assisted Medical Information and Education System via WWW

http://www.medizin.uni-tuebingen.de/nrad/neuroassistant/

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1. Introduction

The project *NeuroAssistant* started at the University Hospital Tübingen in 1996. Its purpose is to establish new methods for storing, retrieving, visualizing and transfering complex medical knowledge gathered in many different clinics and research facilities throughout the world. The bilingual system, based on an object-oriented DBMS, is accessible via the Internet and is available at any time and place. The HTML user interface offers read access for all users and write access for authors with suitable privileges. Different access profiles for users and authors offer an appropriate way to present the required, interesting data. Figure 1 gives an example.

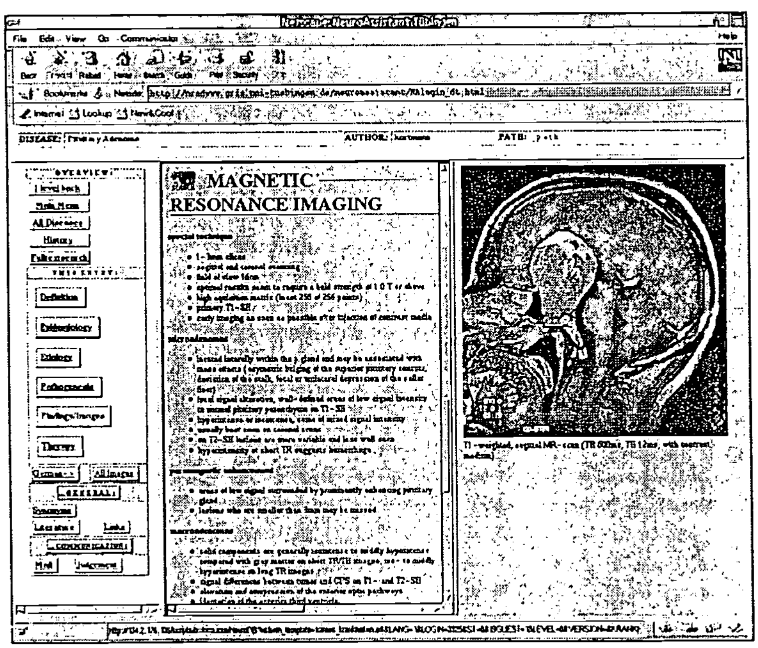

Figure 1:Database entry of *NeuroAssistant*

The facility to provide the data from distributed locations by different medical experts results in a new quality of work. Compared to books and journals there is no time delay in publishing both up-to-date knowledge and new research issues to all sites connected to the Internet. Furthermore, the use of various multimedia data offers completely new possiblilities to present high sophisticated knowledge. One point of view we have to focus on is providing these data in an appropriate way and combined with comfortable information retrieval facilities.

2. Contents of *NeuroAssistant* and Target Group

The database contains medical knowledge of all theoretical (anatomy, embryology, physiology, neuroinformatics) and clinical aspects (neurologic diseases, methods of examination and therapy) of neuroscience with numerous case reports and diagnostic images. For educational purposes a collection of treated cases and their follow up is offered, comprising all steps which led from diagnosis to treatment. A reference brain offers users the chance to interactively identify all anatomical structures with a suitable pointing device. Cross links allow fast access to related topics in the database. A fulltext search and some content based search engines, and a glossary tool are also available. To improve its educational capacities, all kind of contents are supported by multimedia objects like text, (animated) images, videos, Java Applets, sound, etc. Authors, in general medical experts, have the privilege to check in a new topic including all kind of mulimedia objects by defining its context and specifying links to other items to thematically related entries. By following these links, a user may get further context information.

Typical users are physicians, medical students, technicians, or patients. Physicians can exchange their knowledge and can share access to anonymized data of already successfully treated patients. Students are offered insights into the clinical routine as well as a detailed description of basic sciences and the respective theoretical background. Finally, patients are able to obtain information about their therapy, which could facilitate the process of patient empowerment.

2. Platform

The DBMS *ObjectStore* (ODI, Burlington, USA) has been chosen for the platform of *NeuroAssistant*, because it is object-oriented and offers interfaces for C++ and Java. This is the technology required to traverse the complex medical data structures of the system. Furthermore the unique architecture provides database clustering, client caches with callback locking and high-performant virtual memory mapping. A special connectivity product integrates the database system with a WWW server by transferring the object requests to the multi-threaded database server and returning the objects. So-called *ObjectManagers* enable the integration of multi-media objects.

3. Database Design, Realization and User Interface

The conceptual database structure of *NeuroAssistant* was cooperatively developed by both physicians and computer scientists and consists of two base and 10 specialized classes. Two further classes are necessary for storing advanced user-specific data.

When accessing any database content via WWW, the HTML skeletons that define the graphical user interface are implicitly accessed. These skeletons consist of ordinary and extended HTML tags which contain the invocations of several queries. By requesting data, users transparently send a query via their web browser, our web server and a CGI script to the database service application (Fig.2). The service application which implements all existing query callback functions, executes the query and sends the obtained results in form of an HTML page back to the client. So far, we have implemented nearly 400 different skeletons for the web user interface and more than 90 different query callback functions that manage multiple tasks for navigating and editing the NeuroAssistant.

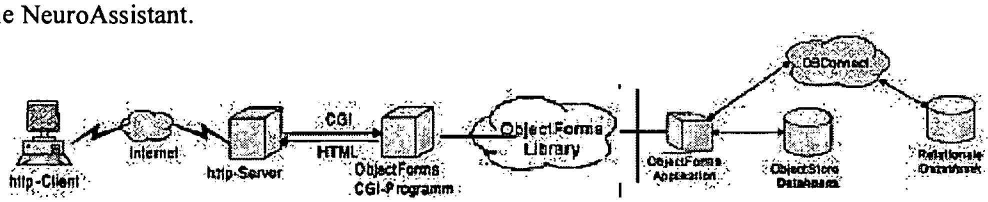

Figure 2: Performing a database query via *ObjectForms*

4. Future Works

At the moment, several physicians are working on further database contents. We also want focus on a more comfortable user interface with advanced information retrieval facilities. Furthermore, for educational purposes the development of an authoring tool for generating case based simulations of medical treatment methods is in progress. These case studies will be offered to medical students to support the training on patients treatment. In order to establish *NeuroAssistant* as an international education system more renowned experts have to be convinced to publish topics in their particular field. To manage this increasing number of authors, a more advanced mechanism of reviewing database entries is necessary to ensure a high standard of quality.

Towards An Advanced Multimedia Platform for Co-operative Work and Learning: The PLATINUM and MESH projects

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1. Intertwinement of developments in use and user, and in technology

Our aim is to develop innovative multimedia support for co-operative work and learning settings. We are well aware of the 'technology stalemate' that plays a role in this. On the one hand advanced technological developments require a clear demand from potential users. On the other hand, users have difficulty envisaging their potential use of novel, not-yet-existing technology, and thus cannot articulate this demand. The only way to speed up the development process, is to intervene and invest in either pulling user demands so that the required direction of technological developments becomes clear, or in pushing technology development so that users can develop their ideas and requirements. In the PLATINUM MESH below, we have chosen to first invest in a collaborative effort of relevant parties in bringing technological development a step further.

user point of view, work and learning situations are very diverse in terms of task, duration, group, organisational contact, and culture. Likewise, the various groupware applications supporting these work and learning situations have to differ substantially in terms of functionality provided to the users. Moreover, the characteristics of user settings are likely to vary from one moment to another (e.g., switching between subtasks). Groupware should support multiple modes of Cupertino, ranging from users being closely coupled via video-conferencing applications to users working relatively independently on different sections of a document. Finally, various media should be supported, ranging from continuous media (e.g., 3D virtual reality, video and audio) to discrete media (e.g., text, graphics and pictures).

From the *technology point of view* the development of groupware applications involves many additional technical issues from distributed systems development and (broadband) telecommunication networks when compared to the development of single-user applications. Groupware applications requiring multimedia support for both synchronous and asynchronous collaboration are complex in design, difficult to develop, and hard to implement. Groupware systems that consist of independently developed groupware components provide a solution to these problems. The development of the groupware components should ideally be supported by a platform.

Where user and technology perspectives meet. A platform for component groupware allows users to make their own 'pick and mix' of functionality within the collaboration environment which with they are used to work. They can also add functionality which they require for a particular task, or which has become available newly, at will. Developing and pilot-testing such a platform for component groupware is an important part of the PLATINUM and MESH projects described below.

2. Two research projects

The PLATINUM project [Ouibrahim & Schot, 1995] was a co-operation between Lucent Technologies, the Telematica Instituut (formerly known as the Telematics Research Centre), the University of Twente and Deutsche Telekom and run from October 1994 through June 1996. It focused on the development of technology, applications as well as their (anticipated) use. On the applications level work focused on CSCW applications, in particular on desktop conferencing and co-authoring of multimedia documents. The MESH project (*www.mesh.nl*) is a two-year co-operation between Lucent Technologies, the Telematica Instituut , the University of Twente, KPN Research and SURFnet with several user organisations in higher education and health care. The project started in November 1996 and is a follow-up of the LATINUM project. It focuses on the

technology to requirements of the specific pilot settings.
The overall architecture of the systems we have developed is depicted in [1]. The main mission for the

by the users. In order to realise this, application developers should be able to easily develop new components that integrate with the existing platform and already existing components.

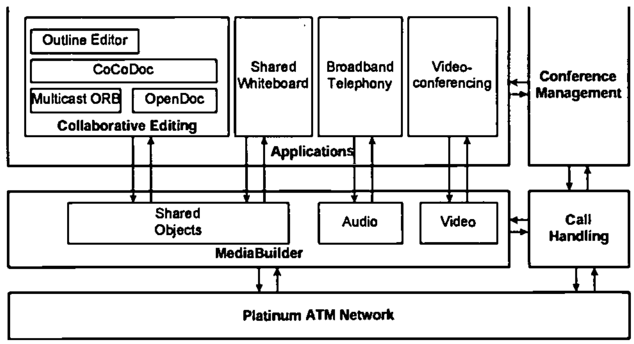

Figure : P and ESH

The main elements of the system are (from bottom to top, from technology to user applications):

- *Network services*: Research focused on the realisation of dynamically configurable multiparty multimedia conferences via ATM technology. This would allow for connections between multiple parties, providing support for several media, all under user-control (opposed to operator-control).
- The *mediabuilder* and *call handling* hide network-specific details for the application programmer. For example it provides facilities for the dynamic management of conferences, and enables stream support.
- The *conference management* component forms the overall user interface of the system. It enables the users to configure conferences (e.g., by means of a "conference wizard").
- On top of the mediabuilder several *groupware applications* are developed. The key research issue is to demonstrate that application developers can indeed develop there own favourite component, being it video, audio, chat-facilities, shared whiteboards or others. The platform guarantees the interworking of the components. As innovative application we developed a collaborative compound document editing framework, CoCoDoc [ter Hofte & van der Lugt 1997], with an accompanying example application, called CoCoTree. The example application allows for collaboratively editing of the outline of a multimedia document.

The MESH project builds on the technology developed within PLATINUM, in order to achieve a user-demand pull movement. For this purpose, the PLATINUM/MESH platform is used in four pilot settings. Two of these are in higher education, involving *teleco-operation* among university teachers, and *telelearning* in student teams. The collaboration will be among faculty and students of the University of Twente and the Technical University of Delft, who are located at a 2.5-hour train trip from one another. The MESH platform will facilitate the development of a new inter-university course on multimedia (interface) design. The main argument to develop inter-university education is the knowledge and learning gains expected when faculty and students from different traditions and with different sorts of expertise work together.

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Creating a Web-Enhanced Curriculum in German Studies

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Abstract: This presentation will address both practical and theoretical issues involved in developing standards-based, web-enhanced courses for German studies. The presenter will speak about the instructional design of several course sites, the pedagogical strategies implemented there, as well as the benefits and occasional disadvantages to integrating web resources in a consistent way into foreign language instruction. The course web site for intensive elementary German will be especially highlighted during the presentation. Other course web sites currently in use or under development such as *Intermediate German, Creation and Production of a German Play,* and *Political and Literary Cabaret in 20th Century Germany* will also be discussed.

The German Studies Department at Mount Holyoke College recognized early on the value of the World Wide Web for language, culture and literature teaching. Since 1995 the department has been making a concerted effort to develop web-enhanced courses on all levels of instruction. Course web sites were created that linked students to timely, authentic materials in German that addressed social, political, historical, literary and cultural issues in the German-speaking countries. These web sites also included web exercises and access to asynchronous discussion fora.

The department's effort was spurred on by the release of *The Standards for Foreign Language Learning: Preparing for the 21st Century* in November 1995. This document defines "*content standards*--what students should know and be able to do--in foreign language education in grades four, eight, and twelve" and is recognized on the national level as "a gauge for excellence, as states and local districts carry out their responsibilities for curriculum in the schools" [*Standards* 1996]. In reference to the use of technology in foreign language instruction, the standards document suggests that students "have access to a variety of technologies ranging from computer-assisted instruction to interactive video, CD-ROM, the Internet, electronic mail and the World Wide Web" as their use will help students develop and "strengthen linguistic skills, establish interaction with peers, and learn about contemporary culture and everyday life in the target country" [*Standards* 1996].

There is currently a push to develop national standards that include college-level foreign language instruction. In fact, the American Association of Teachers of German's *Student Standards Task Force* is currently in the process of developing German-specific standards for K-16 students of German. Recognizing the need for instructors at the college-level to become familiar with the national standards so that entering students could continue to receive instruction consistent with the principles articulated in the standards document, the German studies department at Mount Holyoke College set about developing standards-based web sites for all courses. This effort was supported in part by grants from the Hewlett and Mellon Foundations recently received by the college. These grants not only increased student/faculty access to the World Wide Web (in campus computer labs, faculty offices and dormitories), but also provided funding for "student web technologists" who were hired by the department to assist with development of additional course web sites. This allowed for integration of the Web in an even more systematic way into the German studies curriculum.

In the intensive elementary German class at Mount Holyoke web resources were used extensively. The purpose in creating, designing, and implementing the course web site was to provide students in the class with links to a wealth of culturally authentic web resources related to the German-speaking countries. The idea was to provide students and and the instructor with the least painful way of accessing sites linked to cultural topics and grammar explanations discussed in each chapter of the textbook. The course homepage features a table with links not only to sites in Germany, Switzerland, Austria, and the U.S., but also offers a link to a list of web exercises coordinated with the material covered in each chapter. Students were required to complete these exercises as regular homework assignments. To earn extra credit points, they had the option of e-mailing the instructor the URL of a site on the Web that they discovered and found interesting. The instructor then set up a separate page where the "student URLs" are listed. At the start of every class meeting the instructor displayed a site related to the chapter the class was covering. The class looked at maps, heard German songs, viewed live video from Germany, played interactive games, searched for an apartment in Germany, "bought" furniture and clothes, decided what to order in a German restaurant, etc. The instructor discovered that doing web activities as a sort of "warm up" at the beginning of a class period was the perfect way to energize the class, especially since she taught at 8:00 a.m.!

As foreign language instructors begin to use the resources found on the World Wide Web more regularly in their teaching, they must reflect on how use of the Web has affected and changed teaching and learning in substantive ways. The Web itself is both a content provider and a delivery medium that offers nearly instantaneous access to the most current resources and experts in various disciplines. However, the Web is merely a tool. A tool does not teach, but assists students in the learning process. The key is to make this tool work effectively for the instructor and the students. Integration of the Web into instruction has the potential to impact positively on both the instructor's approach to teaching and on the learner's approach to learning because its use creates a community in which students are not afraid to take charge of their own learning. Using the Web in instruction encourages student interaction and collaboration. This interaction/collaboration can happen between classmates in or outside of the classroom, or between students and instructors at different schools or in different countries. Use of the Web should be encouraged so that students become engaged learners whose work with one another helps them perform real-life tasks and solve real-life problems.

The Web offers non-linear access to a wide variety of complicated and complex information. Students can also be introduced to many different ways of evaluating this information, especially when access to newsgroups and E-mail is integrated into the design of a web site. What the WWW does especially well is enhance already developed curricular goals--i.e., it helps instructors expand on what they have already been doing and offers students new perspectives on various topics. For instance, if students in a 4th semester German class are studying the history of the Berlin Wall, they can be alerted to the existence of a limited number of web sites in Germany that address this topic and/or can be asked to do a search to find other relevant sites. They can then explore these sites, most of which will be written in the target language, in order to ascertain the viewpoint or perspective of the site developers and others from the target culture. If students are normally asked to give oral presentations in a course, they should be encouraged to incorporate information found on relevant web sites into their reports. When given permission to surf the Web, students will often find sites that the instructor has overlooked. Thus, in effect the students become instructors themselves in an environment where cooperative learning is encouraged. Another activity that lends itself particularly well to use of web resources is pair investigative work. Students in a 4th or 5th semester German course could work in pairs to find information on the Web about a topic they are studying. Student interaction within the pair encourages cooperative learning and allows the instructor to act as a guide or facilitator of the activity, not as the sole information provider. After the pair has completed the research, both students could be asked to report in German on their findings--i.e., explain how they located the sites, what information is available on those sites, and how they have evaluated the information found there. Students who are writing theses or are engaged in independent study projects could do searches on the Web to locate information for their project. For instance, a student writing a thesis on the *Stasi* could do a web search to locate Joachim Gauck's address and then write to him to request an interview. Such activities underscore the value of the WWW as a medium that not only supplies content but also teaches about process.

As instructors begin to use the Web more and more frequently in instruction, their assessment methods will also have to change. Instructors may ask students to use the Web as a presentation tool. In this scenario other members of the class (the "audience") should be held responsible or accountable for what they have learned by listening to the presentation. For instance, they could be required to ask presenters at least one question to make sure that they have comprehended the material. Students could also work in pairs to create their own web exercises for the class. Pairs then exchange exercises and work together to complete them. This sort of discovery-oriented work calls for much more flexibility on the instructor's and learners' part since students drive or guide the instruction to a certain extent. They are working on complex, real-world tasks and should be encouraged to challenge information presented to them by a number of sources.

There are certainly disadvantages to using the WWW in instruction which should not be denied or ignored. For one thing anyone may publish his/her thoughts on the Web. Students will have to learn to look beyond the information presented and consider the source. Can this source be considered credible? Why or why not? It is a wonderful class activity to have small groups of students evaluate selected web sites with the goal of determining which ones supply useful and valid information. This allows them to develop higher order thinking skills as they learn to discriminate between good and bad sources. If students in a course are considering use of certain web sites when preparing oral reports or papers, they should be asked to defend their decision to use the information gleaned from them. In this way they learn to take responsibility for the choices they make.

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Internet for Schools: a New Way of Learning and Working

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1. Introduction and Objectives

The aim of this paper is to seek the application of Information and Communication Technologies (ICTs) in the children training process within the region of Castilla y León. This Spanish region is mainly featured by its sparse population. Internet for Schools deals with the development of a support tool for children in rural areas. The main objective is the establishment of an "Educational Intranet" which will provide additional contents and more accessibility to those services traditionally located in urban areas.

The above signatories take part in a Research Work Group named *Canalejas*. The research of this interdisciplinary and inter-university group is focused on Educational Multimedia and Telematics Networks in an educational context, evaluating the possibilities and advantages of applying ICTs to the training process. *Canalejas Work Group* is formed by researchers from two different Universities (Valladolid and Salamanca), more precisely from the Telecommunication College and the Education College and from the Pedagogy College respectively. The collaboration carried out by these two teams is justified by the interdisciplinary character of the project. Due to the experiments and the nature of the research, the collaboration of professionals from the education and the telecommunication sectors is required, in order to asses the pedagogical and telematics developments respectively.

Internet for Schools consists on developing a pilot project about the possibilities of Internet in Primary and Secondary Schools [Verdú et al. 1997]. About 100 schools in Castilla-León will participate in this project. The actions to be undertaken are: Evaluating the use of Internet, focusing on the possibilities of ensuring equal opportunities of access; and giving occupational training for students, who will familiarise themselves with the use of ICTs.

2. Schools and the Information Society

Nowadays we are witnessing the evolution from the *Industrial Society* to the *Information Society*, where citizens will be able to use the advanced telecommunication services to improve the quality of their every-day life. With the emergence of the Information Society, everyone must upgrade their skills constantly and obtain new qualifications. In this way, education and training will play the main role. Distance Learning lets students get the best training, where they want and whenever they prefer, and they can always contact their teachers. The fact that all students can have the best teaching makes possible giving the same chances of training to everyone. Moreover, ICTs give students immediate access to universities, research centres, museums... and also provide new learning methods in which personal and group work is stimulated.

3. What does "Internet for Schools" offer?

The project has been recently initiated and among the services we are developing, can be mentioned the following ones:

1. With the *Electronic Tutorial* students can contact different teachers from different schools. These students can ask questions and discuss with the teachers.
2. *University Guidance* has the aim of informing last-year-Secondary-Education-students about the information about different careers. Not only students can know about where they can study one career or what it is about, but they can also contact university students, teachers or people who have taken a degree on that career, who will inform and talk to them about their own experiences. The contacts are made via e-mail.

Internet for Schools is implemented at the following Web site: *http://www.intesc.cedetel.es*.

4. Future services

First of all, we must analyse the consequences of introducing Internet in the Schools and identify and fulfil the needs of the primary and secondary school community.

Finally, an Intranet [Holtz 1996] will be created. The establishment of an educational Intranet will prepare children for intelligent use and management of information. Besides, the technology is accessible, cheap and easy-to-use, and can be easily addressed to Primary and Secondary Schools. We are trying to connect schools to the Network and lead teachers and students towards the Information Society, using innovative learning methods based on interactive information search and distributed working groups. And all of these, ensuring equal opportunities for all children.

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Understanding the System:
the Key to Sustained Task Competence?

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Introduction

The operational power of civil and military organisations is becoming increasingly more determined by the competence of its personnel in acquiring and retaining skill in operating devices. One of the good properties of operating tasks is that they can be learned relatively quickly, even if the set of operations is complex (Kieras, 1990). Problematic is, however, that skill in procedural tasks deteriorates very rapidly during periods of no-practice (Christina and Bjork, 1991). Several training measures have been proposed to enhance skill retention (e.g. Hurlock and Montague, 1984), for example:
- Provide system insight: explain the structure of the task and the underlying system principles
- Mixed practice schedule: practise tasks in random order rather than one by one

The effects of these training design factors on skill retention have been studied separately, and in the context of different tasks. Moreover, their effects are not always clear (e.g. Konoske and Ellis, 1986).

Design

Subjects were soldiers of the Airborne troops of the Dutch Army (age: 18-25 years). Their educational level varied from lower vocational training to high school; Subjects were divided into 8 groups, matched on their scores on the subtest Technical Insight' of the Differential Aptitude Test (DAT). 94 subjects completed the learning phase (i.e. attained the criterion level of performance); 84 came back for the retention phase and reattained the criterion level.

Subjects learned to direct a simulated ship from one side of a lock to the other by mouse-clicking (simulated) controls on a computer monitor. The required sequence of actions depended upon the sailing direction of the ship and the water level in the lock. A total of four procedures were to be learned, each containing 14-17 steps.

The learning phase involved instruction, a written test (10 multiple choice questions) and training to criterion (three errorless performances of each task). Retention was measured after two months. Subjects retrained all tasks until criterion level and then completed a written test (25 multiple choice questions).

Three variables were manipulated:
1. Type of instruction: Subjects in the *low system insight* groups received only procedural explanations, i.e. a description and demonstration of the actions to be performed; subjects in the *high system insight* groups were shown how the task can be decomposed into five logical subtasks and they received additional information about the principles governing the lock's behaviour and how these relate to the task procedures.
2. Training schedule: Subjects in the *blocked training schedule* groups trained one task to criterion and then continued with the next; for subjects in the *mixed training schedule* groups, trials of the four tasks were mixed.
3. Retention test schedule: Half of the subjects received a *blocked retention test*, and the other have a *mixed*

retention test.
For both learning phase and retention test the following measures were obtained: number of trials needed to reach criterion, amount of time needed to reach criterion, number of errors in the first 12 trials (possible minimum to reach criterion level), score on the multiple choice test.

Results and Discussion

The results of the learning phase show that subjects in the high system insight groups (i.e. who had extra explanations about the structure of the task and the underlying system principles reached) the criterion level of performance with less trials and that they made less errors. The practice schedule had no significant influence on learning and there were nog significant interaction effects between the two factors.

The results of the retention test after two months show no significant effects of type of instruction or practice schedule. There was a clear interaction between the practice schedule and the retention test schedule: subjects made less errors when they were tested in the same condition as they have practised. Especially the combination of minimal instruction, a blocked practice schedule and a mixed retention test seems unfortunate.

Strangely enough, the results of both written tests show ed no significant differences between high and low insight groups. A post-hoc analyis showed, however, that subjects who scored better on the first test immediately after the instruction, performed significantly better during the retention phase: they needed less trials to reattain the criterion level of performance during the retention test. These finding ssupports the hypothesis that system understanding improves the retention of procedural skills. But they also make clear that the type of instruction was, in this case, not the main factor promoting system understanding.

Almost all subjects reported that they had some experiences with locks before the experiment. This background knowledge probably helped them to understand the function of the lock and the tasks of the operator. The results of this experiment suggest that explanations about the task structure and the underlying system principles are less important when trainees are already familiar with the system, even when they are not familiar with the operating tasks themselves.

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Student Perceptions of Internet-Based Interactive Teaching and Learning in the Communication Arts

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Up to 1997 the film studies-oriented unit *Screen Studies* had been taught in the traditional way: a lecture of about one hour was followed immediately by a film screening, with a small group (approximately 15) of students meeting for tutorial sessions of one and a half hours during the same week. However, Central Queensland University (in the state of Queensland, Australia) is not a normal university in that it comprises five campuses in the geographical area of central Queensland and two campuses in the capital cities of Sydney and Melbourne. (The unit in question was not taught in those last two campuses in 1997.) Previously, lectures were delivered from one campus to the other campuses by videotape, recorded on the Monday and freighted to other campuses (Bundaberg, Gladstone, Mackay), where it was played for the students before their tutorial.

The rationale for the change to a computer-mediated course delivery and interaction derives from both negative and positive imperatives. On the negative side is the unique geographical dynamic of the central Queensland campuses, the forecasts for ever-diminishing funding relative to increasing student numbers, and the traditional rift between internal or on-campus students, and external or off-campus students in terms of access to resources, peers and lecturers. On the positive side is the potential for accessing information in ways that threaten to change the nature of a print-based library, the dismantling of geographical limitations to student communication and other features of learning that might be enhanced or generated by online learning and interaction.

One theory of Australian historiography postulates distance as the major influence on Australian history and further, argues that this tyranny of distance hindered western development in Australia [Blainey 1982]. The 'delivery' of 'Education' has been a major player in the conflict against that tyranny and the internet heralds a decisive victory in the war against the tyrant. Just as the telegraph wires disarticulated the delivery of news and information from the domain of geographical distance [Carey1989], the internet will liberate education.

In 1997 I trialed electronic delivery and interaction of *Screen Studies* via the internet, by placing 'modules' on the WWW that would replace traditional lectures [see Vieth 1997], coupled with four ISL (Interactive Student Learning) sessions during the semester, and electronic tutorials using e-mail that would bring together students from different campuses. ISL is simply vidoeconferenced lectures, where students from all campuses can interact via a videoconference link. While many examples of communication arts teaching material exist online, fewer examples of units taught interactively via the internet exist for communication arts units.

The students are generally communication and arts students not necessarily noted for interest in computing nor computers. All students at secondary schools in Queensland receive some training in computer literacy and incoming students at the university are briefly oriented to the WWW and email in the first week of their university life.

The study

In the fourth and twelfth week of the thirteen week teaching semester students were surveyed to gauge their responses to the unit in both its content and negotiation. Students were asked questions relating to their access to computing facilities, computer literacy, and orientation to computer skills; followed by questions relating to the film screenings, the ISL sessions, the WWW modules, electronic tutorials and general questions about their expectations. Questions were both quantitative and qualitative, although the qualitative seemed to be more useful for my purposes than the quantitative, because the students who did not reply to the survey might well have been those who failed through the computer-mediated nature of the interaction. Twenty-six students responded to the week twelve survey of a total of 52 remaining in the unit at the time. In this brief session I can only mention a few significant aspects of the results.

The survey shows that students have expectations about teaching and learning at tertiary level that impact strongly on their beliefs about the efficacy of teaching without face-to-face contact. For many students human interaction is a primary expectation of university life and for some this interaction is not only a pedagogy but a means of establishing social contact with others. This type of response is not determined by the students liking for the electronic mode of offering; indeed, students did comment on the value of the pedagogy in such a film studies unit. Yet there is an obvious paradox here in that it is not unusual for student attendance at lectures to decrease markedly during the course of the semester, and further, it is likely that those students who did not answer the survey would also be those who would stop attending lectures.

The mode of interaction also presents difficulties because the usual interpretation implicit in face-to-face communication is not available: that is, students are not able to 'know' the people they are responding to because they have no other medium of communication, such as sight and sound, through which to establish meaning. In addition, in one case a student complains that she has made 'no friends', linking this to her belief that the mode of offering is ineffective. One student iterates this sense of loss of visual and auditory identification, but then questions her need to attach an image to a response, asking whether such attachments 'mattered'. Some students realise that their expectations about the way education is practised is a learned expectation that might have no intrinsic basis, but for others face to face interaction is inseparable from education in the communication and the humanities while they believe that, in other disciplines of science and computing, such computer-mediated communication might be acceptable.

Related to the question of human and computer-mediated interaction is that of motivation. A common thread pervading the responses is that motivation and self-discipline to communicate and complete the tasks is a formidable hurdle. A student who failed the unit told me that she failed because she was not motivated to read her e-mail, respond and submit an electronic essay. Responding students also report a lack of incentive to read e-mail, a sense of being on one's own, a general lack of motivation, the need for motivation to complete the assignment requirements. One response was that face-to-face teaching and learning is 'forced learning' and is 'good', and that the computer-mediated pedagogy is not forced and is therefore not desirable. This response reveals more about the student's beliefs about education than the pedagogy itself.

Nevertheless, many students do both enjoy and approve of this different mode of teaching and learning. For this group motivation is not a problem and they enjoy the ability to choose their times of study and writing. Those who live up to 100km from the campus, or are otherwise employed at the times when lectures and tutorials are held, are very happy with the medium of interaction. Apprehension at the start of the teaching time is not unusual, but this apprehension sometimes turns into liking for the electronic tutorials and for the peer assessment that is an integral element of that mode of pedagogy. The lecture 'modules' on the WWW enable students to return to the text for re-reading; seen as an advantage over a lecture delivered orally, as is the enhanced research options the hypertext links provided. One student commented that it was more interesting than any other unit she had done.

The implication for distance learning in the communication arts units is marked and some responses note the increased potential for offering a full range of units on small campuses. Interestingly, some students find the computer-mediated mode of offering isolating while others experience the opposite. But the potential for the establishment of a 'tutorial dialectic' for off-campus students is one of the most potent elements of computer-mediated education.

Conclusion

Teaching and learning using computer-mediated communication might revolutionise the way we think about education. However, work needs to be done to establish, for students and educators, the validity of the pedagogy. At the same time, the need for face-to-face interaction in communication and arts disciplines as intrinsic to the learning process needs to be further researched to determine whether it is as important as students believe, and if it is, then some way of accommodating that requirement can be established while allowing for the broadening of possibilities computer-mediated teaching and learning offers.

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Teaching Spatial Orientation using Virtual Worlds

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1. Introduction

We are developing an educational software system to teach children (grades three to four) spatial orientation in two and three dimensional space. We understand the term 'spatial orientation' as the ability of a person to find physically and mentally one's way in two- and three-dimensional space [Maier, 1994]. Facilitating spatial orientation in two and three dimensional space is one important aspect of geometry in the mathematics curriculum of elementary schools in the state Nordrhein-Westphalia of Germany. Spatial orientation is an important ability for understanding, interpreting and developing the world in which the children live.
The current media-based approach (in Germany) of teaching spatial orientation typically involves pictures of a town depicted in a book. The used perspective projections of the three dimensional buildings awake an impression of their real three dimensional counterparts. Children are given tasks of navigation and orientation inside the town, using these perspective projections together with two dimensional city maps. They are also encouraged to accomplish the same tasks in the real world, using a map to navigate through their home towns.

2. The 'City Game'

Together with a research group at our University specializing in didactics of mathematics we are developing the 'City Game', a game to orient and navigate through a virtual city on a computer. The development of the 'City Game' is an interdisciplinary process between the didactics group and the computer science group.
To implement the 'City Game' we have chosen VRML 2.0, the Virtual Reality Modeling Language[1]. The complex scenes of the city are modeled with Cosmo™ Worlds, a powerful editor (and free on Silicon Graphics™ workstations) to create VRML worlds. The 'City Game' consists of a realistic city structure and typical buildings and objects of a city. Animated objects such as a bus or a train enliven this virtual city. Navigation through the city, along the streets, can be done interactively with various navigation help, e.g.

- a 2D-map (bird's view), which is showing the actual position of the user in the city
  and optionally displaying the covered way
- road signs and a hard-copy of the city map
- a wind rose for orientation with the four directions of the compass

Interactive navigation can be done by the standard mouse and direction buttons (forward, backward, left and right). It is implemented through viewpoint animation by automatically keeping the viewpoint at a fixed height.

One of our main interests in the City Game is the value it possesses for teaching children spatial orientation. The use of virtual reality to improve human abilities in the real world has been proven to be successful in other

[1] „It is the International Standard (ISO/IEC 14772) file format for describing interactive 3D multimedia on the Internet." (*http://vrml.org/Specifications/*)

areas as well, such as the overcoming of phobias by training subjects in virtual reality [Strickland et al., 1997]. The main interest of the computer science group is to improve the requirements of teaching spatial orientation in virtual worlds.

A first informal study was performed to see reactions of children and adults by using the 'City Game'. Another goal was to determine what kind of features children use for orientation as compared to adults. The study included ten children (grade four) of an elementary school and ten students of the University of Paderborn. Each group consisted of five male and five female subjects. In this study subjects had to find their way from different initial positions to different target positions. Each trial should be performed with a different help or method, e.g. with the city map, with photos along the way to be found, with the wind rose or by backtracking a way that was shown before.

Before beginning the study each subject was shown a walk through the city and taught the use of the direction buttons. The subjects were asked "to think aloud"[2] during performing their tasks. The comments were recorded by video and in written notes by the evaluator.

An unexpected result was that adults and children hardly used road signs and the city map for orientation in the virtual city. Their orientation occurred mainly through buildings with particular characteristics (e.g. function, size or color). An explanation may be the relative small number of streets and the great number of particular buildings. Also the experience with three-dimensional computer games might influence the behavior of the subjects. Mostly the navigation help of such games are objects and directions. The buildings used recurrently for orientation were the museum with a large dinosaur in front, the church, the city hall, and the school.

Differences between the children and the adults occurred when they were asked to remember objects of the virtual city after the study. The buildings mostly named by the children were (by decreasing frequencies): the museum with the dinosaur, school and church. In contrast to that the major buildings named by the adults were: grocery, petrol station and church, and museum. This indicates that children and adults use different objects for orientation dependent on subjective perception and the experience in daily life.

One important result was that subjects (both children and adults) often focused on the navigation tools (mouse and direction buttons) rather than on their tasks. Nevertheless the reactions of the subjects were very positive to the 'City Game', specifically to the structure of the city, the appearance of buildings and details. Some of the subjects suggested to populate the streets with people, who can be asked for directions.

Based on this preliminary study and the extensive development of the 'City Game' we are starting off a series of further tests of teaching spatial orientation in virtual environments. We are currently improving the navigation tools of the 'City Game' to develop a more intuitive navigation control to simulate a natural walk through the city. Formal studies based on more specific hypotheses will give us a deeper insight into the navigation feature used by children and adults in virtual and real environments.

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[2] A common evaluation technique of user interface design.

On Virtual Utopia: Collaboration in Interactive Hypermedia

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Abstract: The process of constructing a set of three dimensional interactive web-based utopian communities has engaged two university professors in the challenge of mastering new technologies and operating within the limits of current hardware and software while maintaining their original vision. The authors invite participation and collaboration in the construction of MetaTopia.

Two teachers from different disciplines, one who knows nearly nothing about the construction of virtual worlds, the other who knows absolutely nothing, attempt to collaborate on the construction of an elaborate set of interactive utopian communities for the World Wide Web. Socrates would have said that such teachers are possessed of a divine madness. We lay claim to neither divinity or madness--though there may be those who argue the latter label is appropriate due to our lack of knowledge and experience with the practical processes of virtual world construction. One of us, then the other, sometimes dreams. These dreams sometimes manifest themselves as nightmares, reflecting our fears. At other times these dreams simply remind us of our hopes, our vision. This paper addresses our original reasons for conceptualizing a three-dimensional, web-based educational project, our observations during its initialization, and issues both encouragement and cautionary notes to others who would either undertake similar endeavors or choose to join us in ours.

The MetaTopia Project began with a vision. Through participation in the project and in collaboration with other participants students will learn about the central concepts, norms, customs, and traditions of utopian and dystopian communities (historical, literary, and operational) by becoming virtual members. Students will interact with one another and with the character population within each community. Students will also move among communities in order to examine the processes of social construction, as well as the individual-level and community-level social, political, and economic repercussions of community membership. As a long-term goal, we envision the creation of an over-arching community, a utopian virtual world called MetaTopia, where the insights gleaned from exploration of the smaller communities will be applied in the construction phase and then operationalized and revised in the later phases.

We turn now to the practical task of construction. Where to begin? It's like the story of the blind men who sought to identify some strange object in their path. The first, grabbing hold of the tail, thought the object was a vine. The second, stumbling into a leg, surmises he has found a tree. The third, upon encountering the trunk, insists he has discovered a massive python. None of the men can see the object in its' entirety. They do not know that that which is before them is simply an elephant. MetaTopia is our elephant.

Web-site construction sometimes seems as if it has little to do with the world of ideas in which we have dwelt for a dozen years or so. The technology overwhelms us. The difficulties of loading other people's virtual worlds onto our computers overwhelms us. If the technology is so complicated that we can't use it (or so simple that it is comparable to reading a book or a journal article), then there is little motivation to continue its use. While we could hire an expert to build what we consider frustratingly complex, that would defeat our purpose. We are invested in the creative process and in the process of intellectual collaboration. Our inexperience also strengthens us. Our discomfort constantly reminds us that user-friendly designs will be important to our students.

Three-dimensional technology for the Web was, and still is, relatively new. We have searched and continue to search for ideas that are kindred. The virtual worlds which we have examined on the World Wide Web may share some ground with the worlds we are in the process of posting, but our work as we envision it serves to fill in educational, technical, and aesthetic gaps. We were novices standing on the cutting edge of web-technology. Gathering information about software packages and comparing them was quite challenging. Our decisions were confounded by changes in vendor offerings and delays in funding. Our original plan was to produce a fully three-dimensional Plato's Republic as the first component of MetaTopia. Instead, we began work on Charlotte Perkins Gilman's Herland in flat text. It was only then that we realized that MetaTopia had become a monumental task. One with no end.

In the initial stages of development, students were asked to read utopian literary works, original texts, second-hand descriptions of life in community, and critical analyses. Student responses, accompanied by citations supporting each answer, to a series of questions will provide guidance as each community selected for inclusion is mapped. The first stage of the project included laying out flat text HTML for one community (with the expectation that this layout would serve as a map for more complex communities that would follow) and linking it together in two ways: 1) so that site visitors could follow a character through the website (allowing those more comfortable with linear thought processes to follow a path that was story-like) or 2) so that site visitors could follow a theme (allowing those more comfortable with a topic-oriented approach to move through the text). At all times during this early construction phase, we also kept in mind that we wanted site visitors to move among the communities with ease so as to foster comparison among them. We also kept in mind that visitors would vary in terms of their levels of sophistication and interest. For those who had, for example, some familiarity with the concept of utopia, we assumed that the theme-oriented path might hold more appeal. On the other hand, those who had little or no experience with the concept of utopia might need to be encouraged to continue their exploration by following a character with whom they could in some way hopefully identify.

It was precisely that, that there is no end to the task we have outlined for ourselves, that drew us initially to the task--and then in deeper and deeper into what seems a dangerous morass. Building utopian worlds, literary, historical, even contemporary, seems to be a thankless task. It was for them, we think. Why would it be any different for us? Those who have created utopian worlds, both those who have constructed their dreams on sheets of paper and those who have built them out of sweat and brick and stone, have had to endure not only the criticisms of their contemporaries, but are hounded still, even as they turn to dust in their graves. Unrealistic, say some. Unattainable, say others. Idealistic, charge still others. We, by undertaking this project, simply rejected these charges. Our engagement in this project should be read as an affirmation of the argument that heaven on earth can be created.

Our work is intended to serve as an operationalization of systems theory. The notion of interconnectedness, central to systems theory, remains a guiding force as we develop the sites. Students, like most academics, continue to live out their lives in one discipline, giving little thought to the relationships among them. By inviting students, or any site visitors for that matter, to examine utopian experiments, and to look for the commonalities, to examine what exists at the interstices, we may engage them in an exercise that has, ultimately, practical applications.

We believe that anytime anyone is engaged in a discussion about the proper goals of society, about the boundaries between personal behavior and the prohibitions of the group, about the rights, liberties, and duties of citizens, it is of benefit to the social compact. People who engage in such discussions are likely to be more active, more intellectually engaged. Simply being part of, and to some degree in control of, the process of exploration fosters the development of efficacy and power. This may be of relatively little value if confined forever to a virtual world—but if transferred someday to the real world, translated from attitude and belief to behavior, then heaven on earth is indeed possible. So, what was initially an intellectual exercise, a mindwalk of sorts, becomes a walk toward heaven which includes the body.

The single most problematic flaw in all utopian efforts, literary and otherwise, may be that the efforts at utopia building were conducted by single authors, or in the case of actual historical communities, by relatively small leadership cadres. Can one or a few people truly be expected to understand the functioning of an entire system, with all its constituent parts? Can one or a few be so omniscient? What if building utopia (not *a* utopia, which is what people have been attempting to do over the ages) takes the input of a large group? What if it takes us all? Utopia building in the virtual world is nothing short of the democratization of utopia building.

Towards Advanced Hypermedia: The Minimalistic Java Approach

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1 A Minimalistic Approach towards design of advanced Hypermedia

Development of a Java hypermedia application differs from WWW hypermedia development. Where most conventional WWW applications focus on the server, in advanced hypermedia development the focus is on the client application. In addition, development with Java is not based on existing components but will usually be implemented from the ground up. With Java, application design is more extensive. The object-oriented nature of Java encourages a fully object-oriented design.

We present the Minimalistic Java Approach (MJA) as a framework that links the advanced Internet hypermedia design process with implementation in Java. MJA does not intend to be a general hypermedia design methodology, since several extensively-used platform-independent methodologies already exist for hypermedia. Instead, MJA is result-driven and specifically aimed towards implementation. It is minimalistic because it does not rely on any specific development tool. All activities in MJA are based on a strong bottom-up and object-oriented approach to software engineering.

1.1 Consequences of Implementation in Java

Three aspects, specific for Java hypermedia, are addressed in MJA. They are the availability of development tools, the hypermedia authoring bottleneck, and integration with existing hypermedia:

1. *Availability of tools and components:* A large software library exists with freely available 'plug-in' extensions, languages and libraries for WWW browser and servers. In contrast, Java components and libraries for support of existing media formats are rare. This implies that only applications, which cannot be accommodated within the limits of conventional hypermedia development are worth the extra effort of custom hypermedia development.
2. *The hypermedia authoring bottleneck:* A second issue for hypermedia development is the central role of the authoring process. Without a supportive authoring environment, realization of a real world hypermedia application is laborious. This hypermedia *authoring bottleneck* [Nanard and Nanard 1995] is a major factor in the success or failure of new hypermedia architectures. Well-designed authoring tools or adaptation to existing hypermedia standards remove the bottleneck.
3. *Integration with existing object-oriented hypermedia design:* Among various hypermedia design methodology alternatives, two were selected for MJA because both methodologies share language- and tool independence, as well as full object-orientation. The Extended Object-Relations Model (EORM) [Lange 1994] is based on the definition of a class hierarchy of semantically rich relationships. These linked classes allow designers to express the complex relations between hypermedia objects in fully object-oriented content. The objects are central in EORM because complex semantic information regarding hypermedia object relations can be stored in a single object. EORM's relevance for Java based hypermedia design is to improve the conceptual shortcomings of most existing direct and non-semantic hypermedia link models.

   The second hypermedia methodology in MJA is the Object Oriented Hypermedia Development Method (OOHDM) [Rossi et al. 1995]. It is a complete and graphically oriented methodology, specializing in hypermedia user interface definition. OOHDM applies graphical notation to define abstract data views, which express user interface dynamics in petri-nets. The communication between objects is expressed in configuration charts. With its graphical notation, OOHDM complements EORM, in particular for user interface specification.

1.2 The In- and Output of Java Hypermedia Design

MJA follows the waterfall model of software engineering, with seven development phases [Figure 1]. The top two layers display the design-input elements. The top input layer display is specific for Java; the second layer contains general design input. In seven phases, Java classes are defined, and after repeated refinements integrated in one prototype application. In MJA, Java source code has a role as a tool-independent design formalism. The language dependency of MJA promotes the direct implementation of abstract concepts from object-oriented modeling, closely integrated with the Java key technologies. The strong bottom-up approach, combined with prototyping and inclusion of two hypermedia design methodologies aims to overcome the incompleteness of abstract object-oriented software design, which are insufficient when used in isolation [Bryant and Evans 1994].

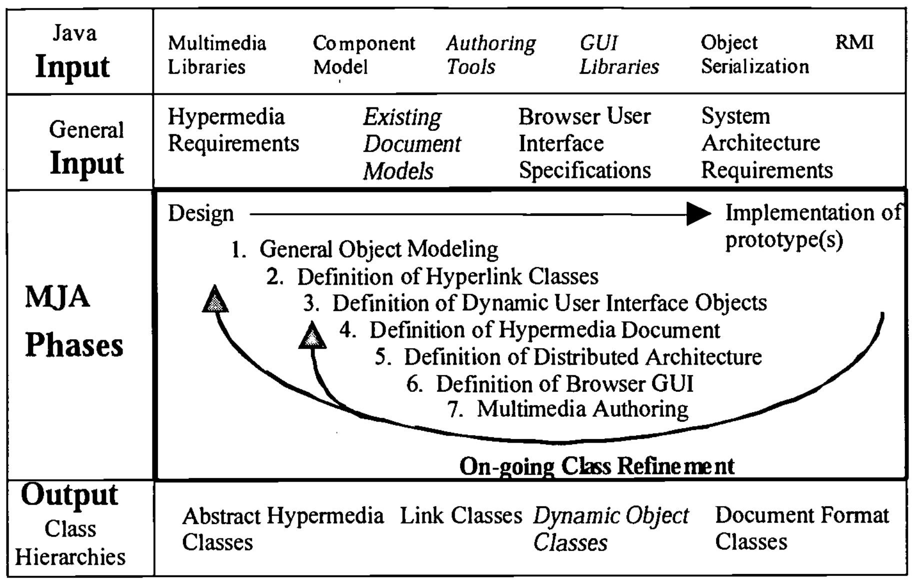

Figure 1: The Minimalistic Java Approach (Italicised items are optional, depending on availability)

2 Conclusion

We have introduced Java as a mature platform for advanced Internet hypermedia. With its platform independence, continuously increasing multimedia capabilities, and flexible distributed architecture, a hypermedia browser implemented with Java can eliminate various limitations of WWW hypermedia.

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Acceptable Use Policies for Schools: An Educational, Ethical, and Legal Analysis and Proposed Model

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The Internet offers a powerful new technology for the schools. However the promise the Internet offers for a free exchange of ideas and information is accompanied by concern for the potential online dangers to students being exposed to obscene material, sexual predators, material advocating or depicting violence to others, or racism. Media accounts of students accessing pornographic material or becoming victims of sexual predators have heightened parental concern about what their children are exposed to, a concern which is matched by educators' concern over school district liability [Marcus 1996]. The challenge for the schools is to provide Internet access to acceptable material, while denying access to unacceptable material in a manner that does not violate students' rights to privacy and freedom of expression.

The response of some schools to this challenge has been simply to not allow any Internet activity. Other schools have attempted to screen material through the use of blocking or rating software. Blocking software such as Cyber Patrol, Net Nanny, or InterGo block Internet sites that are known to contain pornography or violence or scan incoming text for specific words. Rating software, such as that produced by the Recreational Software Advisory Council or Safe Surf, are designed to permit or deny access to sites that based on their rating in specific areas [e. g., violence, sex, nudity, profanity, racism, gambling, etc.].

While blocking and rating systems can help protect students from objectionable online material, they are relatively new systems and their effectiveness depends heavily on the cooperation of the Web sites themselves [Truett, Scherlen, Tashner, & Lowe 1997]. Moreover, they require continuous updating and can be circumvented by expert users [Trotter 1996]. Another problem with the use of blockers is that in blocking certain potentially offensive words [e. g., "breast"], they block access to valuable information on many important topics [e. g., breast cancer] is also blocked [Trotter, et al. 1997].

Recognizing the limits of blocking and rating systems, as well as the fact that it is virtually impossible to prevent students from accessing materials whose existence can never be fully anticipated [Fishman & Pea 1994], many schools have adopted acceptable use policies (AUPs) as a strategy to ensure safe student use of the Internet. An AUP is a written agreement detailing the terms and conditions of Internet use. It also typically includes the penalties for violations of the policy [Laughon, Blacksburgh, & Hanson 1996]. Most school districts require that the student and a parent sign the agreement before Internet use is allowed. In addition to protecting students, AUPs intend to deter parental complaints and to reduce or remove the liability of the district resulting from any misuse by students [Sanchez 1996]. More importantly, acceptable use policies shift the focus from external control to students taking responsibility for their own behavior [Dyrli 1996].

While numerous schools have adopted acceptable use policies, too often these policies are internally inconsistent, lack clarity, and are illogical. For example, AUPs often include phrases which state that students shall not access "inappropriate" or "unacceptable" material without defining what these words mean. Such imprecision "shifts decision making away from students and toward administrators who decide after an incident whether the policy was violated" [Trotter 1996, p. A13]. Another common phrase in AUPs states that students should not intentionally obtain copies of files or data that belong to someone else. On its face this statement would prohibit collaborative student projects--clearly not what its drafters intended [Kinnaman 1995].

This paper discusses the major educational, ethical, and legal issues related to AUPs, including liability, censorship, copyright protection, and students' privacy rights. It also presents the results of an analysis of AUPs from several dozen schools across the United States and Canada. Each policy was analyzed from an educational, ethical, and legal perspective. Based on this analysis, as well as a review of print and online literature, a model AUP is presented. The major components of the suggested model policy are: (1) an explanation of what the Internet is; (2) a statement that access is a privilege and not a right; (3) the process for governing local Internet system security, user accounts, and user privileges; (4) terms and conditions of use, including expected Network etiquette; (5) a specific explanation and reference to what is and what is not acceptable use; (6) the sanctions for violation of the policy; (7) a non-liability disclaimer of school responsibility or warranty for the services it is providing; and (8) student and parent signature.

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Teach/Me -- Data Analysis
Teaching Multivariate Statistics in an Interactive Learning Environment

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1. Introduction

Constructivism seems to be the new paradigm in teaching. Most textbooks and older computer assisted learning (CAL) software are built upon behaviourism. New technologies and the increase of computational power of desktop PCs allow the implementation of this paradigm using highly interactive learning environments on desktop PCs. We implement CAL software on Windows based systems; our system is called Teach/Me.

2. User Interfaces for Learning Environments

In order to successfully implement such a learning environment, motivation of students has to be seen as one basic requirement. Providing different access methods and information retrieval features seems necessary to adjust to to the different skills of users. The users of our courseware can be categorized into beginners, advanced students and experts. According to their experience in statistics and their familiarity with our software they have different expectations and needs.

Beginners want to get a quick and easy start and need short texts that explain the overall context of statistical methods and their application. They have to be motivated to start exploring the teachware. This can be achieved e.g. by applications using interactive graphics and sound.

Advanced students that already know how to use Teach/Me need to access more detailed information. To prevent users from getting lost in details it should be easy to change the level of detail, to zoom out, i.e. to look back to introductory chapters. Graphic and sound effects should still be used but less frequent than for beginners.

Experts are users that already know most of the contents of Teach/Me. They can use our program to study details or as a quick reference. A concise and powerful index and other retrieval features without any „cute" graphics and sounds is the best choice to avoid annoying this group of users.

3. Implementation

3. 1. Beginners

One basic problem for beginners in any field is the danger from getting overwhelmed by details. The student first has to structure his/her thoughts by building up a mental „landscape" of the subject to learn. This conceptual clustering of [Hu 93], [Kremer and Gaines, 96] information is considered to be an efficient way to show students that are not familiar with statistics the basic structuring of and the relationships between chapters.

Each page of the underlying textbook is represented by a mountain in the landscape. The formation of the knowledge landscape is governed by two general rules: (1) fundamental chapters, explaining basic concepts, are visualized by high mountains, whereas more specific lessons are displayed by smaller mountains. (2) The placement of the mountains is done according to the similarity of the contents of the corresponding lessons. Since a great number of mountains may confuse and therefore demotivate beginners, the landscape can be flooded with water. The rising sealevel hides small mountains leaving only the fundamental texts visible.

Although students can explore the knowledge landscape on their own we also implemented what we call „guided tours". Teachers may advise students to study regions in a given sequence. This is accomplished by an aircraft that follows the course set by the teacher. We found this feature most useful for beginners who do not know what texts they should read and where to start. Students that are used to reading printed textbooks can

now use our aircraft to learn how to explore non-linear, non-hierarchical texts.
For a large part of the textpages we have implemented small, highly interactive applets to support the understanding of mathematical concepts. Reading just the formulas and some text will never have the same positive learning effect as experimenting with the examples that illustrate the concepts.
Further more Teach/Me features self adapting courses which configure themselves accordingly to the needs of the individual student.

3. 2. Advanced Students

More advanced students may want to have access to more details, and more demanding methods. Therefore, the sealevel of the knowledge landscape can be lowered, uncovering more of the mountains which represent advanced material. Whenever a student is unsure about the context of a method, he they only has to look for bigger mountains, i.e. overview chapters.
Once a region has been explored students may want to mark this region. By placing light houses we allow them to set 3D bookmarks into the landscape. Those bookmarks can be preset by teachers but students may delete or edit existing light houses or add new ones.

3. 3.Experts and Teachers

Students who already know most of Teach/Me's content and teachers who want to compile lectures and courses need ways to search the text efficiently. Therefore a full text search engine is provided which indexes the whole material of the textbook. In addition, we implemented the analogon of an index within the information landscape. All texts that contain the searched phrases will be marked by a user-specified texture.
We improved this feature by using the transparency of textures. Mountains representing texts which contain the search expression often or contain it in headlines or bold-face, will only be emphasized with the user-specified texture. If the texts does not fit so well to the search, the original texture of the mountain shines through.
Teachers may also want to use our interactive applications for demonstrations . We therefore strictly separated conceptual explanations and exploring texts from the interactive applications. All applications can be run in „teacher's mode“, allowing full access to all parameters and modes.
Although the 3D information landscape is still useful for this group of users (e.g. texturing) we also provide a 2D overview map. This 2D representation allows the same basic interaction as in 3D; only the transparent texture mapping is not available.

4. Immersion and Future Tasks

The main task is to get people to like using our program. Games seem to attract people: productive, intelligent people often spend a lot of time playing adventure games. We hope to be able to fascinate users in a similar, though less brutal way by a more detailed, „nice“ 3D environment. Looking at animated objects, light houses, etc. does not directly help students with statistics but it keeps them interested in the subject.
Since computers are used for many tasks, users have the option to run a small program in the background. This program resembles the Tamagotchi [Chia 97]. Our little creature comes alive right after booting. Depending on its „annoyance“-setting it asks questions about statistics. Further investigation will show if adding small games that are not correlated to the learning task will increase the acceptance of our little creature. This approach seems a good way to keep people involved ; Whatever they are doing , they are led back to statistics by this creature.
In conclusion, we think that the combination of serious presentation of knowledge, and motivating visualization is a key issue in teaching . A user interface that can be adjusted to the user's needs keeps students involved.

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Abstract: Motivation of students has to be seen as a basic requirement for interactive learning environments. Ways to increase motivation can be seen not only in nice graphics but also in providing fast and easy access to any detail of the learning material, and in various kinds of user interfaces the user may chose from. We developed a networked learning and teaching system in the field of statistics ("Teach/Me - Data Analysis") which not only provides access in the way of a classical electronic textbook but also offers some new approaches, like knowledge landscapes, self-configuring courses, or embedded interactive applications. Teach/Me has been designed as an open system based on HTML and VRML, thus providing a framework for presenting material from any other subject, too.

CLear - A Cooperative Distributed Learning Environment

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1. Introduction

In today's dynamic business world lifelong learning is a vital precondition of success. Often, the necessary knowledge to fulfill job requirements is not available from books, but is created in organizations and companies during the progress of the work. „The behaviors that define learning and the behaviors that define being productive are one and the same. Learning is not something that requires time out from being engaged in productive activity; learning is the heart of productive activity. To put it simply, learning is the new form of labor“ [Zuboff 1988]. As a general goal, a method of utilizing this distributed knowledge, i.e. storing, retrieving, presenting and using it on the job, is required. A special challenge is the exploitation of the potential of cooperation in producing, comprehending and handling this information.

CLear (Cooperative Learning) is a prototype of a cooperative learning environment to support learning and training processes of groups including distributed remote learners. CLear is based on a hypermedia data model and supports a wide variety of learning situations, such as synchronous and asynchronous learning, co-located and distributed learners, and individual as well as a wide range of cooperative learning processes. Its architecture is flexible enough to extend learning processes to collaborative work or to integrated working and learning on the job. The objective of this paper is to report work-in-progress concerning several facets of the CLear approach: implementation and communication issues, psychological-educational issues such as methods and techniques of cooperative learning in virtual environments with a focus on training in companies, and learning/working interactions. In addition, the paper presents some preliminary concepts with respect to evaluation issues.

2. Theoretical Approach

Cooperative learning can be defined as the acquisition of knowledge and skills driven by a collaborative and interactive effort of a group of individuals, thereby gaining knowledge and competence not only by increasing individual competence, but also by obtaining social skills through permanent communication and immediate transfer of knowledge (see, for example [Bouton & Garth 1983]). The CLear approach is based on the metaphor of a virtual world and virtual rooms which are shared by an arbitrary number of persons. Each individual who participates in the learning process is an „inhabitant“ of the virtual world and is associated with a virtual room, which provides functionalities to store and use hypermedia documents. Other virtual rooms such as auditoriums, group working rooms, public rooms for non-work related communication, and special rooms for trainers currently exist and users can easily create new rooms as needed. In addition, users can have different roles, e.g. trainer, learner, tutor, and different rooms may indicate these role assignments. As in the „real world“, individuals can move freely throughout this virtual world, visiting and cooperating with other inhabitants. This general model can be adapted to fit the specific type of learning/training task and the individual characteristics of the learners. Constraints such as access rights for different rooms, documents or other resources, and the provision of specific functions (e.g. help features) can be implemented according to user requirements.

3. Features of CLear

CLear is based on previous work at GMD-IPSI in the field of cooperative work and learning. Specifically, CLear builds upon ideas of the DOLPHIN system [Streitz et al. 1994], but has extended DOLPHIN's functionalities to meet the requirements of the virtual room metaphor. The prototype is implemented using the COAST framework

[Schuckmann et al. 1996], which allows easy development of cooperative applications. CLear provides functionalities for

- synchronous and asynchronous learning,
- remote and co-located learners/trainers,
- individual and cooperative group learning.

All learners are equipped with individual workstations which are networked and connected via audio/video communication channels. Each virtual room offers a shared workspace for the inhabitants. Co-located teams make use of (real!) team rooms equipped with video projectors and an electronic whiteboard. This enables tele- as well as face-to-face communication. Individual self-study is supported by private virtual rooms which provide facilities to work on various hypermedia documents and access to databases. Synchronous presentations, demonstrations and discussions are supported by access to a common virtual auditorium (public whiteboard) and by functionalities that support parallel communication of a trainer to all or to a subset of learners. Synchronous cooperative learning is supported by virtual group rooms for special work and discussion groups. In all virtual rooms the documents may be shared, jointly edited and annotated by the participants.

4. Research Questions

The basic platform with its flexible role assignments and open access policy can be tailored to specific demands by putting constraints on the communication and document access features. In general, however, CLear aims at supporting small or medium sized groups of adult learners (e.g. departmental training groups) and focuses on a task-oriented learning style. We have begun to introduce modifications and/or restrictions of the general platform by adapting the following variables: individual access and communication rights, group structure (hierarchies, heterarchies), group size, content characteristics, instructional strategies, form of presentation.
Type and amount of necessary modifications to the general platform are derived from considerations about: content type (from motor skills to problem solving), content difficulty, content scope, individual differences in knowledge, individual differences in learning competence, amount of common knowledge in the group, cooperation capability of the group, time constraints.

5. Evaluation

Prototype evaluation, done in the winter semester 1997/98 at the Technical University of Darmstadt, focused on the handling and acceptance of the virtual room metaphor for cooperative learning. Results indicated that students found the system easy to use and generally accepted this metaphor. Furthermore, the evaluation provided us with invaluable input concerning the functionalities of the virtual room in relation to hypermedia documents.

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Tools for Multilingual Management of Corporate Intelligence

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1. Introduction

Traditionally, expert knowledge has been documented monolingually in printed form (typically linear texts) and trained in classroom environments. Progressive specialization, decreasing life-cycles of expert knowledge, and the growing decentralization of corporate knowledge in the wake of the globalization of industry and trade have made us painfully aware that the needed expertise is increasingly difficult to obtain or learn through the traditional forms of documentation and training.

Moreover, global communication among experts as well as between experts and non-experts, but also political developments such as the unification trends in Europe and the shortcomings of available automatic translation facilities have brought another need to the surface that can no longer be satisfied by an individual expert or traditional printed resources: the need for multilingual dissemination of expert knowledge.

As surveys have shown, the needs in institutional as well as industrial environments in terms of knowledge management (corporate intelligence) are manifold. They include

- to secure specific knowledge for the organization
- to centralize distributed knowledge to make it accessible
- to provide knowledge in multilingual and multimedia representations
- to organize knowledge in flexible ways (different types of ordering criteria)
- to make knowledge accessible for distant and on-the-job training
- to present knowledge to clients

The objective of this paper is to outline possible solutions for such demands as instantiated by the knowledge management system FILCOM 3.0. Three topics were considered particularly relevant in this context:

- how knowledge should be organized
- how a high degree of flexibility in representation can be obtained
- which features have proved valuable in the design of the tools and the knowledge bases so far implemented

2. Knowledge engineering

The conceptual design underlying FILCOM development rests on the assumption that different people may share knowledge and that such knowledge may be structured irrespective of any particular language. It was further assumed that expert knowledge consists of an inventory of atomic knowledge elements (conceptual units) which may be related in particular ways within a semantic network. The relations used in FILCOM are directional and labelled. Classifications are made with resort to "type-relations", extensions with resort to "topic relations", "part-whole relations" etc.

A special feature of the FILCOM knowledge management system is the potential for multiple classification. First, subordination can be made relative to different ordering criteria. For example, a particular product type may be classified into subtypes relative to size, type of production, type of ingredients, or else. This feature has proved particularly helpful for non-experts to disentangle otherwise heterogeneous concept classes. Second, one particular knowledge element may be multiply associated with other knowledge elements. For example, "safety precautions with machine-based drilling procedures" may be classified as a subtype of "safety precautions with machines" or "safety precautions with milling". Moreover, it may desirable to classify this knowledge element as a relevant topic of discussion relative to "milling". The multiple connectivity is a characteristic feature of the conceptual network as developed by our group.

3. Knowledge representation

FILCOM allows a highly flexible display of knowledge to serve the needs of different user groups.

For the display of conceptual structures two alternatives are offered: hierarchical tree diagrams to provide macroscopic orientation within a given domain of knowledge, and conceptual networks to provide for microscopic orientation relative to a selected point (concept) of interest. Trees and networks are convertible.

Natural language representations can be freely appended to the elements of the knowledge base. Within-language representations include terms, definitional paraphrases, text passages or documents. One should note that one knowledge element may have more than one linguistic representation (e.g. synonyms), and that vice versa a particular language unit may represent more than one knowledge element (i.e. polysemy). Further language representations can be freely added, however, cross-linguistic representations are not directly associated among each other (for lack of 1 : 1 correspondence), but only via the knowledge base. It is only due to the knowledge-centred representations that a reliable multilinguality can be established.

Multimedia representations can also be freely appended to knowledge elements and displayed in parallel to language representations. In particular, multimedia facilities may be used for the purpose of displaying the pronunciation of words and text (sound files), the graphic display of objects (images), and the display of processes (videos, animations).

First experiences with users of the existing knowledge bases in industrial environments (e.g. metal processing, automation techniques, and food production technologies) suggest that there is no single type of representation that can be usefully applied generally or is generally preferred over others. For example, concepts of the abstract type seem to be most easily accessed through symbolic (verbal) representations, whereas concepts referring to real world objects are often most comfortably accessed in an analogue (visual or acoustic) representation. Moreover, individual learners may differ as to preferred representation. There is also evidence that exposure to multiple representations may have both, favourable or disfavourable effects on the process of perceptual intake, depending on the kind of display. Images with convertible cross-linguistic inserts have proved particularly effective to help learners overcome language barriers.

4. Where the system is bound to be intelligent

The amount of AI implemented in the current version of FILCOM is still modest. Among the AI-related features which users have found beneficial are the following:

- a multilingual dictionary can be dynamically generated from the knowledge base where the user can freely choose source and target language from the languages implemented and where they can define the scope of the output (selected domains of the knowledge base)
- translation of terms among languages can be automatically produced even where a dictionary does not yet exist
- documents for autonomous and distant (multilingual) learning of expert knowledge can be issued (on-line and off-line)

For further information about the scope of the application cf. the workgroup's homepage http://www.f-com.at

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Enculturating On–line Learning

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1. Introduction

Distributed learning systems on the Web have the potential and often the intention of reaching greater numbers of culturally diverse students. The key to success in the use of the Web across cultural boundaries lies in the appropriate design of on–line educational environments (Harasim, 1995; Henderson, 1996). Our own research (Henderson, Patching, & Putt, 1996; Wild, et al., 1997) has demonstrated that the Web is almost always chosen as a delivery medium for instruction primarily for its ubiquity and insignificant costs; however, it is not chosen for its instructional effectiveness; nor is it chosen as a medium particularly suited to carrying a range of information types for culturally diverse learners. In this context, creating systems for teaching and learning on the Web may well work to limit efficacy in learning, despite the Web's ever–developing technical capacities to carry multimedia materials and information, and its growing provision for various levels of complexity in learner–material interactions. Indeed, while many learners might possess the basic information and navigational skills to contend with information access on the Web, instructional designers are yet to consider those aspects of this medium that determine its effectiveness for all learners, whatever their cultural characteristics. Henderson has determined, as late as 1996, 'the relationship between cultural context and instructional design has received little attention in the educational technology and instructional design literature' (Henderson, 1996 85). It seems apparent that the lack of research to target cultural issues in instructional design for distributed and interactive learning systems, such as those being placed on the Web by universities in ever–increasing numbers, is even more noticeable and is likely to have serious consequences, particularly for students as well as for universities.

This paper rationalises the need for further research into the use of Web sites as vehicles for flexible learning, especially for students of diverse cultural backgrounds. The presentation of the paper will also describe an original conceptual framework for conducting such research and demonstrate some of our early findings.

2. The influence of culture

The nature of the Web has attracted a great deal of rhetoric in favour of its potential to provide for a student–centred model of learning, where the learner is both intrinsically motivated and active in the learning environment (Becker & Dwyer, 1994). Certainly the Web, in terms of being a dynamic, extensive and extensible information base, provides for the ultimate in resource–rich learning. However, there is little guidance, and virtually no empirical research, to help determine the most appropriate ways of using the Web to stimulate effective learning. It is apparent, however, that instructional design for Web–based learning systems cannot, and does not, exist outside of a consideration of cultural influences—both the cultural influences operating on the authors and instructional designers of Web–based learning materials, and similarly, those influences that impact on the interpretation of such materials by learners.

Defining culture is a difficult proposition and many different classifications exist in relation to national culture. The most pervasive view appears to be that culture is a manifestation of ways in which an identifiable group adapts to its changing environment; that people often belong to more than a single cultural group, embodying a subset rather than a totality of a culture's identifiable characteristics; and that they do not remain totally allegiant to their birth culture (Scheel & Branch, 1993).

There is also a clear consensus that culture must have a definite and very strong influence on the design and use of information, communication and learning systems, as well as on their management, despite the lack of identifiable research in these areas. In all areas of human activity, the behaviour of people is affected by the values and attitudes that they hold and the societal norms which surround them. When values are widely shared by a group of people, they are provided with a common mechanism by which they can share understandings and interpretations of their world. Culture, however, is more than just an abstraction, it also consists of a distinctive symbol system together with artefacts, that capture and codify the important and common experiences of a group. Distinctive significant symbolic meanings and values develop around information, its use and structuring in any cultural group. Also, at a practical level, when the act of instructional design translates this information into products or artefacts of learning, that artefact embodies cultural influences, such as the instructional designer's world view, their values, ideologies, culture, class and gender, and, their commitment to a particular design paradigm (Henderson, 1996).

These interacting cultural factors have a particular importance for the diffusion and efficacy in use, of information, communication and learning systems, such as the Web, and the products and materials of learning provided in those systems.

3. The need for investigation

Henderson describes three existing instructional design paradigms in static (ie. CD–ROM) multimedia products: (i) culturally unidimensional or exclusionary; (ii) inclusive; and, (iii) inverted (Henderson, 1996). For each of these paradigms, there is clear evidence they are either incomplete or problematic in terms of providing culturally appropriate instruction (Henderson, 1996 91). Also, work in progress by Wild and Henderson (Wild & Henderson, 1997) has begun to show that these same, unsatisfactory, paradigms also dominate in learning systems presently being provided on the Web by a range of educational and training institutions, and intended for use by culturally diverse students.

Thus, we presently have a situation where adverse cultural influences in the Web are present and are largely created unknowingly; and as a result, work to the detriment of large groups of culturally diverse learners who cannot identify with the instructional designs in Web–based systems of teaching and learning, originating as they do, in single cultural (usually 'western') identities. This problem, if uncorrected, is likely to become more evident as Web–based learning systems are increasingly put into place in the later 1990s and into the new millennium.

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Situated Learning Environments: Theories and Perspectives

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1. Introduction

Today's society demands that individuals be capable of problem-solving, learning new tasks, and adjusting to change. Many schools have come under criticism for failing to develop in students the ability to apply knowledge in diverse contexts.

Authentic or situated learning environments have been proposed as a possible solution to these problems. Advancements in technology offer the possibility for the economical implementation of such learning systems. Problem-based learning, an instructional strategy which emphasizes problem-solving in situated contexts, exemplifies situated learning. Therefore problem-based learning will be used to explore the theories and perspectives that can benefit students working in authentic/situated learning environments.

2. Background

2.1 Situated Cognition

A problem that has been receiving increased attention is the failure of students to transfer what they have learned in school to everyday situations. One can argue that information becomes knowledge in its application. Therefore schools must emphasize knowledge in action (e.g. activity). The application of knowledge requires the consideration of context since activity takes much of its meaning from the situation. The context and activity that individuals engage in are impacted by the culture that embodies it. Therefore, understanding is a result of activity, context, and culture [McLellan 1993]. This view is embodied in theories of situated cognition.

Situated cognition grew out of research which explored the manner in which people reason and solve problems in everyday life. In dealing with everyday events, individuals reason with intuition which is developed through experience in specific contexts [Choi & Hannafin 1995]. The context and the activities in which students engage are an integral part of what is learned [Brown, Collins, & Duguid 1989].

2.2 Problem-based Learning: An Example of Situated Cognition

Problem-based learning (PBL) embodies many of the elements of situated cognition though it grew out of a different research tradition. PBL is a type of case-based learning which places emphasis on solving authentic problems in authentic contexts. PBL was developed in the 1950's for medical education. Today PBL can be found in business schools, schools of education, architecture, law, engineering, social work, middle schools, and high schools [Barrows 1996].

Three implementations of problem-based learning are of particular interest since each emphasizes different design features. The Cognition and Technology Group at Vanderbilt developed *anchored instruction* where video-based scenarios "anchor" instruction in authentic problem-solving tasks. Roger Schank at the Institute for the Learning Sciences, utilizes computer simulations to embed learning in authentic problem-solving activities called *goal-based scenarios*. *Cognitive flexibility theory*, developed by Rand Spiro, emphasizes learning from multiple perspectives in ill-structured domains. Each of these implementations emphasize different elements of authentic learning environments and situated cognition.

The Cognition and Technology Group at Vanderbilt developed an implementation of problem-based learning which is called anchored instruction. Anchored instruction is an approach to instructional design whereby learning is situated or "anchored" in authentic problem rich environments [Cognition and Technology Group 1992]. The problem is set in a "macrocontext" which creates an environment for shared exploration by the teacher and students. By providing these elements, anchored instruction helps create authentic learning situations in the traditional classroom.

A Goal-Based Scenario is a problem that lies in the student's area of interest that presents a goal to be accomplished [Schank, Fano, Jona, & Bell 1993]. From Schank's perspective, the learning of skills and processes provides students with meaning and value for education. A skill is something one knows how to do. The student feels empowered by learning the skill and society benefits from having a skilled work force. A process is a system of relationships. Processes should be taught by selecting a goal the students will achieve and the skills to be learned in the context of the process. Students will seek out relevant information that they need to acquire while learning the skills and processes.

Cognitive flexibility theory grew out of research on the learning of advanced concepts in ill-structured and complex domains [Spiro & Jehng 1990]. Ill-structured knowledge domains present unique problems for learning since the application of concepts varies from situation to situation. In other words, the high case-to-case variability prohibits the development of concepts which have broad application. In contrast, structured knowledge domains allow for the development of concepts which can be applied to many cases thereby facilitating learning.

In order to accommodate advanced learning, one must have *cognitive flexibility*. Cognitive flexibility is defined as the ability to restructure one's knowledge in many ways, depending on the learning situation. The ability to restructure one's knowledge facilitates the accommodation of the high variability found in ill-structured domains. The storing of knowledge in multiple representations in long-term memory and utilizing processes of schema assembly results in cognitive flexibility.

3. Conclusion

These implementations of problem-based learning provide insight into the benefits of instruction that embody elements of situated cognition. Anchored instruction, goal-based scenarios, and cognitive flexibility theory illustrate the efficacy of learning that is situated in authentic contexts and activities. But further research is needed to establish which tools and features can support student learning.

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What Are They Learning with Technology? The Situated Learning of Collaborative and Service Work with Information Technology Management

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Abstract
Students taking a new Information Technology Management (ITM) course in high schools are learning to deliver technical support, services and training to their schools and communities. This experience of service learning opens a new range of skills that can best be assessed by using a "situated learning " framework that moves the analysis of learning away from specific technical skills to a much broader range of contexts that include problem-solving, collaboration, reflection and communities of practice. The advantages of this focus, when it comes to assessing the learning that goes on when with the introduction of technology into education, includes school to work transition, authentic evaluation, and community engagement.

The Information Technology Management (ITM) program was initiated in 1994 by Knowledge Architecture Inc., a Vancouver company that was established by a University of British Columbia professor and IT industry professional to make a distinct social and technological contribution within Canada's telecommunications, information and education infrastructure. In a very short period, the company worked with teachers and industry people to develop one of the first project-learning programs. Students are currently taking ITM courses in Quebec, Ontario and British Columbia.

The ITM program is designed to provide students with authentic problem-solving experiences, engaging with different communities of experts as they seek answers to technology challenges encountered while supporting users who need assistance with new technologies. It places the students in collaborative learning situations that develop their sense of accountability and responsibility. They are learning about the nature of work in today's new economy, a workplace fueled by the development of new technologies, where business success is determined not by the ability to "build a better mousetrap", but by exemplary service delivery to the customer or client. In British Columbia the services which students provide as part of the ITM program has been recognized as a valid form of accredited "work experience" required for graduation.

This paper describes how students using new information technologies to provide service to others can be said to be engaged in "situated learning" (Lave & Wenger 1991). The literature on situated learning, under which we group a number of related concepts such as cognitive apprenticeships and situated cognition, provides a framework for analyzing various qualities of learning that relate to how people acquire new skills and become members of communities of practice (Greeno, 1997). We find this emphasis on the <u>situation</u> of learning, and the social practices that support learning, to be particularly salient when assessing the value of students' work with information technologies, especially when that work entails projects that support the technology needs of the school and community as an instance of "service learning" (Olszewski & Bussler, 1993). See Table 1for how we have created a framework for analysis of learning, with research currently underway by Larry Wolfson documenting the learning achieved by students as observed by researcher, student, teacher, and "client."

Students in the ITM program are supported by Studio A: Website as Worksite (http://www.knowarch.com). This website offers them a personalized workspace has at its center a project book which provides the student with the templates, tables and informational links needed for planning projects in close collaboration with other students. The project book encourages students to achieve a high degree of accountability to both the "client" and the teacher. They also have an electronic portfolio for placing materials to be evaluated by the teacher or for showing to prospective employers. The student's project book includes a skills matrix for students to set goals and review progress in light of the course's goals and assignments which also forms part of the project book. The student can also reach out through the project book to a wide variety of telementors who have joined the ITM program to provide online help with technical and service questions, as well as career advice. After working in their project books, students can also take a stroll through the Studio A neighborhood which offers ITM students and teachers a chance to check out what others in the program are up to in the Student Showcase, visit the Cafe' for up the minute news and a chance to exchange opinions, seek or offer help, make conversation, use the ThinkTank for evaluating issues and policies in essays or reports, or look up Just-in-Time-Learning to help them build the know-how in Information Technology they need for projects.

What do the students actually do in an ITM course? Laurane Parris who teaches the program in a B.C. writes that, "with this emphasis on helping people manage, ITM students offer services ranging from providing on-the-spot relief to such calls as 'Help, the printer's jammed!' or 'How do I send e- mail?' They also get deeply involved in more complex, longer term projects such as...

- Building a school home page that will go up this year on the Web.
- Creating animations in 3-D to run on the hall monitors displaying school/community events.
- Participating in the planning, configuring and installation of a LAN at the nearby elementary school.
- Developing a hypercard stack on peer counselors to guide students.
- Implementing a FirstClass Server as the school's e-mail system and bulletin board.
- Assembling a demonstration computer in a clear plastic case.
- Implementing a web server to create and maintain web pages for non-profit groups in the community.
- Planning a web radio station for the broadcasting class to run.
- Establishing a production center for desktop publishing and multi-media presentations in the school.

Table 1 Situated Learning Criteria in a Service Learning Setting

SITUATED LEARNING Learning results from...	SERVICE LEARNING Possible instances...
A. SITUATED CONTEXTS 1. Communities of Practice (Brown & Duguid, 1993; Lave & Wenger, 1991) 2. Artifacts as Mediating Devices (Engestrom, 1990; Moll, 1990) 3. Multiple Resources (Goldman, 1992)	Students form project teams to offer their new technology and project management skills to the local community center where they will interact with, learn from, and utilise the resources of the center and local businesses to help the center achieve its mission.
B. AUTHENTIC CONTEXTS 1. Authentic Projects (Engestrom, 1990; Lave & Wenger, 1991) 2. Problem Solving Scenarios (Rogoff, 1990) 3. Intrinsic Motivation and Student Responsibility (Volpert, 1989; Collins, 1994) 4. Dynamic Assessment (Lunt, 1993)	Students engage in development of the community centre's web page which serves as an educational/ advertising tool for the center. Students design web page for community center and accessible for all. Ongoing monitoring of page's utilisation and value, while transferring skills to center staff.
C. COLLABORATIVE CONTEXTS 1. Small Group Interactions (Brown, Collins & Duguid, 1989; Saxe, Gearhart, Note & Paduano, 1993) 2. Skilled Peer Guidance (Rogoff, 1990; Tudge, 1990) 3. Community Expert Guidance (Lave & Wenger, 1991)	Students divide responsibilities among components of the project while consulting with center staff, with community professionals for provide services necessary to achieve success, and other students peers who have related experience in this type of task.
D. REFLECTIVE CONTEXTS * 1. Goal Setting (Collins, 1994) 2. Formative Assessment (McLellan, 1993) 3. Teacher Modelling & Scaffolding (Collins, Brown & Newman, 1989) 4. Cognitive Apprenticeship (Brown et al., 1989; Collins, Brown & Holum, 1991)	Students engage in individual and project-team meetings in the classroom with their teachers. They review goal-setting and skill-assessment, while teacher poses critical questions on their work and that of the community center, while preparing them to report on the scope of their learning.

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All references in this paper are found at
http://www.knowarch.com/index/front_office/evaluation/sit-table.html,
with additional research related to this project at
http://www.knowarch.com/index/front_office/evaluation/evaluation_index.htm

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Collaborative Learning: Integrating Student-Created CD-ROMs Into The Teaching of Local/Georgia History

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1. Introduction

For a number of years college and university teachers have been encouraged strongly to adopt computer-based technology into their curricula in order to alter favorably the learning environment and the education process. Many of the faculty, in various disciplines, have awaited eagerly the opportunity to embrace the latest of these innovations and have been more circumscribed by the lack of enabling equipment/software than by their lack of computer-related knowledge or skills. In this paper we wish to present our plans and findings for incorporating the employment of student-created CD-ROMs into the teaching of a single course: Local and Georgia History.

This Local/Georgia History team teaching project was intended to empower students to author the content of a compact disc (CD) through networked interactive multimedia as part of the course requirements. It was anticipated that students would perhaps learn more by doing and become increasingly motivated because of participatory learning [Lennon & Maurer, 1994] and [Laurillard, 1993]. Our secondary objective was to use this successful project as an interactive multimedia model which might be replicated in or at least transferred to similar college-level courses. It was also planned that the student CD-ROMs would be used for assessment purposes.

With the combined course offering, students were assigned a family history project which would comprise a significant portion of the course grade for Local/Georgia History. At the beginning of the quarter, students were directed to bring in old and new family photographs, excerpts from diaries, legal documents, letters, newspaper clippings, etc., to scan into a computer. Furthermore, students were instructed in the methods of researching and writing a family history narrative. Student progress was monitored at intervals during the quarter. Selected contents of the student-created CD-ROMs will become part of the course content and its multimedia presentations as semesters progress. The Local/Georgia History course CD-ROM files will then be dynamic and divided into segments covering such topics as buildings of architectural significance, political events, modes of transportation, landscapes (forests, rivers, streams, farm land, etc.), scenes from area towns, industry, social gatherings, and hunting.

2. Classroom Methods

To provide students with the necessary computer skills in order to produce successfully a compact disc, Professor Troy V. Sullivan instructed our dual enrolled students in the use of Novell networked personal computers using NetWare (100 bit high speed network) supported by a Compaq Prolinea server using the Windows 95 operating system in his Introduction to Computers course (CIS 100). Students were taught also how to use the World Wide Web via the Internet accessed by Netscape Navigator 4.0 software to download text, graphics, video and sound to aid their creations/recordings. These students also used Corel WordPerfect 7 application software as their primary means of text input. WordPerfect topics covered in class included graphics, text boxes, templates, textart, and, of course, word processing for preparation of the family history narratives. They were also instructed in the manner one may employ that software while preparing term papers with appropriate documentation. Also included in the CIS 100 course was Corel Quattro Pro 7 applications so that students might create personalized graphs and charts. The students were further instructed in the use of a Hewlett-Packard (HP) ScanJet high-resolution scanner using HP PaperPort software and, to explain certain parts of assignments, he used a ceiling-mounted Sharp LCD color projector in the microcomputer laboratory. They employed Corel WordPerfect 7 software as their word processor and the HP ScanJet scanner to input pictures and other text into their document files stored on the instructor's LS 120 disks until ready to prepare their compact discs. Easy-CD Pro for Windows 95 authoring software recording to a Pinnacle Micro RCD 4X4 CD-ROM driver was used to create the individual CD's. Easy-CD Pro would prepare the discs for writing by first testing the speed of the CD and then copying the selected files. Approximate creating times ranged from 15 to 35 minutes, therefore, we found that creation time can be a problem associated with large classes. We also discovered that students not having LS 120 disk drives (or comparable) and/or individual CD-ROM drivers within their workstations created unnecessary delays during creation/recordings.

3. Conclusions

It is the intention of the participants in this project to adopt, on an ongoing basis, present and future-emerging computer-based and interactive multimedia technologies that are increasingly being embraced for academic instruction and active learning. For example, the writers intend to seek grant funds in order to equip at least the laboratory in which the Introduction to Computers course is taught with what is known as LS type drives in order that our students creating CD-ROMs will have the capacity necessary to receive photographs from scanner input. The planned structured student use of the Internet and the World Wide Web for online data retrieval and peer collaboration, as well as the development of a CD-ROM, will be part of the requirements of Local/Georgia History and will be added to the existing integration of PowerPoint assisted lectures.

It was comforting to discover that, during the quarter in which we discussed and used the CD-ROM technology, these students demonstrated a hands-on knowledge of computers and their uses which should aid them in the future in many facets of their education and employment careers--which is, after all, what we within the profession are all about.

It is not the purpose of this history instructor to replace the lecture with courseware, however, the infusion of these and other techniques of today's computer-assisted learning into the regular presentation of academic content is beginning to alter significantly the technical learning environment while calling for the development within our institutions of a new infrastructure for "lecturing technology" in the "electronic classroom" [Brennecke, Schwolle & Selke, 1997] and, [Lennon & Maurer, 1994].

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HemoSurf - An Interactive Atlas of Hematology on the Web

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1. Can a Computer Program Replace the Traditional Way of Learning Morphological Hematology?

The examination of blood films is a frequent task in medicine. Physicians and laboratory technicians must be capable to perform it. The best way to learn this task is with microscopes for two or more viewers or with mounted video cameras and monitors which allow students and teachers to discuss all the characteristics of the various blood cell types. This procedure is time consuming for teachers and requires an expensive infrastructure. Additionaly, the teachers and the technical equipement are often not available when needed. Therefore, scheduling of both human and technical resources is essential.
This unsatisfying situation triggered the idea for a computer based learnig programm which would be a valid alternative to the traditional setting. To overcome the restrictions of time and place for its many other advantages [Friedmann 1 1996], we decided to put our a „didgital“ Hematology tutor on the World Wide Web. To express this idea of freedom, the name „HemoSurf“ was given to the program.

2. What Shall Students Learn with HemoSurf?

The objectives for our web based learning program are:
1. To give learners reliable competence in interpreting blood and normal bone marrow films.
2. To link theoretical knowledge of hematological and other diseases to their morphological manifestation in the blood film.

3. What are the Educational Principles of HemoSurf?

Interpreting blood and bone marrow films relies much on pattern recognition. Therefore, HemoSurf is based on a collection of over 1500 images taken with a 3CCD video camera mounted on a microscope and digitised with a framegrabber card. These images can be accessed in different ways and with different intentions. Going through levels of increasing complexitiy and always receiving feedback (see figure 1), the student becomes capable of performing white blood cell counts and recognising qualitative alterations of blood films. Like in reality, the user must finaly differentiate 100 blood cells. At the end, he can compare his results with the correct ones and review the misinterpreted cells. A comparison of the different celltypes and the different blood films is possible throughout the program (see figure 1). A gallery of blood films allows the opposite approach by looking up the blood films of different hematological diseases. The morphological appearence serves as trigger to acquire theoretical knowledge which is provided with context specific links to a hypertext (see figure 1).

4. How is HemoSurf Accepted by Learners and Teachers?

HemoSurf is integrated in the first clinical year at the medical school of the University of Bern. Students prepare with HemoSurf for the practical courses in Morphological Hematology. Teachers report an astonishing increase of competence of the students making the practical courses a lively and rewarding experience for all participants. Nevertheless, nobody wants to give up to learn with the microscope because the quality of of the electronic images is still not as good as in reality and lacks the 3D feeling when moving up and down the blood film.

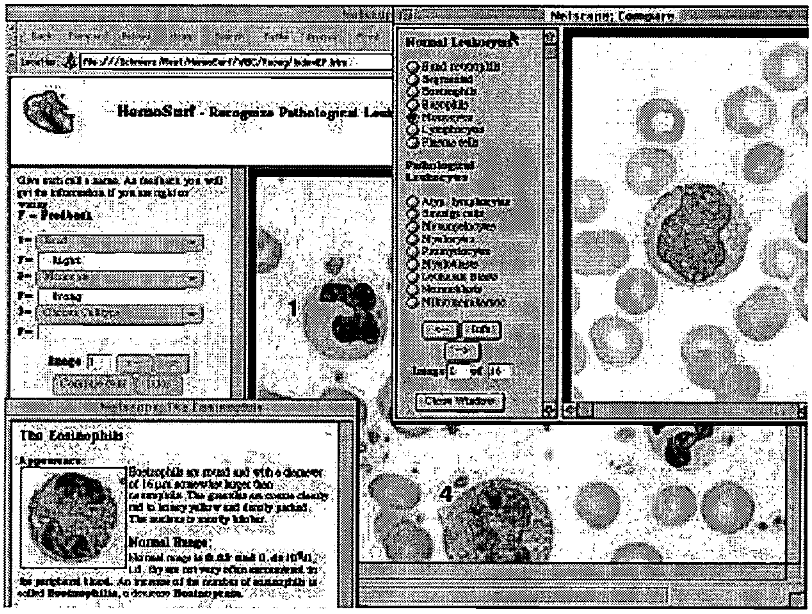

Figure 1: In a serie of images of blood films with numbered cells the learner must identify each cell by choosing a name from a popup menu (left). Feedback is given immediatly. A window for comparision of the different cell types is always accessible (right). Another window provides therotical knowledge when needed.

5. What Brings the Future?

The experinces so far encourage us to continue the further developement of HemoSurf. An important new feature will be the introduction of clinical cases. Emphasis will be put on the demonstration of the course of a disease. The strength of HemoSurf lies in its image related interactivity. It will be a challenge to apply this didactical approach to other image based areas of Medicine like Radiology or Dermatology. These learning resources will contribute to the vision of a Virtual Clinical Campus and hopefully be so called „killer applications“ [Friedmann 1996]. Another idea is to use HemoSurf or similar learnig programs for computer based examinations. Right now, this form of examinations is not accepted by the faculty.

6. Are There Other Websites Like HemoSurf?

There is quite a number of hematological websites. Most of them only allow browsing through an image collection without any form of interactivity. Unfortunatly, the quality of their images is often mediocre and only one image per disease is shown which is insufficient to develop pattern recognition. Many sites offer clinical cases which are very useful to learn Clinical Hematology. A good list of links to educational hematological sites can be found at MedPharm of the University of Torino (http://www.medfarm.unito.it/education/hemato.html)

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Technology Enhanced Instruction: A Model That Improves Science Learning And Teaching

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"What students are gaining is the opportunity to see a different instructional style, one that is perhaps more in line with what they'll be facing out in the real world, not only just in college and university but what they have to do in real jobs. They have to cooperate with one another, have to work independently, have to set goals, have to evaluate themselves. I think that is one of the major strengths of the TESSI program." L. Dukowski, Principal, Poppy Secondary School, Langley, B. C.

1. Purpose

This paper describes the Technology Enhanced Secondary Science Instruction (TESSI) Project which developed and tested a pedagogical model which has enhanced student learning by systematically and successfully integrating technology with instruction and classroom learning. The underlying research questions are: What happens when technology is integrated into science classrooms? What is the impact on student learning and teacher instruction?

2. The TESSI Model

The context for this study is the Technology Enhanced Secondary Science Instruction (TESSI) project [Woodrow, Mayer-Smith, & Pedretti, 1996]. The TESSI project was founded on the premise that if Technology Enhanced Instruction (TEI) were to become an essential part of science classrooms, technology applications must not be supplemental to the educational process but must be fully integrated into courses and programs. Initiated in 1992 in two Physics classrooms, and now expanded to ten science classrooms spanning grades 9-12, the TESSI project combines the educational opportunities provided by classroom-based, multimedia technologies with student-centered teaching strategies that encourage students to access and use knowledge rather than to accept scientific information delivered through traditional, transmissive modes. Student learning is variably paced, individualized, collaborative, and mastery-based. The longitudinal nature of the study, coupled with the consistent use of technology by both students and teachers, provided the opportunity to develop a variety of strategies for implementing technology into science classrooms—the TESSI model, and to reflect upon the impact of these strategies. Fundamental to the TESSI model is the availability of a variety of technologies within the classroom itself: technology is used as an enabling tool to enhance teaching and learning, neither as a substitute for the teacher nor as an "add-on" to the curriculum.

The physical resources of TESSI classrooms and the TESSI pedagogical model facilitate a non-traditional model of student learning. The curriculum is presented through a combination of technology-based activities, small-group instruction, one-on-one interactions, and hands-on activities. TESSI students are active participants in the learning process: they assume much of the responsibility for the depth and rate of their learning. Their learning is guided by a set of interactive Study Guides specifically designed for the process. Students work in small groups on interactive laserdiscs and CD-ROMs, computer simulations, MBL and multimedia activities, and, when necessary or desirable, with more traditional formats including texts, labs, demonstrations, problem sets, and field work. TESSI also incorporates interactive, computer-based testing to enable both the student and the teacher to quickly identify learning difficulties.

3. Outcomes

> *"As administrators, we have all heard about the benefits of technology. TESSI is the first program that I have seen where the benefits are actually being realized." (C. Gesy, Principal, Brookswood Secondary School, Langley, B. C., Canada)*

After six years of operation, the results of the TESSI project support claims that learning can be enhanced through the thoughtful implementation of Technology Enhanced Instruction. Students showed evidence of conceptual change in how they viewed their role and that of their teacher in the science classroom. They regarded themselves as directing and monitoring their own learning, and saw their teacher as a "helper" in that process. Attitudes towards assessment changed as assessment came to be regarded as a means of monitoring and enhancing learning rather than as an "obstacle to be overcome." Students demonstrated increased goal setting and time management skills. Enrollment in, and successful completion of the senior science courses has increased significantly.

The classroom ratio of students to computers in TESSI classrooms of 3:1 naturally results in students working in groups with the technology. Such grouping encourages dialogue among the students. These conversations help students link verbal representations of concepts with the pictorial representations viewed on the screen. Grouping also promotes task collaboration within the context of computer-supported learning. It is not an uncommon sight to see several TESSI students at a simulation, discussing how the physical variables interact or what will happen when a variable is changed.

The implementation of TEI acted as a catalyst for change from teacher-centered to student-centered instruction. TESSI teachers experienced a conceptual shift in how they viewed their role in the science classroom. They saw their roles as changing from that of "transmitter" to that of "facilitator." Mastery-based learning was promoted through the teacher's ability to diagnose specific learning problems, provide additional learning materials, and retest individual students with a minimal expenditure of classroom time. Assessment of students was more frequent and more focused on specific curricular objectives. Both formative and summative assessment procedures have been implemented. The use of technology also permitted the introduction of alternative activities, adjusted to individual student learning styles.

4. Conclusion

TESSI has illustrated how technology can be successfully integrated into daily classroom practice. The TESSI model is a means whereby teachers may be guided to quickly achieve TEI learning benefits such as deeper learning, skills backed with understanding, higher scientific literacy, skills in working with knowledge, communication skills and group problem-solving skills. The TESSI model has achieved these benefits in the two Physics classrooms consistently over a six year period and is in the process of realizing the same benefits in the General Science, Chemistry and Biology classrooms. The model has been particularly successful in attracting women students to Physics and helping the "average" student to achieve success in Physics. A fundamental goal of the TESSI project is to disseminate, as widely as possible, the results of its program of research to enable teachers to quickly and effectively implement technology enhanced instructional practices in their own classrooms. Accordingly, TESSI has developed a multilevel program of professional development that includes: the TESSI Professional Development Project designed to train selected teachers throughout the province to implement the TESSI model and establish TEI Professional Development Centers; the Mexico-based, Enseñanza de la Física con Tecnología project (EFIT - Teaching Physics with Technology) designed to contribute to the educational development of Mexico through the application of new technologies; and the development of a CD-ROM designed to introduce teachers to the use of technology in their classrooms.

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Teaching Resources for Fetal Echocardiography

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Abstract: Fetal Echo Expert System, an Artificial Intelligence (AI) program was created to combine textbooks, an atlase of ultrasound images, and an expert system to form a single resource for reference and education. It was designed to teach physicians and medical students to detect congenital heart diseases in fetus. The expert system guides the user through the whole ultrasound study, asks relevant questions, and supports the process of detection of congenital abnormalities and making diagnoses. The image library contains over 500 different images and video clips related to different heart abnormalities, and ultrasound techniques.

INTRODUCTION

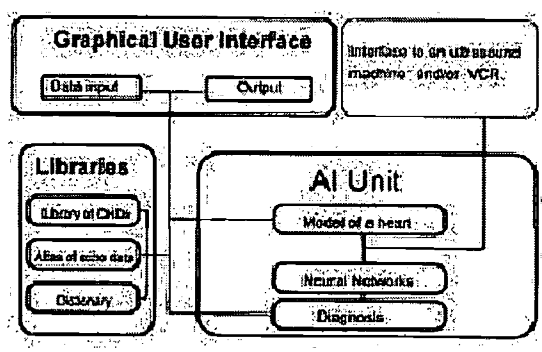
In the United States about 100 babies are born every day with congenital heart diseases. In many, perhaps even most cases, existence of an abnormality surprises the mother as well as the doctor taking care of her during the pregnancy. It is a common opinion between doctors that routine ultrasound evaluation of fetal hearts (Echocardiography) during the pregnancy does not decrease mortality caused by congenital heart diseases. Unfortunately this is partially true. The main reason for such situation is a paradox: the detection of congenital heart diseases depends on non-cardiologists. It is the responsibility of obstetricians and primary-care physicians to detect abnormalities. Today's modern ultrasound machines provide enough power and capabilities to obtain good images of the heart, but still more important than equipment is keen observation and understanding of fetal cardiac abnormalities [Huhta et al. 1991]. Most physicians are not properly trained to detect abnormalities. Obtaining good images of a fetal heart is also non-trivial; so in reality, in many cases untrained physicians are supposed to detect abnormalities while analyzing poor images. It simply cannot work, and unless defects are severe, they remain undetected. On the other hand cases that are diagnosed are usually so severe that even early detection does not promise any help. But the situation is not hopeless. Today's computer technologies can be utilized to support a process of making diagnoses and improve detectability of congenital heart diseases. The goal of this project is not to convert obstetricians into cardiologists, but to use computers to teach them how to detect abnormalities.

METHODS

In this multidisciplinary project linking biophysics, cardiology, obstetrics and clinical informatics, we developed tools supporting effective detection of congenital heart abnormalities by non-cardiologists. For that purpose multimedia program Fetal Echo Expert System has been created. This program includes a step-by-step tutorial, a library of congenital heart diseases, graphic images, digitized echocardiograms, and an expert system [Giaratano et all 1994] that can support the process of detection of congenital heart abnormalities. The block diagram of this program is shown in figure 1. Expert systems are a software technology that has been successfully applied to development of systems that model information processing tasks [Cios et al 1990]. The design of rule-based expert systems involves a process of interaction between a domain expert and a knowledge engineer who formalizes the expert's knowledge as inference rules and encodes it in the computer. Since human experts vary in skill and experience, and they often do not know what knowledge they actually used in solving their problems, the process of building of an expert system requires enormous amount of effort and is rather time consuming. Despite of difficulties in creating of such systems they have several advantages: 1. The expertise is permanent. Unlike human experts who may retire, quit or die, the expert system will last indefinitely. 2. The knowledge of multiple experts can be made to work simultaneously. 3. The expert system can explain in detail the reasoning that led to the conclusion. Knowledge that is attributed to intelligent entities more often has the form of uncertain beliefs rather than crisp, indisputable facts. A consideration in the development of an expert system is the ability to deal with uncertainties as they occur when conclusions are only partially confirmed by a piece of evidence. One way of logically manipulating uncertain propositions is to use one of the models of uncertainty. Traditionally subjective estimates of probability and Bayesian processing have been used to specify and propagate uncertainty through an inference network. One disadvantage of this approach is that it requires the assessment of a large number of conditional possibilities and is subject to combinatorial problems in the inferencing procedure. Another means of logically manipulating uncertain propositions is to use the Dempster-Shafer [Dempster 1968] [Shafer 1976] theory of evidence implemented as support logical programming by Baldwin [Baldwin et all 1986] and successfully implemented in building of expert systems. This algorithm has also been implemented in this program.

RESULTS AND DISCUSSION

Fetal Echo Expert System is designed to guide a physician or a student through the data obtained from ultrasound examination. It is assumed that user can view the study that is stored on magnetic tape at the same time as he/she is using the program. The questions asked by the program are divided into twelve groups that correspond to the different views of a heart and different techniques used. Every time one set of questions is answered, the user may click on the "Make Diagnosis" button and obtain a suggested diagnosis based on the data entered. The program will also search the library and display pictures corresponding to the data entered. It is possible to change the information supplied to the program and observe how it affects diagnoses. Fetal Echo Expert System was already presented at two major medical conferences: American College of Cardiology meeting in Orlando [Wróblewski et al 1996] and Radiological Society of North America in Chicago [Wróblewski et al 1996a] and was very well received by specialists.



Fetal Echo Expert System

Figure 1 Block Diagram of Fetal Echo Expert system

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Development and Evaluation of Japanese CALL System for Scientific and Technical Writing on WWW

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1. Introduction

The purpose of this study is to develop and evaluate a Japanese writing CALL (computer assisted language learning) system using NLP (natural language processing) techniques. This system could be used for supporting the writing of scientific and technical Japanese on WWW (World Wide Web) browser for the Japanese language learner.

2. Japanese Writing CALL System

In a previous study, the authors developed and evaluated a Japanese writing CALL system for learning of Japanese passive voice on WWW browser. The system was development using NLP techniques. Therefore, the learner can use this system by freely keying simple Japanese sentences.

To examine the error types in writing of Japanese passive voice by the foreign students, the authors conducted a survey. From the results, the authors classified the error types of Japanese passive voice into 12 categories, 65 kinds and 228 errors. The system uses NLP tools such morpheme analyzer and syntax analyzer. Then error analysis and feedback processing components were added to the system. This system thus enables the learner to key-in sentence freely, can detect the errors in typed sentence and gives adequate feedback messages back to the learner.

The system consists of the interface (i.e., WWW browser), the sentence analysis system, the feedback system, the dictionary, and the grammar/rules. The sentence analysis system includes morpheme analyzer, syntax analyzer, and error analyzer. The learner can freely type Japanese sentence in either *kanji* or *kana* of Japanese language, as this is the usual input method of most Japanese word processors. The present system analyzes a typed Japanese sentence in the morpheme analyzer and the dependency of the sentence is checked by the case grammar. Afterwards, the type of error is detected by applying the rules of error analysis. The feedback system includes the feedback messages generator, knowledge database, and a list of all learning histories during the operation of the system. At this stage, adequate feedback messages are given to the learner according to the type of error and relative information received as output from the sentence analysis component.

Furthermore, the authors propose a mechanism of *self-correction* that allows the learner to correct the typed sentence herself/himself and allows her/him to detect any error made. The self-correction implies that when the error analyzer detects the error, there will be no answer given back to the learner, but instead, the feedback messages according to the typed sentence will be shown. The learner can either read the feedback messages and correct the typed sentence instantly or she/he can refer to some grammar items about her/his error and correct the sentence later. This mechanism can be considered as a supplement to the prediction of the system and as an improvement in the effectiveness of current CALL systems.

Finally, the authors conducted an experiment to evaluate the usefulness of the system. 22 Japanese language learners participated in this experiment. The purpose of the evaluation is to examine the method of sentence input and feedback. Thus the experiment is designed to compare two different systems with different input method and feedback method. As a result of the evaluation, the method of freely input sentence and the feedback corresponding to the typed sentence is preferred to the method of multiple selection and feedback that just displays the correct answer.

3. Work in Progress

The authors are now going to enrich the system from the current simple sentence level to scientific and technical Japanese sentences level. One of the important and the basic factor to write the text sentences in a foreign language is enough vocabulary and grammatical knowledge. However, the amount of vocabulary and grammatical knowledge is not enough for writing sentences of the foreign language. The reason for this is that the grammatical rules are provided to arrange the structure of single sentence correctly at a time and the tie method of joining sentences is not taught. Especially, the tie method of joining sentences is important in writing scientific and technical sentences.

Foreign student has already experienced the composition writing by using the mother tongue, therefore, the purpose of this study is not to support the act of writing but to support the tie method of joining sentences. This tie method of joining sentences, can be described as conjunction or connection of joining sentences, is an important criterion for writing texts as per researches of cohesion or discourse structure [Yokobayashi and Shimomura, 1988; Kuno, 1978; Halliday and Hasan, 1976].

The method of this study is shown as follows:

1. Targeted sentences are "Text sentences of scientific and technical Japanese."
2. This study empirically clarifies the structure of "Text sentences of scientific and technical Japanese" by considering the finding of other related researches.
3. Sentences collected from the investigation are extracted and classified to some structural patterns. If possible, the rules are extracted.
4. To give support to the composition writing, the extracted rules are implement in the system. The EDR concept dictionary and the EDR corpus are used to generate the resemblance degree and the examples automatically. As a result, a more flexible composition support system will be expected. However, before that how to employ the electronic dictionary to the system is to be examined and problems arising from this has to be solved.
5. Then the foreign student would use the above-mentioned system and the evaluation study for the effectiveness of the system will be conducted.

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AN OBSERVATIONAL STUDY ON EXAMINING LEARNERS' THINKING PROCESS IN LEARNING AND WRITING K-LOG PROGRAM

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Introduction

Programming languages are essentially programs that require their operators to define and solve their own problems within specific constraint of the language and general constraint of a computer. Hence, learning to use the programming language itself is a form of problem-solving. It is claimed that learning to program leads to the acquisition and transfer of important heuristics and metacognitive skills. Recent research in cognitive psychology has revealed that learning to solve problems requires the integrated application of three categories of abilities [De Corte et al., 1990]: (1) Flexible application of domain-specific knowledge base, involving concepts, rules, principles, formulas and algorithm; (2) Heuristic methods; and (3) Metacognitive skills. Polya (1957) developed four categories of heuristics. They are: (1) Understanding the problem; (2) Devising a plan; (3) Carrying out the plan; and (4) Looking back [Polya, 1957]. In views of these claims, this observational study tries to (1) find out how the learner learn a new programming language- K-Log; (2) study the thinking process of the learner; and (3) analyze the student's strategy employed in the problem-solving task, especially on transferring skill from programming to other domain, Chemistry in this exercise.

The study

A Secondary four student was chosen to be the subject of this observational study. He has to complete a worksheet in an hour. The worksheet was divided into three parts. The first two parts are mainly concerned with the learning of K-Log programming language while the last part is concerned with a problem-solving activity. During the first thirty minutes, the student was introduced to the K-Log environment (an expert shell similar to Prolog) and the basic syntax in K-Log- the "object relation object" syntax, and also the ways to generate advice by the computer. After the student has explored with the program Doctor, part of the program listing was given to the student in order to help him in completing part B of the worksheet. The final part of the worksheet asked the student to write a K-Log program, similar to the program Doctor, which gives advice on the structure of any chemical substances in the periodic table.

Data collection and analysis

For the first two parts of the exercise, the data was mainly collected by observation. Since the two sessions were basically concerned with the learning aspect, the interaction between the observer and the student was high. The observer can post questions to the student at some stages of the session when he observed that the student was in confusion. The interaction between the observer and the student was recorded as an source of information for examining the learning process. For the last part of the exercise, the "think aloud protocol" was employed. The learner's thinking process is recorded for protocol analysis. However, the "think aloud protocol" is a method which is new to the student. He often forgot to speak out what he was thinking about during the observational exercise. The observer had to remind him from time to time to "think aloud". As a result, the data collected by this method is somehow affected because the student might just speak out the product of his mental process instead of the process itself. During the process, special attention was paid to any problem-solving skills shown by the student. For example, whether all four categories of heuristics, as suggested by [Polya, 1957], was applied or not. In addition, in solving the problem, the student himself not only has the knowledge on K-Log programming, but also knowledge of chemistry. Therefore , the transfer of the student's skill would also be examined.

Findings

Mayer has identified four kinds of knowledge involved in computer programming [Mayer, 1985 & Mayer, 1992]. Syntactic knowledge refers to lexical units and rules for combining lexical units. Semantic knowledge refers to the actions that are carried out by the computing system for a given instruction or set of instructions. Schematic knowledge refers to knowledge of types of subroutines, such as knowing several different looping structures. Strategic knowledge refers to knowledge of how to plan and monitor the construction of a program such as breaking a program into modules. In the first two parts of the exercise, it concentrates mainly on the learning of syntactic and semantic knowledge of K-Log programming. During the learning process, it is evident that the student did use some kind of strategy in helping himself to understand how the computer program works- the semantic knowledge. He has a hypothesis in his mind, and then put it into test. Since this exercise focuses only on a limited number of commands used in K-Log programming, the student can learn the syntactic knowledge without any difficulty. From the last part of the exercise, it was observed that the student had followed a strategy which was similar to what is described as the four categories of heuristics by Polya [Polya, 1957]. From the protocol analysis, it was discovered that the obstacle encountered by the student was that he could not transfer his knowledge in the program Doctor into the new problem in chemistry. The main factor that hindered such transfer is that the student cannot map the syndromes and diagnosis in program Doctor to the physical properties and type of structure in the new task. With the aid of the hints given by the observer, the student can finally complete the program and solve the problem with minor changes of the program.

Conclusion

A major challenge in teaching of computer programming is to ensure that learners actually learn high-level problem-solving skills- such as how to design an efficient program- in addition to low level syntactic skills- such as how to write grammatically correct commands. However, research on learning to program has shown that learners often have difficulties in acquiring even low-level programming skills such as the syntax and semantics for individual statements, and rarely progress to the high-level skills such as programming design [duBoulay & O'Shea, 1981]. With reference to the chain-of-cognitive-changes theory, learners can learn to apply high-level planning strategies to programming only if they master lower level syntactic skills specific to the programming lanaguage [Mayer & Fay, 1987].

From this observational study, the findings are in line with the above research result. The learner required very clear hints for them to arrive at the solution. The hints given to learners are actually guide him through the problem-solving process and help him to re-organize their knowledge on K-Log language. The transfer of problem-solving skill from programming to other domain cannot be assumed. It is concluded that explicit teaching of the problem-solving skill and acquisition of sufficient language skills are the two factors which determine whether learning programming can promote high-level problem-solving skills.

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Hypermedia's Effect on Declarative, Procedural and Conditional Knowledge Acquisition: An Ongoing Study

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Background

The major purpose of this study is to compare hypermedia with traditional instruction in terms of declarative, procedural and conditional knowledge acquisition and retention in a specific subject area, and students' attitudes toward the units in the subject area.

The significance of hypermedia for learning and its motivational effect is stressed in many studies. Its power comes from organization of information for effective learning. According to Jonassen and Grabinger [1990], learning is reorganization of knowledge structures. These structures are arranged in a network of interrelated concepts known as semantic networks. These networks describe what a learner knows and provide the foundations for learning new ideas, that is expanding the learner's semantic networks. This is the richest conceptual model of learning from hypermedia. To Neuman et al. [1995], hypermedia leads to independent and synthetic thinking, provides freedom to construct personal knowledge, enhances and expands understanding. There are many studies that support Jonassen and Grabinger's and Neuman et al.'s views about learning and hypermedia's ef!fects on learning.

Although many research studies have investigated hypermedia's contribution to learning, hypermedia's effect on different types of knowledge, namely declarative, conditional and procedural, has rarely been studied. According to Jonassen [1991], hypertext systems provide sophisticated tools to integrate cognitive learning principles into practice in the instructional design and development field, and to help us reduce the dissonance between the declarative and procedural knowledge. Smith and Ragan [1993] and Schunk [1996] explain declarative knowledge as facts, beliefs, opinions, generalizations, theories, hypotheses, and attitudes; procedural knowledge as knowledge of how to perform cognitive activities; and conditional knowledge as understanding when and why to employ forms of declarative and procedural knowledge. Schunk [1996] states that the distinction between these three types of knowledge is important in terms of their implications for teaching and !learning. Deficiencies in different types of knowledge not only hinder learning, but also produce low self-efficacy. Hence, discovering what type of knowledge is deficient is necessary for planning remedial instruction. In that perspective, the question of how hypermedia contributes to different types of knowledge acquisition still remains to be answered.

Methods and Data Sources

A pre-test/post-test experimental design will be used in this study. The subjects of the study will include 40 9th grade Biology students of a public high school in Ankara, Turkey. These subjects will be assigned to experimental and control groups by using matched-pair technique and asked to respond to an achievement test and an attitude scale as pre-tests to measure their achievement level in the selected units (human's circulatory and excretory systems) in terms of different types of knowledge acquisition, and attitudes toward the units. Experimental group will be given an introductory session on how to use hypermedia. Then, the control group will receive traditional instruction while the experimental group will study using the hypermedia developed by the researcher. At the end of the five-week treatment, the same achievement test and attitude scale mentioned above will be given to students ag!ain as the post-tests. Two months after the experiment, the achievement test will be given to both groups for the third time to measure retention of knowledge of different types.

The hypermedia designed by the researcher for this study included video episodes, still images and text, and employed instructional system development (ISD) and conceptual linking approaches. At the beginning of the ISD process, needs assessment was conducted to determine what students need to be able to do when they have completed the two units. Then, the instructional goals of the two units were determined. In the light of instructional goals, learning tasks, sub-tasks and procedural steps were described in details. Different types of knowledge that each task required were determined, and the semantic relationships between tasks were identified. In the program, a deductive approach was followed as instructional strategy. Interrelated concepts with general ideas were presented initially and followed by specific points. Finally, concept mapping and story boarding were done. Front Page Editor 2.0. was! used in developing the hypermedia.

Data Collection Instruments

Two types of data collection instruments will be used in this study. First, *an achievement test* was designed to measure different types of knowledge acquisition in Biology. The test has three sections. The first section measures the declarative knowledge acquisition, the second section the procedural knowledge acquisition, and the last section the conditional knowledge acquisition in the selected two units. This test will be applied as the pre-test and the post-test. Based on the framework instructional goals of the units, different types of knowledge were determined and a table of specifications was constructed. The initial achievement test was developed by considering these knowledge types in the form of multiple choice questions and then, submitted to subject matter experts in the field to establish content validity. The initial test developed was piloted with a group of 25 students t!o assess for clarity, consistency, the time required, and item difficulty for each question. The second instrument to be used in the study is an *attitude scale* designed to collect data about students' attitudes toward the experimented units. It was piloted with a group of 25 students to check the clarity of the questions, internal consistency of items, and the time required to fill it out.

Significance of the Study

Although many studies have been carried out to test the effectiveness of hypermedia on students' achievement, hypermedia's impact on different types of knowledge, namely declarative, conditional and procedural, acquisition has little been examined. This study aims to offer useful knowledge to practitioners in terms of how hypermedia may influence different types and level of knowledge acquisition and retention. In the literature, it is stated that hypermedia is more appropriate for large knowledge bases. Knowledge bases can be large enough for using hypermedia, but it may not be appropriate for the types of knowledge those knowledge bases include. Results of this study may help practitioners examine the appropriateness of the knowledge bases for hypermedia from different perspectives, and apply hypermedia more effectively based on types of knowledge they teach.

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DIFFUSION OF COMPUTER-NETWORKED TECHNOLOGY INTO SCHOOLS: A Study of Offering A Web-related Training Course to In-service Teachers and Students

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BACKGROUND. At the launch of Taiwan's National Information Infrastructure (NII) project in 1994, the Ministry of Education made a commitment to bringing telecommunications and computer technology into the classroom at various academic levels over the following six years. To adapt to this technological innovation in education, the Ministry of Education has made a great investment each year to help junior and senior high schools, and elementary schools establish computer classrooms or laboratories equipped with multimedia computers with CD-ROM capability and a modem, or other related equipment. Furthermore, to get teachers and students involved in using the modern technology for their benefit and convenience, certain projects were promoted by the Ministry of Education. The "*E-mail (TANet) to Middle and Primary Schools*" *project*, for example, was initiated in 1994. Additionally, the National Science Council of Taiwan has sponsored more than 50 computer-assisted learning research projects each year [Chan 1996]. Significant results obtained from the research projects which were initially conducted at the college level, were anticipated to be extended to and applied at the junior and high schools and elementary school levels.

PURPOSE & PARTICIPANTS. The intent of this training project is to cultivate "seed" trainees (mentor trainees) recruited from both teachers and students, who are expected to disseminate the information learned and to promote the diffusion of innovative computing technology in instructional and learning settings on campus after the training. This study aims to investigate how a web-related training course is conducted in a natural educational setting. The purpose of the research is to understand and interpret how learners of diverse backgrounds and disciplines interact with each other and learn about web-related information and techniques and what they will be able to do with their new knowledge after the course. Therefore, it would also be worthwhile to conduct an in-depth study of their interactions in a learning setting and to explore the results that the intensive training yield.

THEORETICAL FRAMEWORK. The theoretical underpinnings are constructivism [Jonassen 1996; Duffy & Jonassen 1992; Cole 1992] and situated learning [Young 1997a; Brown & Duguid 1993; Brown, Collins, & Duguid 1989]; both theories are used to examine the way learners construct their knowledge through the training course. There are a variety of factors which might influence the way learners effectively interact with each other and the learning materials, including their background knowledge, attitudes, personal previous experiences with computers, interests, anxiety, and motivations [Young 1997; Young 1996]. In order to gain a comprehensive and in-depth understanding of the process of how the learners learn, how a training program is conducted, and what happens afterwards, a qualitative research methodology is adopted in this study. Within postpositivist paradigms, this study is described as interpretive and descriptive in nature.

RESEARCH QUESTIONS. Three sets of research questions addressed in this study are:

1. How do learners, defined as in-service teachers and students, having various backgrounds, disciplines and ages, interact with the computing technology, construct knowledge, and learn about the readings and software in the process of intensive training?
2. Are the in-service teachers and students able to interact with each other effectively while they are learning the new technology together? Does each group feel comfortable in studying and

working with the other group? Or do teachers feel intimidated by the possibility that students might be more fluent in computer operation and in computer literacy acquisition? How do learners perceive the courseware and the web-related technology presented in this intensive training?

3. Are trainees able to fulfill their roles as expected to disseminate the information learned and further carry out their mission after this training? Who have the potential in so doing and what factors account for these individuals' success in promoting networked learning and instruction or integrating the computing technology into their daily life?

METHODOLOGY. The design of this study is emergent in nature [Patton 1990; Lincoln & Guba 1985]. Basically, this is a long-term study that is conducted in two phases: the intensive web-related training, and then follow-up interviews and observations in classroom settings. The study site is the high school campus and the computer laboratories where the training program is held. The intensive training is conducted in seven sessions, three and half hours per session, on a weekly basis within the first semester of 1997. A questionnaire is used to gather subjects' demographic data, computer experiences. In the study the researcher is the primary instrument for data collection and analysis. Ethnographic observations, therefore, are conducted throughout the training program, reflexive notes and field notes are made immediately after each session. In addition, a journal entry in the form of an open-ended questionnaire is given to each participant at the end of each session to investigate subjects' perception of the learning activities and comprehension of the readings. In the second semester, a follow-up in-depth structured interview is given to all participants on a one-to-one basis to gather information concerning their dissemination and integration of web-related information and techniques in their learning and teaching settings.

Importantly, several methods such as prolonged engagement, persistent observation, triangulation and thick description, peer debriefing, and member check are used to establish trustworthiness and to legitimate the research project. Reflexive subjectivity on the part of the researcher will continue throughout the process of data collection and analysis.

CONCLUSION. The qualitative study is currently in progress. It is hoped that the results of the study will provide insights into how intensive web-related training should be conducted and what factors account for the successful integration of innovative computing technology into junior and senior high school settings. A model of conducting a successful training project based on the research data will be induced. Finally, suggestions for future training projects and suggestions for further research will be indicated for instruction and course design.

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Cyberbike
Virtual Reality in Road Safety Education

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Abstract: The progress in the development of new media, recommends to reflect upon pedagogical concepts on traditional fields of education. Our group, consisting of pedagogical and technical members, developed for a central part of road safety education - cycling - a two level pedagogical concept, based on multimedia and virtual reality as new learning media.

1 Introduction

48209 children had an accident while participating in road traffic during 1996 in Germany [VdTÜV 1997]. For 1997 it is estimated that numbers had not changed very much. Many accidents are caused by behaviour of the children. Today's traffic volume is so high that small mistakes very often lead to severe accidents. Here children are always the looser part.

In most European countries children are trained in school to participate in road traffic. The high numbers of accidents indicates, that traditional forms of training are no longer suitable to decrease accidents substantially. Additional forms of education have to be found.

Virtual reality (VR) is a promising learning method to be applied in this field for the following reasons:
1. Children are learning by doing and repetition. Training environments must therefore provide multiple channels of information (visual, acoustic, haptic) and must be available with little effort. This can be provided by VR
2. Training is especially necessary for critical and dangerous situations, without harming the child. This is not possible with conventional training schemes. It can be done using VR-based scenarios and VR-based training environments.
3. Virtual Reality training can also be used to learn basic qualifications, like estimating the velocity of approaching cars or detecting the direction of movement.
4. The training progress can be measured in this environments, thus training schemes can be evaluated very effectively.

2 Problems of traditional road safety education

Road safety education attempts to decrease number of children been involved in an accident since decades. In Germany the latest concept for the preparation of children to road traffic consist of abstract learning traffic rules in co-operation with the police, one exam to acquire a "cycling-licence" and a test-tour in real traffic.

Anyhow many dangerous situations can't be tested by this tour in real traffic, because risk is to high.

Besides, these useful elements of road safety education are not integrated up with each other. Therefore it is difficult to decide, if the child is able to transfer knowledge learned in lessons to knowledge useful in real situations.

3 Solving Problems by Multimedia and VR

In our project "cyberbike", multimedia and virtual reality are used to form two levels in learning process.
The "cyberbike" consists of a ROad Safety Educational MulitMedia Software (ROSE-MMS), which will be distributed on CD-Rom (DVD) and a ROSE - Virtual Reality Environment (ROSE-VRE), which may later be multiplied for an extended distribution.

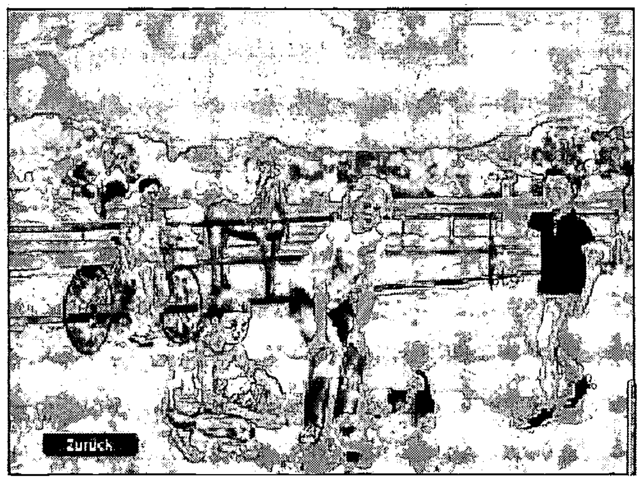

Figure 1: Picture of the ROSE-MMS

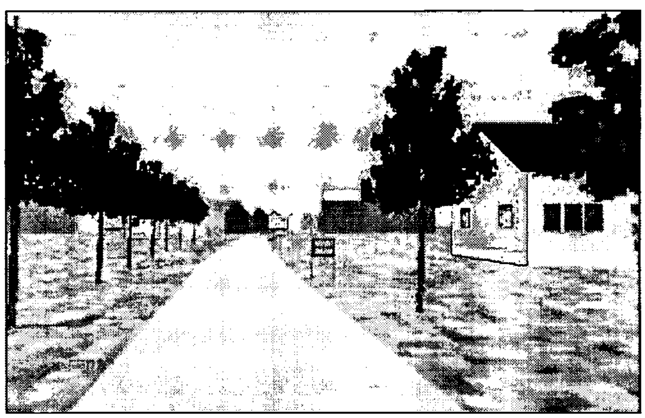

Figure 2: Scene of the prototype VR-world of the ROSE-VRE.

The ROSE-MMS will prepare children to the usage of the ROSE-VRE, to standardise the starting point of the children and to amplify training effect by changing the learning medium.
In this way the "cyberbike" is able to contribute essentially to tie together single components of road safety education and to ease the judgement the qualification of a child to participate in road traffic.
The "cyberbike" addresses children at the age of 8 to 12 years.

4 Pedagogical Concept

Traffic is a complicated process of different events with a high intensity of optical and acoustic information, which must be assimilated very quickly. Traffic is designed for adults but not for children, with their visual, acoustic, emotional, intellectual and kinetic abilities [Warwitz 1994; Spitta 1997].
For example: The viewangle of a child is smaller than of an adult, the perspective perception isn't fully developed. The perception is selective, and the child does filter important stimuli only up to a point. Children learn by doing. Children have got problems to co-ordinate two different movements in parallel. A child acts emotionally [see Warwitz 1994].
In a virtual reality learning environment these special quality of abilities can be respected and deficits can be trained individually.

To respect emotional aspects of the child, a scenario has been developed. A story based training concept deals with children of different social groups, which provides to every child one character to identify with. To amplify learning progress, the scenario of the ROSE-MMS will be adapted to the ROSE-VRE. In this way children know geographical space in which they will move using the ROSE-VRE.

The ROSE-MMS will impart knowledge about appropriate behaviour in traffic and traffic signs. Therefore in the scenario recur dangerous situations, which causes accidents in real traffic repeatedly (turn off left, gateways, get in lane). But the ROSE-MMS not simply teaches traffic regulations, instead explains traffic signs, traffic regulations and last but not least wrong behaviour of other people. Road safety education in this project as a part of social and ecological education too [Spitta 1997].

The ROSE-MMS motivates the child to practice kinetic exercises, which are important for cycling.
The ROSE-VRE doesn't claim to replace exercises of cycling on a real bicycle in road safety education. Kinetic aspects would be large-scaled or even impossible to simulate in a VR environment al least in the first phase of this project. They should be learned by riding a real bike like done before.
The ROSE-VRE is the missing element in road safety education, which allows the child to transfer knowledge learned in theoretical exercises to knowledge which is practicable in real traffic.

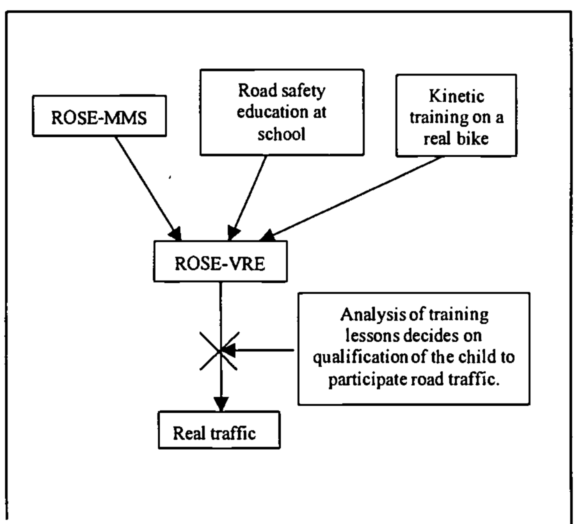

Figure 3: Integration of the "cyberbike" into traditional road safety education.

Figure 3 shows how the "cyberbike" may be integrated into traditional road safety education.
Further by using a ROSE-VRE for training, it is possible to record training lessons, to analyse and to consider them together with a trainer afterwards. In this way individual training for single children is possible.

5 Technical Concept

In the field of road safety education a widespread exploitation of the virtual reality training station is recommended. Every child should get the chance to be prepared to road traffic by this advanced training technology. Therefore the virtual reality environment has to be build at reasonable costs, and should be flexible in setup. To serve these issues we developed an very modular software and hardware architecture for the ROSE-VRE, based on object oriented client\server technologies.

The ROSE-VRE consists of one bicycle, fitted out with sensors, as the input interface. As output devices serves multiple stereoskopic projection screens, an acoustic 3D sound server and the break at the back wheel of the bicycle as a force feedback.
The functionality of various input and output devices of the VR environment will be encapsulated in objects, which have specified interfaces. In a Client/Server like paradigm the input and output devices will be implemented as servers, whose services can be demanded by an VR application as a client [Fig. 4]. For the communication of the single components, Common Object Request Broker Architecture (CORBA) has been used as a standard for communication of Objects over a network.

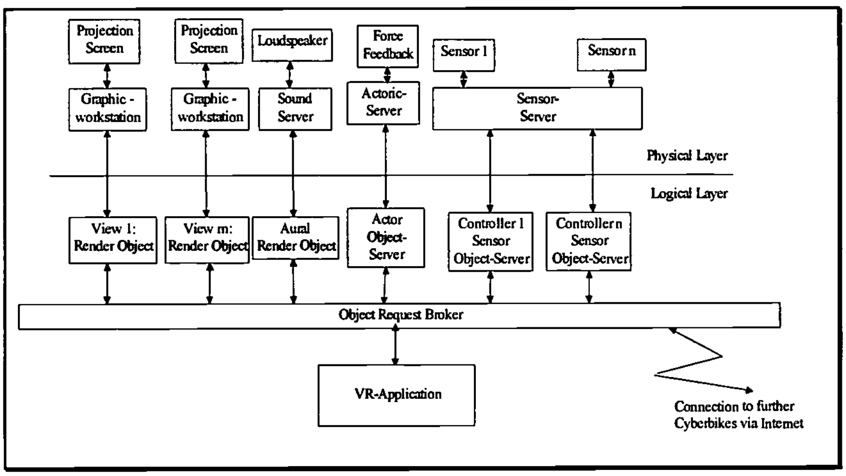

Figure 4: Soft-, Hardware architecture of the ROSE-VRE

By this concept the various I/O Devices can be arranged easily to fit pedagogical needs. Because of the simple integration of various I/O devices, more than one possible configuration of the ROSE-VRE can be tested easily.
Because of the specified interfaces, application software can be developed independently from the present hardware. The ROSE-VRE becomes in this way very scaleable. Hardware components which are currently to expensive for a widespread exploitation, may be at the end of the project at reachable prices to be integrated to the VR-environment without any changes to the software of the ROSE-VRE.

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POSTER/ DEMONSTRATION PAPERS

EXPECTATIONS, EXPERIENCES, AND ATTITUDES OF FIRST-YEAR FACULTY AND STUDENTS RELATIVE TO THE ACADEMIC NETWORKED ENVIRONMENT

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Abstract: This study investigates first-year faculty (n = 11) and students (n = 619) at a public liberal arts college and their: (a) expectations toward using the academic network, (b) background computing experiences, and (c) attitudes toward the academic networked environment. Using a combination of qualitative and quantitative methods, this study provides insight potentially beneficial to many colleges and universities as it directly impacts many programmatic decisions (i.e., computer proficiency requirements, technology training, service and support). Notable findings include interesting similarities in faculty/student expectations, toward their own use as well as the use by each other, of the academic network and highly pronounced differences in expectations warranting further research. Several types of background computing experiences are compared with faculty possessing significantly more experience in some areas while other areas are interestingly non-significant. Significant (and desirable) reductions in self-based attitudinal concerns and concomitant increases in other-based concerns were also found.

ProMediWeb: Problem based case training in medicine via the WWW

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The present alterations in medical education emphasize the authenticity of cases for problem based learning. By those cases future physicians should be enabled to apply their knowledge and skills more effectively to handle real clinical problems. Therefore our objective was to offer realistically designed medical learning cases, provided by the CASUS authoring system, in an interactive way by the WWW platform.

The ProMediWeb client and server applications are developed by the Java programming language. The data of the medical learning cases is stored in a relational database and can be accessed via Hypertext Transport Protocol (HTTP) and Java Database Connectivity (JDBC). Because of the interactive design of our learning system the students are encouraged to communicate over the Internet to become actively involved.

First sample cases are already available. Pre-use and post-use HTML questionnaires and a user and interaction database on our WWW-server allow an evaluation of learning behavior and acceptance. The use of the cases will be useful for all medical students and physicians in continuing medical education.

Student Perceptions and Acceptance with Two-Way Audio Visual Distance Learning

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Telecommunications is becoming increasingly popular as a delivery of instruction to students unable to attend traditional classes. Since this delivery vehicle can cost several thousands of dollars to implement a major question is whether students, accustomed to traveling to classes would accept a less personal modality offering. This study attempted to answer this question by offering several courses using a combination of traditional and distributed modalities. The data for this study was collected from seven courses offered at a major metropolitan university. Graduate students either met on campus or at a distant site connected to campus via a T1 telephone line providing real time audio/video communication with the instructor.

A pretest/posttest design was used to collect the data. Results showed that effectiveness was dependent on the degree of comfort student felt with the instructor and the technology. Students who were more technology sophisticated were more forgiving of technical problems.

A Prototype of a Stand-by System for Secondary School Mathematics

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The goal of the project is to develop a stand-by system which is able to support students during their whole secondary school education when they work at mathematics on their own [Schmidt 1997]. Therefore the organization of the system reflects the typical mathematical activities and working situations of the students. The main structural elements of the stand-by system are the *mathematical objects* (the problem types, concepts, theorems, procedures, and subfields), several *main functions* (solve, exercise, discussion, represent, learn, diagnose), and some typical *working situations* of the students.

The prototype which will be demonstrated (in English language) is the first version of a coherent stand-by system and it will integrate the shells for some of the main functions (solve, exercise, and learn), a tool to process a semantic net, the actual subsystems of formula manipulation and of graphics, and some knowledge bases in the context of word problems which lead to linear equations or systems of linear equations. The programs are constructed in such a way that the use of additional languages is possible. The programming language is Java

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http://www.cs.uni-bonn.de/~peter/edmedia.html (contains an extended version of this abstract)

Teaching Gardening to Developmentally Disabled People: A Multimedia Program.

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Since the program was addressed to disabled people working at the island the plants and tools showed up are the most typical from the region. The fact that most of the potential users cannot read has prevented us from making use of text. The program has been divided into three sections: plants, tools and tasks. The user can move from one section to another just clicking once the mouse. The section devoted to tasks is the main axis of the program: nine very frequent gardening tasks are included. The most important steps have been selected from each task. The user may watch an illustrative fixed picture and listen to a brief description step by step. The plants section offers some relevant information of about fifty plants. At the tools section the user may watch some movies to learn how thirty of the most commonly used tools work.

An Infrastructure for Collaboratively Building and Using Multimedial Corpora in the Humaniora

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In recent years the Max-Planck-Institute for Psycholinguistics has build up considerable experience developing software tools for creation and analysis of multimedia corpora for spoken language and accompanying gestures.

In the *CAVA* (Computer Assisted Video Analysis) project a client-server system for annotation and analysis of digital video movies was realized [Brugman & Kita 1995]. Components are:

- *MediaTagger* client application, a sophisticated Macintosh based annotation tool. It handles media data and added text data in a closely synchronized way.
- A *relational database* to store annotation text and media references.
- A *graphical query builder* tool for generation of complex time related queries.

The CAVA project has reached it's final stages. To overcome CAVA's limitations (it is platform specific, uses a proprietary corpus format, offers no streaming media, allows no Internet access) the *EUDICO* (European Distributed Corpora) project was started [Brugman & Wittenburg 1997]. As proof-of-concept a prototype using Internet technology was finished successfully.

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Planning, Designing and Implementing a Technology Training Center for Foreign Language Teachers

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To train foreign language teachers for today and tomorrow, the Department of Modern Languages initiated the design of a new computer-based training laboratory in which prospective elementary and secondary teachers, and faculty in foreign language and culture studies can gain expertise in the area of TELL (Technology Enhanced Language Learning). In planning, designing, and implementing the TTC lab facility, the foremost concern was to provide foreign language teachers with up-to-date hardware, software and authorware. My presentation addresses key issues related to the development of faculty expertise in TELL, to the selection of hardware, to criteria for a foreign language software clearinghouse, to the challenges involved in the various phases of planning, designing, and implementation of the TTC. If the imperative in teacher education of today is to train (prospective) teachers in the appropriate use of the current technology and to fuse current technology with sound pedagogical paradigms, a TTC is a necessary step in that direction.

Using Multimedia and Hypermedia in a Teacher Education Program

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The Graduate School of Education at Portland State University offers a variety of courses and programs to meet the needs of both pre-service and inservice teachers in the Portland metropolitan area. Schools in Oregon are committed to hiring teachers who know how to effectively integrate newer technologies into their teaching and learning. To better prepare students, and model effective teaching, we are using multimedia and hypermedia in various courses and student teaching experiences. This demonstration describes the "genealogy" of the Graduate Teacher Education Program as it has moved to teach students to use the World Wide Web, multimedia and hypermedia into their coursework and teaching. Examples of courses and projects created by students and faculty in the program will also be shared.

Alea - An Educational Software Program on Quantum Physics

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Quantum physics is extremely hard to teach in high school as there are only few experiments that can be shown and the students don't meet the mathematical prerequisites that are needed for a quantum mechanical treatment of quantum physics. Consequently many students don't understand quantum physical phenomena and a deterministic view of the world persists.

Therefore the software package Alea simulates experiments which cannot be done at school and illustrates mathematical connections which are otherwise hard to show.

Alea covers most of the quantum physical themes that are taught at high school: e.g. electron diffraction, the uncertainty relation, the Schroedinger equation, potential wells ... . It consists of fourteen components some of which allow the student to conduct experiments by himself others offer animations or simulations. All components have information pages for the students and a didactic manual which gives hints for the teachers.

TOON Into EDUCATION!

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Technology has become the essential tool for today's teachers. Animation is an especially appropriate tool for teaching a concept or for illustrating that which the eye cannot see. Disciplines in which animation is vital include the biological and the physical sciences. Animation can also demonstrate the application of technology in a classroom setting.

Since the learning styles of students are varied and additive, Pitsco uses a variety of formats to present material. Some students are readers, some are hands-on performers. Some students learn best aurally and others visually. The use of animation in conjunction with text, audio, and hands-on projects to explain and illustrate concepts is the key to reading and engaging more students. Animation is the crucial element in helping students learn.

Technology Readiness and Vocational Education and Training Clients: An Australian Perspective

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Much of the literature on the flexible delivery of learning products for vocational education and training clients is based upon assumptions that these diverse clients already possesses the personal characteristics and technology readiness skills necessary to benefit from flexible delivery and on-line learning of these products.

The paper describes research which tests these assumptions.

Results, based upon the questionnaire responses of six hundred para-professional, skilled and semi-skilled clients, show that the Australian vocational education and training clients are in the lowest category of distance learning readiness when compared with international norms (Guglielmino, (1991). Results also show a lack of confidence in using various forms of communication for learning and that the majority of respondents either had no experience of the internet or were not confident in using it for learning. Noticeable percentages of respondents also reported that they did not find computers or the internet useful as an aid to their learning.

Internet Database Access: Scaleability of Projects through Shared Database Creation and Use

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The Internet contains excellent collections of scientific data compiled by and for professionals in the field. These data, on earthquakes, weather, fossils, whales, astronomy, etc., have great potential to get children excited about learning and doing science. However, most of the databases are presented in formats that make little sense to children.

Grand Central Science, a National Science Foundation-funded project, addresses the accessibility and scaleability of these databases. GCScience is a centralized web locale for students to do and learn science by accessing and analyzing real scientific data from existing and newly created online databases. Students find and use information through GCScience's easy-to-use graphical queries for these database systems. Students choose the way they want to display their results — as graphs, maps, tables, spreadsheets, etc. Students also can participate in the scientific process by publishing the results of their analyses at GCScience, and can seek supplementary material through web libraries.

Introducing Students to Online Distance Education

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This presentation discusses the merits and difficulties of a flexible online course that serves as a springboard for students into the world of online learning. We developed the course in response to an evident need for guidance on the part of students who were undertaking graduate level study in a flexible advanced degree program. Our experiences in designing this course will be useful to those who are setting up online distance education programs or who feel more learning support is needed by their distance learners.

The full abstract of the presentation is at http://www.fcae.nova.edu/~duchaste/ed_media.htm. The course itself is at http://www.fcae.nova.edu/~duchaste/ltde2/ltde.html.

Teaching Using Online Technologies: A Review of Approaches to Staff Training within Australian Universities

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Academic Staff Development Units (or equivalents) were set up in most Australian universities by the end of 1970s with a common charter of institutional research and advice on improvement of teaching.

These units are now under pressure to respond to an environment which has seen a rapid growth in the demand for the provision of online teaching and course delivery. While individual institutions have reported isolated activities aimed at assisting staff, there is no comprehensive national picture of how this issue of staff development is being addressed.

This poster reports on a national Web-based survey of the 1997 activities within Australian universities. Results show the most common form of delivery is still traditional classroom presentations and demonstrations and half day tutorials with relatively low use of online teaching strategies. In terms of the content of the training, highest priorities are: designing web pages, course authoring systems and pedagogical issues in designing online courses. Attendance tends to be from a cross-section of academic levels with individual institutional profiles determining the level of representation across discipline areas.

Microeconomics in Internet - an Internet based learning environment

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Summary

Permanent learning and training of individuals and organizations will be the key for competitiveness in an increasingly globalized market.
Information and communication technologies are becoming more wide-spread.
Both individuals and companies trying to understand and to apply the contents of business administration will have to update their knowledge constantly.
Presently nothing like an online-learning system for microeconomics in Germany exists.
Learning microeconomics is important for the understanding of economic comprehension. It is a decision-making tool that has a wide variety of applications. So far there are not enough suitable computer-based solutions for facilitating the learning of microeconomics.

Approach:

1. Development of an interactive, multimedia, modular online-learning environment for the Internet for low bandwidth with the content "microeconomics" for the European market.
2. Accompanying evaluation about the added value of the use of new media in learning and training.

During the whole development user groups will interact with the suppliers.

Course Management and the New Technologies

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The quantity and quality of computer based course materials created in the last few years has been impressive. Managing and delivering these resources in a systematic and productive way has become the problem. The features of a ideal computer managed learning environment to resolve this problem will be outlined. In delivering economics courses at Mount Royal College we have used computer managed learning (CML) for over a decade with some 20,000 students. The lessons gained from this experience in conjunction with new software with the ability to incorporate all of the latest computer based multimedia will be provide an illustration of one approach to solving this problem.

Summary and Keyword Extracting Environment for Mailing-list Review: A Trial

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Compared with other methods of traditional learning environment, the network-based collaborative system is difficult to provide real-time analysis and feedback by the teacher when the number of learners increases. Therefore, the teacher is not able to facilitate the process of learning effectively, as the latest statuses of the learners are not available.

So the authors envisaged the purpose of this study as the trial of keyword extracting from the series of e-mail in the mailing-list. Japanese natural language processing technology has been employed for the appropriate keyword extraction from the articles belonging to the same topic with which the group deals.

This extraction procedure is an extension of the WWW mailing-list reference environment with the additional feature of substituting the Hiragana character (simplified cursive script from Chinese characters) to the Chinese character of article. The result shows that the error rate is quite low for practical usage of this transformation.

Act on Line – Design of Distance Learning Integrated Environments for Teachers and Students

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Act On-line is an academic research project that aims at the development of instructional design of interactive environments of learning through the use of Internet/WWW resources.

Its main goal is to develop educational projects to meet the emergent demands for continuous cultural and professional enhancement. Simultaneously, it researches how distance learning occurs through interface instructional drawing, emphasizing the use of interactive tools destined to active, autonomous and cooperative learning. The project of courses for the University internal and external public, arises from an interaction between teachers who produce content and the project development team that supplies technological and pedagogical consulting, including interface frames models and models of activities for students. WWW environments have been structured for the internal public, combining activities started in the classroom with Internet research.

MULTIMEDIA APPLICATIONS AND TOOLS ON THE WORLD WIDE WEB

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Multimedia helps people communicate and learn quicker and more easily. The incorporation of multimedia into the Internet via the World Wide Web has made it possible for many more individuals to experience the power of multimedia. It is also the contributing factor for the popularity of the Internet today. Predictions have been made that this trend will continue in the future.

This demonstration deals with the multimedia applications and tools that can be used with a connection to the Internet. The main types of Internet-related multimedia applications include: computer conferencing, videoconferencing, and virtual reality. Some of the types of Internet-related multimedia tools that will be demonstrated and explained are as follows: Adobe Acrobat, Progressive Network's RealPlayer, ASAP WebShow, and Macromedia Shockwave.

Assessing Low-Attaining Pupils in Arithmetic Word Problem Solving

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Our work sets out a theoretically and empirically based description of a teaching strategy and a flexible knowledge representation for intelligent tutoring systems (ITSs) in the context of a system called ASSA (Adaptive System of Student Assessment) designed to assess pupils who show low performance in solving simple word problems of addition and subtraction. The paper describes an assessing planner able to take decisions in order to achieve two goals: Traversing the domain and maintaining the student's personal learning characteristics and optimal motivational state. During assessing further student's characteristics are diagnosed, for example preferences in context, learning strengths, effort and confidence. ASSA's aim is to adapt its performance to the diagnosed student's characteristics and encourage him to interact with it accordingly to his strengths. The assessment process provides the student's cognitive profile as output, accomplished with pedagogical information about the student's individual motivational characteristics.

Multimedia, Multi-campus and the Teaching of Health Informatics: The Lived Experience

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Health Informatics, is a multi-campus first year health science (nursing), undergraduate unit. Teaching utilises information technology as multi-media, with computer applications, software presentation, email, mailing lists and the worldwide web. Evaluation revealed positive student outcomes included increased competency and confidence using information technology. However, students encountered problems trying to apply concepts and principles of information technology as health informatics to health care. Consequently, the unit will be split in two modules. Module One - Information Technology will be introduced in year one, The focus will be on aquiring expertise in information technology skills with references to health care as health informatics, incorporated. Module Two - Health Informatics will be taught in the third year, following the students' clinical practice Health Informatics will be reviewed, using student exposure in the clinical experiences to its application in health care, as a learning medium.

Technological Trends in Continuing Education in the Banking Sector

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Situation of Continuing Education Today

The challenges of achieving higher productivity and skills level, and of providing on-going support to learners at every level of work, will place increasing demands on the capacity of financial institutions to educate and train large numbers of employees. Lean management, reduced hierarchies, and overall staff numbers, moving decisions and responsibilities to lower levels make it more difficult for employees to leave the job for additional education and training.

Dynamic and constant changes in technology and new products of an internationalised financial market as well as new regulations and fundamental changes in the economic sector require that education evolves into life-long learning. Information delivery and education are becoming essential services that need to be made available on demand. Traditional means of education are not adequate to meet the needs of the banking staff for life-long learning.

The cost for training great numbers of staff can be reduced by using new technologies instead of traditional classroom education. Although multimedia learning environments may incur higher start-up costs the investment will pay off from about 100 participants onwards.

New Trends and Projects

To accommodate the trends outlined above, Bankakademie will add more on-demand educational services and streamline its production of educational material in order to react more quickly on the demands of our customers. This includes consultation for analysing the demand, planning and evaluation of the educational needs.

Learning to Learn

Many of our students have been working for quite a while before signing up for a course with Bankakademie. Bankakademie and CogniCom, Munich, are developing a multimedia program to help people refresh up their learning skills and strategies. Users are introduced to the workings of the human brain and to different learning strategies. Different scenarios and strategies are proposed for the different aims of the users (e.g. preparation for examinations). Our surveys show that a majority of our students have access to computers with CD-ROM drives (60%), and are willing to buy it (55%).

Multimedia Networks

Hyperwave and Bankakademie jointly developed an WWW-based multimedia database capable of holding all documents that are created during a course into one unified system. This includes preparational materials (handouts, literature), the material created in class (slides, sound/video of the presentation, students' notes) and all (electronic) notes and discussions created after class. This system is based on the Hyperwave Information Server. It can be accessed from any computer connected to the Internet or the corporate Intranet. All documents can be customized and annotated by students and trainers, access rights provide the necessary privacy.

Online Certification

CertiFire is a database system for the management of questions, tasks and examinations developed by Bankakademie. Every questions can be associated to different projects and groups, allowing to tailor the grading of the answer to the group or project selected. Questions can be arranged as self-tests, tests and real examinations. These can be conducted on paper, on the students' computer, or over the

Internet/Intranet. On examination, the user can request additional hints and information to every question. These hints may contain pointers back into the multimedia database and thus help the students to compensate for discovered deficits.

Implications for Virtual Reality in Natural Resource Recreation Management Curricula

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Since 1992, researchers at the University of North Carolina at Wilmington have been gathering data in multiple media formats concerning physical impacts due to recreation on Masonboro Island, a pristine barrier island off the coast of Wilmington, North Carolina, USA. The data have been integrated into a hypermedia database and are now being used by both managers of the island, as well as researchers. More recently, the hypermedia database was also used by students in a Coastal Natural Resources Recreation Management course in developing coastal management plans. One primary limitation which emerged from utilization of the hypermedia database in both academic and professional settings was the static media itself (eg. photographs, drawings). To address this limitation, navigable virtual reality images of Masonboro Island have been integrated into the hypermedia database utilizing Apple Computer's QuickTime VR system.

Hypermedia Authoring as Learning Tool: an Approach from the University of Rijeka (Croatia)

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The project presents an attempt in preparing the senior students of Computer Science at the University of Rijeka School of Education not only to learn hypermedia and search the World Wide Web, but also that they themselves create their own seminar papers. The idea that rooted this study is that change in content, but in methods as well, have to be obtained in today's contemporary education in order to prepare the students for the information age. In this project students with no prior experience with Internet and hypermedia were introduced to elementary hypermedia concept and how to design WWW hypermedia applications using HTML.
Introducing hypermedia by allowing the students to design and build their own hypermedia application was very motivating to them. We hope that those students, as future teachers, will know how to implement and use both hypermedia technologies and the independent study method in schools.

Hypertext Learning Environments as Model Activity Systems: A Pilot Study

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The poster presents findings from a pilot implementation of CSILE (Computer Supported Intentional Learning Environment) developed at the Ontario Institute for Studies in Education (cf., e.g., Scardamalia et al. 1994) in a Grade 10 computer class. The aim of the study was to identify changes and contradictions within the activity setting following the implemetation of CSILE as a "model activity system" (Cole 1996).
Looking at how communication operates in CSILE and how it is related to ordinary oral communication, we could identify typical changes and problems on different levels:
- physical and technical frame factors
- CSILE as a tool for cooperative communication
- CSILE–windows and features
- teacher and student roles
- products and objects of the activity setting, especially as regards form and content of the notes.

On the basis of the findings conclusions are drawn for future classroom applications.

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HyperMeasure: A Video-intensive, Case-based Hypermedia Teacher Development Tool

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Abstract: Recently, there has been much optimism about the promise of hypermedia in case-based teacher education programs. Despite such optimism, however, there has been little evidence of how people learn with case-base hypermedia learning tools. This presentation describes the design and assessment of one such tool. First, I describe the learner-centric design of a hypermedia teaching tool (HyperMeasure). Second, I describe an empirical test which determined that pre-service teachers can learn about the growth and development of children's understanding of measure. I conclude with a discussion of the importance of design cycles in the development of educational software.

INFORMATION SHARING ISSUES, PRACTICES AND TECHNOLOGIES

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This session is related to the *Information Sharing Special Interest Group* session. The issues we are looking at are:

- Time to share information.
- Sharing "quality information" which will increase productivity.
- Common indexing systems.
- Common value systems.
- Standards.
- Technology.

Currently we are using email and exploring listservers and collaborative workspaces as means of sharing information with each other. We have been sharing information using informal profiles of each other's interests and reviewing information that relates to the Special Interest Group. David Ibsen has been working on a pilot project to develop a semiformal structure for information sharing and Irene Langner had been exploring the use of collaborative workspaces. Others in the SIG have reviewed their work and provided quality feedback.

An ITS Authoring Tool with Automatic Generation of Courseware Knowledge

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Our laboratory has been carrying out research and development on an Authoring Tool for CALAT (a Computer Aided Learning and Authoring environment for Tele-education), an intelligent tutoring system (ITS). To facilitate wide-spread use of CALAT, the system must provide a variety of content, therefore an authoring tool must allow easy courseware creation. Our Visual Authoring Tool of CALAT supports almost all aspects of courseware creation, including design, input of design data, testing and evaluation. The tool includes Automatic Generation of Courseware Knowledge which is mainly composed of learning goals, scenario, exercises and their relationship information. This Automatic generation produces courseware from a part of Courseware Knowledge. After this process, we expect that courseware author rearrange their courseware to refining. By repetition of these way, it is promoted spiral-type's rapid development of courseware. We will demonstrate both the Visual Authoring Tool and the Automatic Generation of Courseware Knowledge.

Reifying Design Approaches for Education and Research Web Sites

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The purpose of this poster session will be to articulate and reflect upon selected educational research Web projects with which we have been involved. The poster will demonstrate selected design features of Web sites such as the National Infrastructure for Education Web site (National Center for Supercomputing Applications at the University of Illinois), "Smart Web" for the Scientists-in-Action Project (Learning Technology Center, Vanderbilt University), artNtec Project (U.S. Army Construction Engineering Research Laboratory), Cognition, Technology, and Complex Systems Project, the Knowledge Mediator Project, and the Learning and Performance Support Laboratory Web site (University of Georgia). The poster will cover issues such as design processes, concept development, user interfaces, user feedback, content organization, platforms, implementation, and team work. Overall, we hope that the educational research design approaches we have been working on may stimulate interesting interactions with Ed-Media 98 participants related to ways to better design and utilize Web educational resources for students, teachers, researchers, and the general public interested in education.

Partnering in Technology Integration: South Texas Style

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The role of universities in preservice and inservice training of teachers is vital. Successful integration of technology to improve teaching and learning depends on the capacity of the university faculty to model and support public school teachers as they become familiar with, and comfortable in, using multimedia technology to enhance their instructional programs. This paper describes a model for partnering between a regional university and 17 area secondary schools that reflects ongoing support from the development of competitive grant proposals through the implementation and dissemination phases of the Technology Infrastructure Fund projects. This process involved four distinct phases: 1) developing a vision, 2) building computer literacy skills, 3) linking curricular objectives to technology, telecommunications and multimedia, and 4) designing and implementing technology-enriched courses. The scope and sequence of training and dissemination activities, together with examples of printed materials and products will be shared.

Designing Web-based Instruction

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The WWW cannot guarantee learning. The design of WBI must take into account visualization, goal orientation, motivation, and structure so the design enhances the educational opportunities of the learners. By allowing learners to set goals and reflect on the content, the learners' attention is focused and they understand the interrelatedness of ideas. Multiple media provide the learner with rich and realistic contexts for multichannel learning. Motivation is increased when learners are in control of navigation and encounter realistic examples. The structure is enhanced through simplicity so the interconnectedness of ideas is clear. Instructional design must translate design issues and learning theories into plans for web-based environments. Through the development of ThermoNet (instructional web site), we can determine the following: impact of visualization on learning and retention, importance of setting goals for learning, optimal navigational device to enhance students' learning, and benefits of utilizing the web as a research medium.

Using The Wisconsin Sequence Analysis Package for DNA and Protein Analysis

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A WWW Based Tutorial

The computer analysis of DNA and protein sequence data is an important technique in molecular biology and molecular medicine. The Wisconsin Sequence Analysis Package of the Genetics Computing Group (GCG), Madison, USA, is one of the major tools for the computer analysis of genetic data.

We have developed a WWW based tutorial for people who have to become familiar with the GCG program suite. The course aims at students, who need an appropriate preparation before attending experimental courses in molecular biology and at scientists, who need a 'living cookbook' for their work on the bench. Our tutorial provides the possibility of a linear path to learn to access the programs as well as the fast access to a specific program which is actually needed.

Standard WWW browsers have the advantage to provide for each scientist or student at the same time on-line access to the program suite, his or her sequence data and access to the tutorial.

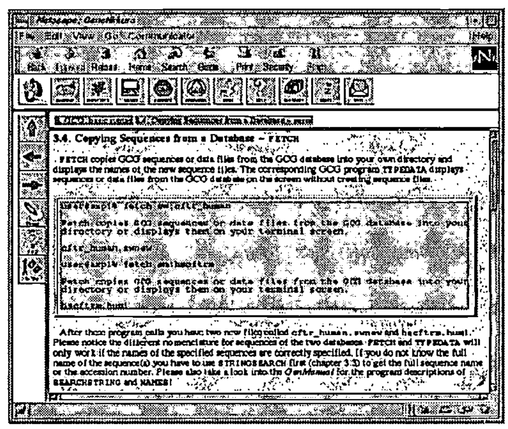

Figure 1: sample pages from the tutorial - starting page (left) and lecture page for program *fetch* (right)

Space for Learning and Teaching Exploration

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Space for Learning and Teaching Exploration (SLATE) was developed at the University of Michigan through a collaboration between the School of Education and the Office of Instructional Technology. It is a combination of custom software and existing applications, designed around a rich set of multimedia data that U-M Professor Deborah Ball collected during a year's teaching in a third grade mathematics classroom. In this environment, mathematics education students observe a common classroom, complete multimedia research and writing assignments, and – in the process – learn to think about new ways of teaching mathematics.

Approximately 30 days of classroom interaction are represented with multiple media types, including classroom video, full-text transcripts, children's notebooks, and the teacher's journal. SLATE supports browsing of all media types, multimedia authoring, and full-text searching of the transcripts and teacher's journals. The transcripts are linked paragraph by paragraph directly to the video clips. SLATE is used on a Macintosh, and the search engine runs under UNIX and is accessed via the Internet.

A Bon Port/Ficelle: Designing and developing a multimedia language activity CD

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After writing our new French language textbook *A Bon Port* (Prentice Hall, 1998), we began to develop a companion CD-ROM using the *Ficelle* authoring system. This CD-ROM will allow students to do independent work and receive immediate feedback about their progress.

The program originated not from a computer programmer but from language teachers who submitted a list of requirements to meet the needs of their students. The *À bon port* CD-Rom has
- activities that complement the textbook rather than an electronic repetition of the textbook;
- truly interactive, communicative activities;
- a user-friendly browser-like interface;
- activities at different levels to accommodate a wide range of proficiencies;
- generic feedback reflecting in-depth error analysis;
- an end-of-activity scoresheet showing number of trials, and number of right and wrong answers;
- culture and grammar links.

Lessons in the *À bon port* CD-Rom may include:
- fill-in-the-blanks type questions to be used with text or graphics;
- multiple choice questions using either words or boxes to click;
- lesson sound files to play or the recording and playback of the student's voice;
- pictures and photographs;
- capability to play video .avi files;
- coloured and highlighted text;
- "hotkey" glossary words.

The CD-Rom will be piloted in a number of French classes in September 1998.

Engineering Educational Environments for Tomorrow: Quality, Virtuality and Reality

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The vision proposed by MIT's Council on Educational Technology points to exciting ideas for combining the capabilities of new technology with the commitment and skills needed to achieve ambitious educational goals.

The educational activities and environments proposed - from Virtual Reality for freshman Calculus and animated sequences for teaching electromagnetism to visualization-intensive collaboratories for biomedical research and a Virtual Design Studio for architects - suggest the possibilities of a re-invented campus and a new sense of place.

Moving from the rhetoric of the rich, technology enabled educational vision to the reality of implementation will entail some interesting and challenging transition issues:

- Building an architecture of systems and services that supports experimentation without disrupting production.

- Making high performance available on highly available environments.

- Retaining the strengths of MIT's current distributed computing environment, Athena, while adding new capabilities and functionality to support a high-performance, media-rich, distributed educational technology.

The Pros and Cons of RealVideo

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Pros: Using web interface as the overall container, RealVideo can show a combination of video, audio and text and thus can be used to provide interactive self-access language learning materials to students through the campus network. For off-campus students, there is also the flexibility to deliver just the audio component over the Internet. When technology improves, the video content can be delivered as well.

As many students are already familiar with World Wide Web, they will find the interface user-friendly and do not have to spend time and energy over the technology, thus focusing more attention on the language learning process. Also, RealVideo can be used for authoring complicated interactive learning programmes.

Cons: The web interface is not particularly strong in synchronizing different objects. But now RealVideo has the functionality to allow webpages to synchronize with the video. Nonetheless, the authoring tool for this is not simple enough for everyone to use.

"New Collegialism" Approach: Basis for Using Computer-Mediated Communication in The Improvement of Higher Education Teaching in Croatia

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In the ongoing research which final goal is to develop a model of university staff development, we consider the "new collegialism" approach as appropriate basis for using computer-mediated communication in the improvement of higher education teaching. This approach is participant oriented, opened, responsive and innovative, promotes networking and teamworking, welcomes change, facilitates active learning, has opened access and explicit quality criteria, and empowers the participants [Harvey & Knight, 1996]. We believe that computer mediated communication will open the process of continuous improvement of teaching and learning at the universities, primarily from the bottom-up direction. From 203 teachers who participated in our study, 108 of them want to start communication. Computer mediated communication we intend to use in our model will include: establishing news group: "What's new in academia?"; establishing mailing list; establishing Web-pages where teaching materials, teaching "tips", information about activities will be exposed, and establishing e-mail consultancy.

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The Development and Analysis of the Effectiveness of a Multimedia Introduction to Plant Secondary Metabolism.

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Dr. Brian E. Ellis, Professor and Head, Department of Plant Science, University of British Columbia, Canada.

This demonstration/poster will describe the development of a multimedia introduction to plant secondary metabolism and report the results of the effectiveness of the application.

For the uninitiated encountering most of the current literature in plant secondary metabolism is somewhat daunting. Since secondary metabolism is a visual and dynamic field, and since computer–based multimedia allows one to visualize dynamic phenomena that is not well represented on paper, it was anticipated that an accessible multimedia application may hold some potential for bridging the gap between the neophyte and the literature.

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Introduction

Finland is one of the leading countries in Internet technologies. Universities have pioneered in the creation of Internet services which have proved to be of great benefit both to the students and teachers. This year, 1998, the various services of Finnish open universities have been brought together on the same WWW-pages. Internet technologies create new possibilities for studying and learning, including, naturally, the possibilities to search information, to compare different courses and get guidance from tutors.

Education Through Transcription Using Personal Computers

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Abstract: In this research a multimedia software package was developed to improve students' Kana (the Japanese syllabary) writing with respect to the shapes of the letters and the proper use of the brush in their calligraphy lessons at junior high school level. This software 'Internet Shodo' was produced using HTML and it is now on the Web. Students can learn how to write each letter by carefully watching the QuickTime movie with sound explanation on it. Considering the research results this software was very effective in improving the students' writing ability and motivating them to evaluate their calligraphy works over and over again checking in detail the order of the strokes, the required change of ink thickness and the necessary height of each letter, etc. The students found that the software had increased their interest toward writing the letters properly and also changed their attitude more in favor of daily improvement of their syllabary writing. Further research is now developing to facilitate international Shodo collaborations between schools in Japan and the UK.

URL: http://www.city.kitakyushu.jp/hanao/

Flexible and Open Hypermedia Authoring Tools Need Courseware Modularity

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This poster/demo describes an Hypermedia Document Composer (HDC)[1] which can also be used to play documents in several collaborative education and training scenarios and that is being extended to support collaborative composition of hypermedia documents[2]. The HDC uses the overhead and transparencies metaphor to build the hypermedia nodes and to hold multimedia objects through the use of OLE technology which allows the composition of very flexible hypermedia documents supporting any type of multimedia OLE objects produced by MS-Windows applications (word, excel, video, audio, etc.) [PINTO et al, 1995]. This open architecture allows the easy integration of existing documents as well as new ones regarding they are produced by OLE /ActiveX applications. In modern authoring tools this flexibility is very important to allow the teacher/students to deal with and to build dynamic teaching/learning situations by reusing the several components and modules to handle with different pedagogical scenarios in more appropriate ways. The key to this flexibility and modularity is a centralised resource center which stores the multimedia objects, the hypermedia structures defining the documents, public annotations, OLE/ActiveX servers to support specific teaching/learning modules[SANTOS et al. 96] and mechanisms to support the related organisational issues [MARTINS & PINTO 96]. In "composition mode" a HDC user connects to the resource center, through ODBC, and browses it to find the multimedia objects or modules already stored to insert into the hypermedia document or adds new objects. All these operations to compose the hypermedia document are done graphically by direct manipulation. The possibility to support multimedia annotations (public and private) is also very important, because users can add their comments to the hypermedia documents. All public annotations are stored in the resource center, allowing user mobility. Public annotations are visible by every user while private annotations are visible only by their authors.

The Resource Center (multimedia database) is a key feature of this hypermedia composer since, we believe, the resources to build flexible courseware are a fundamental issue for an open teaching and learning environment. We need very flexible courseware modules, with low granularity, so that they can be reused to build dynamically several teaching and pedagogical scenarios which isn't possible with long, static and linear courseware. In this way the HDC acts like a courseware resource center dynamic front end allowing the reutilization of objects in different contexts which are the hypermedia structures (new object) that hold a new hypermedia document.

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A New Two-year Program in Multimedia at Utah Valley State College

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The new two-year associate of applied science degree program in Multimedia Communication Technology is the only stand-alone multimedia program in Utah. Its curriculum was developed with considerable input from industrial multimedia consultants. This program is now completing its third year and its popularity with the students is growing rapidly. The program has two tracks to allow the students to choose an area of multimedia specialty. One track is multimedia technical support, the other track is multimedia design and production.

The multimedia courses are offered both during the day and evening. Because of this program, UVSC is gaining a reputation as being the multimedia learning site in Utah. Multimedia oriented industry in Utah is recognizing the importance of this new program and is commencing recruitment of the students. The program is also serving residents of the local community as an alternative new and rewarding career path. A unique and solid relationship with high schools in Utah has been established; their students, who are excited about multimedia, are looking to UVSC as the place in Utah to further their education in this blossoming field.

A Multimedia Installation as Critical Environment of Experience –Tendencies of Change in Everyday Communication –

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As artists and educationalists we have developed an interactive multimedia installation which presents a room of experience and exploration. It deals with a vision of telecommunication in the future. Our view: By means of the dissemination of multimedial abilities in communication the everyday communication will change.
In our artificial room of conversation the variety of effects of a simulated part of everyday conversation is to be experienced. At a laid table conversation partners are to be chosen at the touch of a button. Talking heads are projected at the face of a doll. Those Partners of conversation are present in the shape of the figure in a visual, auditive and physical way, but they are not real. The boundation to the effect on communication on the environment, on the interpretation of the user and his ascription of roles are to be experienced. The question of the impression of communication-reality is emphasised.

Internet Training for Teachers Using Content Area Earth Systems Science

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Our approach to teacher training is to offer a web-based, on-line graduate class ("Internet-Based Earth Systems Science Instruction for K-14 Teachers") limited to in-service teachers. Project activities are used as the content vehicle by which teachers can gain practice and experience on how to use the internet in their own classroom. As the teacher participants work through activities, they are required to develop their own extensions of the materials that are most appropriate for their classroom and situation. The ultimate objective is to inspire them to see the possibilities and to give them a framework in which to expand their knowledge of an important content area, earth systems science, *and* the internet medium. Teachers report using the internet more in their classroom and in a more significant ways. Content-based activities encourage teachers to gain experience with the internet medium.

"Minds on Science" vs. "Hands on Science" - Lab Science in an Internet Class

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I refer to laboratory science on the internet as "minds on" to distinguish it from traditional physical geography "hands-on" laboratory offerings revolving around paper maps, globes, aerial photographs, weather and climate data, soil samples and so on. Probably more than most sciences, these tools and topics are well represented on the internet. Rethinking what "laboratory" actually means, interpreting it in a "minds on" way rather than just "hands on" frees the teacher to make use of the richness of images and data available on-line. My Earth systems Science (http://www.math.montana.edu/~nmp/opening.html) class for the Network Montana Project at Montana State University, and my Physical Geography (http://wind.cc.whecn.edu/~gnelson/physgeog/IntroG.html) class at Casper College are attempts to put this philosophy into action. These projects demonstrates that "minds on" science activities on the internet can supplement and perhaps supplant traditional laboratory science activities.

Students Creating a CD-ROM Yearbook Addition: A Constructivist Teaching Approach

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This project helped high school students develop computer literacy and skills through the use a constructivist teaching strategy, the development of a CD-ROM supplement for a high school yearbook. Because of a wide applicability for other computer uses, students used a combination of Microsoft PowerPoint and HTML to develop the contents of the CD-ROM. Contents included an introductory page with buttons for sports, student organizations, school events, and class pictures. Included were video clips of football and basketball highlights, a scene from a school play, students with musical talents, and interviews with students, staff, and teachers. The students were highly motivated! They learned PowerPoint, HTML, graphics, the making of a CD-ROM (etc.), and developed high rapport with each other and their teachers. Special thanks goes to the Corporation for Public Broadcasting (CPB), *Ernest L. Boyer Next Step Grant*, for providing the opportunity for this project.

Electronic Hypertext Reports Teach Content, Skills, and Teamwork

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Having science students create hypertext multimedia reports by groups provided stimulation and encouraged teamwork while helping students learn new information and skills. Each group identified a question to be investigated, designed and conducted experiments, collected data, and made interpretations. As work progressed, a camcorder and a 35mm camera were used to document the project. Video images were captured, photographs were scanned, and voice clips were recorded for use in the final hypertext reports. Computer generated spreadsheets and figures were inserted. Final reports were presented to the class. Each student was involved with all phases of the project, using as many of their five senses as possible. The constant peer-review inherent to collaboration was more effective motivation than evaluation by the instructor. The creation of hypertext multimedia products instead of typed linear text reports fostered improved writing by many of the students because it introduced flexibility into their thought process.

Interactive Electronic Problem Based Learning (iePBL): An Internet based Application for Clincial Medical Education in the PBL Case Format

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Project Description

Interactive Electronic Problem Based Learning (*ie*PBL) incorporates the PBL case format into a multi-user computer-assisted information exchange. An Internet web-browser is used to provide platform-independent access to multiple users at remote locations.

Students are able to login to the *ie*PBL web-page at a self-determined time. Case information is reviewed independently as it is progressively disclosed. During each session, the student enters his/her hypotheses and interpretation of information and identifies learning issues.

Individual user input is compiled by the *ie*PBL web application for review by all users and the Faculty preceptor.

Students revisit the web-page at designated intervals for review of peer submissions and analysis of new case information. Students also order and interpret diagnostic tests. At each diagnostic decision point, the student is required to outline his/her medical reasoning and comment on other students' ideas as desired.

The Faculty Preceptor plays an integral part in facilitating the *ie*PBL discussion forum. He/she provides feedback to individuals and/or the group and asks pertinent questions to guide the learning session.

Attempts to incorporate computer technology and e-mail-function into PBL sessions have already been made with favorable results [Schor 1995] [Coulehan 1995]. *ie*PBLs new approach has several potential benefits in undergraduate medical education.

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An Implementation of Individualized Tutoring in the WWW based ITS for Guiding Differential Calculations

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We demonstrate our WWW(World-Wide Web) based ITS(Intelligent Tutoring Systems) for guiding differential calculations[Okazaki et al. 1996]. It is a practice type ITS and you have access to the system from http://www.is.saga-u.ac.jp/ai/ai.html.

Its individualized tutoring mechanism is as follows.It dynamically generates individualized HTML documents in the phases of setting problems, guiding and summary of study. Hidden tags are used to embed user identifiers. Teaching module driven by CGI facility identifies student's error origin based on buggy model. We have grouped student's states of the identified error origin into 6 categories based on his/her score and frequency of the error origin. Teaching module generates guidance messages according to teaching paradigms which are assigned to each states.

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Using Streaming Media in Online Courses

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Abstract: The Internet is being used more and more for the delivery of college coursework as millions of users go online. Although internet-delivered courses offer advantages to students such as convenience and increased access, a number of problems have resulted as well. One of these is the lack of a mechanism to provide demonstrations and short lectures in a format with which the student is familiar. In addition, courses that primarily use e-mail and web pages lack the interpersonal communication and visual imagery available in the classroom. With the advent of streaming media technologies, instructors can videotape short lectures, demonstrations, and other presentations, digitize and compress the video, and post the file on their course home pages. Students may then view these videos over the internet using a web browser and the appropriate plug-in. Our first experience with streaming video as part of an internet-delivered course was a qualified success. The current technology is adequate for the delivery of video and is relatively easy to use by both viewer and producer. There is no question that this technology will continue to improve and will become a major factor in the delivery of distance education materials. However, no matter how good the technology becomes, the emphasis will always be on the content and quality of the video production.

An Instrument for SMEs Workers Long-Life Learning in Castilla-León

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A multimedia educational software tool named *Virtual Class* has been developed. It offers interactive multimedia courses about various telecommunication services; and it is based on the use of telematics networks, what makes possible the interaction between teachers and pupils. *Virtual Class* is a server-client system, which uses the Internet protocols. The client side, along with the courses, is distributed in CD-ROM.

Virtual Class is the result of the coordinated action between diverse kind of specialists, mainly Pedagogues and Telecommunication Engineers.

Virtual Class is intended first of all for SME´s workers, although it will subsequently be extended to cover other segments. It has been evaluated while giving a course for SME´s workers in CEDETEL in September-October of 1997 and we will have the opportunity of evaluate it again in the first semester of 1998, this time in a course about Distance Learning for future teachers at the University of Salamanca.

Site-level Authoring, Revisited

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In the early days of the World-Wide Web, most sites were small enough and the web was new enough that it was possible to create and maintain sites by hand. However, as the web has grown, so have individual sites and the effort required to maintain these sites. Site maintenance may require gardening to prune unneeded pages and links, redesigning pages or groups of pages, and even restructuring the whole site. Too often, effort that should be spent on global design or content issues is spent instead on repetitive details.

Fortunately, a number of systems have been developed to support authors, designers, and maintainers of larger information spaces. Academically-developed site-level authoring systems include ASML (the automated site markup language), CourseWeaver, Gentler, HtX, HyperWave, I-CARE, Siteview, Siteweaver, WebCT, and WebMapper.

This work describes the tasks of site-level design and summarizes the similarities and differences of these different tools as well as their applicability to different tasks.

Teaching And Learning Languages with the Internet: A Case Study

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Introduction

The use of the Internet as source of a wide variety of information for academic studies is already well established. Some courses also use the Internet for distance and flexible learning e.g. by putting lecture notes and reading materials on a server or the Web. The novelty of this project is, that it goes beyond hyperlinked pages by using interactive HTML language exercises with direct feedback.

Over the last two years, the project on *Teaching and Learning Languages with the Internet* has resulted in the production of a number of courseware units and enabled me to explore the possibilities the Internet offers as authoring and learning environment. The main objective was to produce language learning courseware that include links to Internet sites as well as specific language learning exercises. Envisaged outcomes are models or templates of language learning exercises to support faster and more efficient courseware development in the future.

A sample unit can be visited on *http:\www.eon.anglia.ac.uk\CALL*.

The Authoring Environment

General

HTML is an authoring language that is fairly easy to learn at least compared to other authoring tools. It could be compared to a word processor that needs to be programmed what to do such as font sizes, tables, etc.. However as with word processing more and more sophisticated editors make life a lot easier and authoring faster. However, because HTML is mainly an interface language anything involving computing such as learner progression or performance in a courseware unit demands more complex computing skills depending whether the processing is client-[1] or server[2]-based.

Language Learning Exercises

Many traditional language learning exercises can be produced using different HTML forms such as gap filling using text boxes, multiple choice using drop down menus, various matching exercises using text or check boxes and true/ false exercises using radio buttons or icons.
By using frames the interface can be divided into different windows, whereby each window can be used for different activities and functions. In my courseware units for instance I used a small frame at the bottom of the screen for navigation but also for feedback.
Additionally, HTML[3] and the e-mail facilities of browsers open up the possibility for writing and conferencing tasks that are difficult to cater for in traditional language courseware. With these tasks learners can be asked to produce a summary, short essays or other types of texts, which they send to the tutor to give feedback. Furthermore conferencing facilities can be included which enable learners to communicate with each other on a topic, text, video or audio in the unit.

Conclusion

The Internet can open up new dimensions of language learning and teaching as it is possible to include text, image, audio as well as video with specific interactive learning tasks and relevant Internet links in a courseware unit, using only an Internet connected multimedia computer as equipment.
Authoring on the Internet is inexpensive and editing software is getting more and more sophisticated. The authoring environment is developing rapidly and is getting more powerful by the day, so that handy solutions for the current limitations of HTML could soon be found.
However the effective application of courseware also depends on the speed it is delivered to the learner's computer. Computers, modems, servers and telecommunication lines are improving, but many factors are involved in the state of a particular network. It needs to be seen if the current state of

[1] Cookies in Java Script can be used to store information on the hard disk of the client.
[2] Computing expertise in a programming language such as PERL necessary
[3] With text blocks and 'mailto' function

networks in particular areas (i.e. in education) can keep up with technological developments.

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Canadian and Russian Universities on Joint Design of the Distance Learning System in Russian Teacher University

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This presentation sets the historical, philosophical and theoretical framework for the present and future needs of Russian education. The authors present the view that the deficiencies of contemporary Russian education can be addressed by a return to certain pre-revolutionary educational paradigms which parallel contemporary western thinking. An attempt is made to address the geographical and economic challenges which stand in the way of developing a distance education modal which will facilitate the organization and delivery of curriculum to meet the needs of modern Russia. To this end the Canadian experience, which has evolved through similar challenges to those of the North-Caucuses region, is described as a possible modal. The presentation concludes with a discussion of the first attempts at cooperation between Lakehead University in Canada and Rostov State University in Russia.

NephroCases

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Introduction

The project group 'Autodidakt' and the division of nephrology at the University of Ulm are developing a case-based, interactive learning program. Representative diseases of the kidney are elaborated. Every case is designed according to a general structure: history, physical findings, laboratory, investigative results, diagnosis, treatment and prognoses.
This program will offer for medical students an opportunity to train their understanding of diseases, and their ability for the treatment of patients.
For this task the content of the program is subdivided into information-units. Interactive sequences, animation and a varity of clinical images and videos support the decision and learning process of medical students.

Aim

The program addresses advanced medical students and postgraduate physicians. It is intended to provide a learning tool, which trains especially the case-based decision during the medical treatment of patients with diseases of the kidney.

Concept

The case-based learning as opposed to the textbook learning has the advantage of simulating real situations of the daily clinical life. The student is confronted with a concrete situation and is asked to make decisions for the treatment of a patient. In the interaction with the program the student gets feed back on his decisions, and additionally he can gain advanced expert knowledge in a relevant field.
Using the links, the student will be able to learn more about pathophysiology, differential diagnoses and discussion refering to the latest published results. In order not to confuse the student, additional information is presented in special windows, the socalled expert-windows. These windows are displayed, as if they were placed in front of the main layer.
In the expert-windows the medical content is arranged in a systematic way. Additional pathways lead to knowledgement layers with more detailed information. Using the links, the student is able to determine the extend of knowledge of a special subject, he wants to learn.
For example: the virtual patient is suffering from diabetes mellitus. After the student has ordered a special bloodtest, the value of HbA1, he can recall the pathomechanism producing HbA1, which is named glycosilation of hemoglobin-molecules.
Whenever the pathomechanism is more impressive, an animation is shown. We have integrated 2D- and 3D-animations, sounds and videos.
The program will comprise 20 cases from all fields of nephrology.

Methodology

The program is produced for CD-ROM, running on the operating systems Windows95, WindowsNT and MacOS.
For the development we use the authoring tool 'macromedia director ' and other software for editing images, soundfiles and movies, such as 'Adobe Photoshop', 'Adobe Illustrator', 'Adobe Premiere', 'Macromedia SoundEdit', 'Equilibrium DeBabelizer' , etc.

Evaluation

The evaluation of this program will be acomplished in two steps:
The first step involves the user-tracking; it is performed by the program. User activities, such as the time spent on a single page, the type of button clicking, and the correctness of interactive answers are captured in a protocol file, and are used for evaluation.
In the second step a questionaire form is involved, which is given to the user in order to obtain information about the user's subjective impression of handling, and his satisfaction with the program.

Conclusion

Performing this project at a university containing a major medical school has the advantage of easy access to professional discussions and advice by experts knowledgable in the most recent developments. Our program is designed to take advantage of this opportunity.
Case-based learning combined with the ability to look up expert knowledge and to learn medical fundamentals in a single, electronic medium are the main advantages of this program.
Multimedia elements, such as animations, support the appreciation of complex medical situations, and they can also add enjoyment to the learning process.

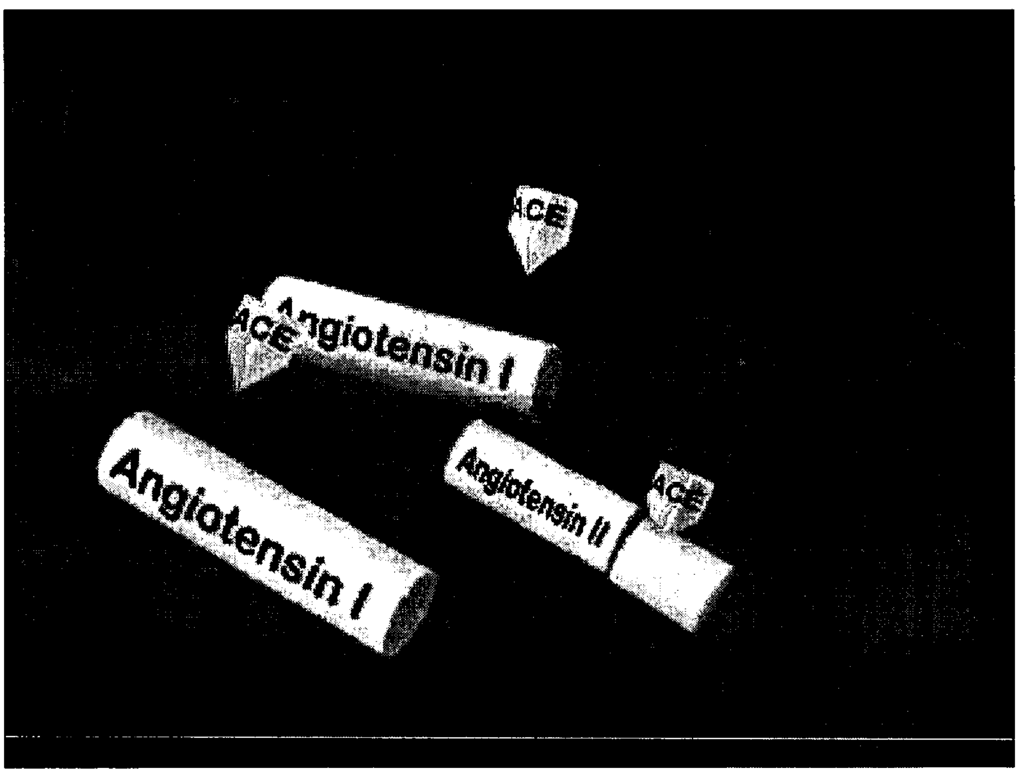

Figure 1: 3D-Animations convey physiological proceedings in medicine

Information Technologies and Quality Management - An Integrative Strategy in the Design and Delivery of Postgraduate courses

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Abstract: Though, advanced technologies such as World Wide Web (WWW), Internet, e-mail, and interactive visual media are increasingly being used for distance education and for public relations or communications purposes, in normal day-to-day design and delivery of the courses in the context of on-campus education, its application appears to be minimal. Apart from its advantages in terms of the speed, convenience and interactivity, these technologies, are expected to supplement experiential learning strategies and meet to some extent, the different individual learning needs and learning styles. This paper explored the complementary nature of information technology to the on-campus face to face teaching mode of learning. By adopting quality management approach with its focus on continuous improvement and student as a customer, this paper argues, that a successful deployment of policies and procedures with regard to these information technologies lay foundations for continually improving education processes for life long continuous learning.

Geoinformation Systems: Education and Engineering Media

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Geographic Information Systems (GIS) can serve as appropriate Media for creating convenient learning, presentation and exploring background for engineering and other branches of human activities. GIS belongs to new and fast growing direction of modern information technologies. They are integral systems, having important range of properties and facilities:

- 2D/3D raster and vector CAD-quality graphics editors;
- multi-layered presentation of spatially distributed objects, sensible to current scale factor;
- SQL graphics database subsystem;
- powerful interactive interpreter of visual structured program language;
- open systems architecture having DDE and OLE mechanisms;
- common GUI, web and paper publishing tools.

GIS can become attractive learning platform, capable to create structured space navigation media filled with objects from any territory distributed area, reflecting various engineering branches: architecture, water/power/gas distribution, telecommunications, transport systems etc.

Institutionalizing Distributed Learning

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The University of Central Florida (UCF) is aggressively developing distributed learning programs, particularly asynchronous learning networks (ALN), to meet the diverse needs of its growing student population. UCF has institutionalized distributed learning by developing the technical infrastructure, providing administrative support and leadership, systematic faculty development, and a plan for ongoing assessment of distributed learning.

UCF has formally recognized distributed learning as a strategic direction to increase access to educational opportunities for students within our service area and beyond. The university has chosen to employ ALN as a primary approach to address the challenges of a rapidly-growing student population, a shortage of classroom space, and the need to maintain quality--all within available resources.

Over the past two years, UCF has made significant investments in technology infrastructure, faculty and student support services, and organizational development to support both regular campus instruction and the ALN initiative.

Institutionalizing faculty development for ALN course instruction has provided cross discipline sharing of teaching techniques and has produced cohorts of faculty across all five colleges who continue to meet and discuss the teaching and learning process and evaluate their successes and failures. The faculty development process has evolved to a model ALN 'course' approach.

In an effort to determine the impact of online courses on both faculty and students, UCF began a pilot study in 1997 to examine teaching and learning in the ALN environment. This pilot study is focusing on five areas of investigation:

1. examining the demographics of students who enroll in ALN courses;
2. examining the perceptions of students who have enrolled in ALN courses;
3. determining the perceptions of faculty toward the experience of teaching in an ALN setting;
4. assessing student outcomes in ALN and traditional environments; and
5. identifying best practice ALN courses on the UCF campus.

To date, this pilot work has focused only on those courses that have been offered entirely in ALN mode with no face-to-face meetings beyond an orientation on the first day and perhaps a final examination. Data from ALN-enhanced format courses initiated in the fall of 1997 are currently being examined. We are expanding and enhancing this preliminary work to a scale that will support the necessary analyses to achieve program success, and to provide valuable information for dissemination to a broader audience.

Interactive Lock-In Simulation

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One of the most often used *nontrivial* electronic measuring instruments in the experimental sciences and in engineering is the so-called *„Lock-In" amplifier.*

Since the instrument is *difficult to understand* and there is only little concise and comprehensible literature covering this topic, there is generally a *lack of knowledge* among the students, as well as the researchers, in the sciences and in engineering.

In order to *remove this lack*, and as an example of the *feasibility and usefulness* of technical, and even *experimental,* teaching on a *university educational level* via the „new" medium *Internet,* the *Interactive Lock-In Simulation* has been created.

Here, for the first time, a *complete virtual experiment*, which is now a fully acknowledged part of the Advanced Physics Lab of the University of Konstanz, is offered for *worldwide access* and use on the Internet via the URL http://fp.physik.uni-konstanz.de/Applets/LockIn/LI1.shtml.

Biology 110 + Biology 120

A Case Study: CD Development for Classroom Use

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The premise of this project is that while the student's ability to directly interact with faculty or to have class time for learning through mistake and repetition is diminishing, an interactive CD has the potential to provide much of that inquisitive experience. To this end we have developed lab books which include an interactive CD for use by students in the General Biology program at the University of Tennessee.

There are several advantages to working in a multimedia environment. First is the ability to utilize graphics, text and video to reinforce a specific concept. Second is the users ability to organize information in a way that is individually meaningful. We chose to present the information using three main outlines. The Directory includes a glossary which allows the student to choose a key word to launch their investigation. In addition we included a Laboratory Tutorial section and a Testing section.

The Role of Digital Intranets in the Development of Collaborative Relations Between a Faculty of Education and Geographically Isolated Schools - A Canadian Work in Progress Report

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Most schools are small and rural in the Canadian province of Newfoundland and Labrador and are far removed from the single local University. Digital intranets provide teachers in small, rural schools and pre-service teachers and their professors in the local Faculty of Education with new ways of teaching and learning from one another. In this process extended links between educational theory and practice are made possible and relations between schools on dispersed sites are strengthened. It is expected that as the Vista School District Intranet is expanded to accommodate further subjects and, with the likely growth of intranets in other school districts, a province-wide virtual school (which will include Memorial University of Newfoundland), will be created. The Digital Intranet project challenges the notion of geographic isolation as an educational consideration while increasing the role of the University as a mediator between local, national and international sources of learning.

Use Of Graphic In Language Learning System

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The sentence parsing with automatic grammar tree building is embedded in the natural language learning system. Our developed approach to parsing bases on the relationship between the natural language comprehension and other psychic processes.

We have developed the interactive system. The student builds a sentence according to the dictionary defined by first. This sentence is analysed by parsing and the result is displayed. For correct sentence the grammar tree is presented and the functions of words are marked by different underlines. Otherwise there is not the connected tree.

The visualisation makes possible to perceive the sentence structure and its components as a whole. The students learn to analyse and generalise the information. The used approach allows to active the student's creative work.

DEVELOPMENT AND IMPLEMENTATION OF NP-ONE MULTIMEDIA LEARNING ARCHITECTURE

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Abstract: NP-ONE, Ngee Ann Polytechnic's Optimum Nurturing Environment is a campus-wide initiative aims to inaugurate various state-of-the-art classrooms to develop our students' potential to their fullest ability. The Multimedia Learning Architecture (MLA) was conceived to support the development and implementation of innovative educational programmes. Our presentation will address how MLA is currently being implemented at the Polytechnic to deliver computerized tutoring and assessment to our students. The discussion will focus on how the architecture supports the delivery and development of component based learning objects.

The notion of OOI, Object Oriented Item is put forth for discussion and call for further study. OOI has been widely used for implementing innovative and pedagogically sound tutoring and assessment items in which learning process has been the focal point. The approach has opened up many forms of item, over the traditional multiple choice item, in which appropriate item response theory needs to be derived for item calibration.

Acknowledgements

The authors wish to thank the Principal of the Polytechnic, Mr. Khoo Chin Hean, in particularly, for his foresight and vision which lead to the actualization of the above.

LETS: A language educational tool for using closed captioned movies

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Planned Demonstration:

We plan to demonstrate an English conversation educational support system called LETS (A language educational tool for speaking-up), which makes use of video closed captioning. LETS consists of a CC extraction device, a CC decoder, a PC controlled laser disc player, and a program running on PC which allows users to a variety of searching for specific dialog. Participants will have the chance to operate LETS and can search for a dialog scene. And the demonstration will show how LETS assists English teachers to use movies in a classroom. We hope to encourage additional creative ideas for further enhancement of LETS. We also hope, through our conversation, to distribute our system to participants to experiment of LETS' effectiveness in actual ESL/EFL classes.

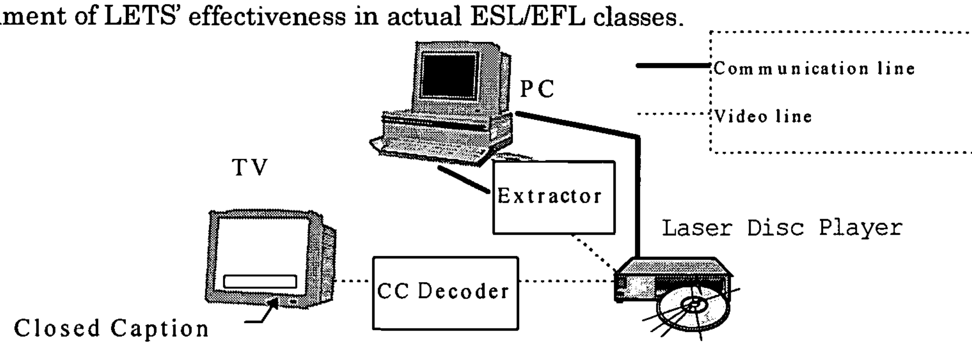

Fig. 1: System Configuration

Problem:

Closed caption is a feature for English speaking deaf people to understand movies by reading English subtitles. Most of video tapes and laser discs sold in North America today have a encoded closed captioning. Closed caption in ESL/EFL has been used as supplemental material. English teachers showed students video movies without closed caption to practice their listening skills, and then would show the video again with closed caption to confirm their listening ability. This method is very effective in teaching natural, everyday English, as video movies have many variety of speech patterns of many different speakers.

However, one of the problems in using videos in the classroom is that we have to search for dialog that suits the needs of the class. It can be difficult to search for exact CC sentences in a video, and to stop the player at the exact location. Furthermore, there are requirements that teachers want to use a huge amount of scripts of movies.

Solution:

LETS makes use of video closed captioning. By using LETS, teachers can make a script database for each CC-encoded movies. Once the database is made, users can search and view a specific dialog scene. LETS allows users to search for dialog in many ways. Some of them are:

(1) Script Display function
Users can view the overall script of the target movie. Each sentence has film's lapsed time and a link to the location on the laser disc. If a user clicks on a certain sentence, laser disc player plays back to the corresponding scene.

(2) Statistical Information
To select the movie for a class text, it is a great help that LETS provides statistical information of the target movie. This function gives the information of the total number of sentences, the total number of words, the total number of punctuation marks, and word lists of appeared order, alphabetical order, length order, and frequently-used order.

(3) Syntax Search function
Syntax search function is used for search for a sentence example of a class. Users can specify one or more words, LETS searches and shows the sentences including the words in such order.

(4) Minimal Word Pairs Search function
The minimal word pair means the pair of words which have a same pronunciation except one letter. For example, "fry" and "fly" are a minimal word pair. When students learn distinguish between two similar sounding letters like R-L, MWP will be a great help. This function search for MWP in the target movie.

Users of LETS can instantly playback to an exact dialog location on a laser disc in any of these specific and instant ways.

Significance of this Work:

Using LETS in a classroom has the following advantages:

(1) Without LETS, English teachers have to watch overall movies to search for appropriate sentences and note the position before class time. Using LETS, teachers can search for the text easily and can show certain scenes repeatedly and skip silent scenes. Therefore, the teachers can teach English in a class more efficiently.

(2) Closed captioned movie script includes a variety of syntax, everyday idioms, and sound-reduction-words. These are important elements in learning English, but hard to teach for one teacher in a classroom. LETS and video movies assist teachers to teach these elements as well as body languages and speech patterns of many different speakers which are also hard to teach without using movies.

(3) Additionally, LETS provides the functions for English conversation education, such as the Minimal Word Pairs Search function, Syntax Search function, etc.

Hypermedia Applications for Programmable Logic Devices Education

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Programmable Logic Devices (PLDs) are very complex devices that can be described using a lot of different non-excluding but related concepts. Usually, PLD education is based on the analysis of specific devices of several manufacturers, but this method is not suitable because it gives only a particular insight.
This work proposes an original method to accomplish PLD education supported by the use of hypermedia tools. The method is not restricted to PLDs but constitutes a general method for complex technologies education.
This method comprises four stages. In the first one, a lot of representative different systems are chosen and analyzed. In the second stage all the common characteristics (basic concepts) are determined. The third stage comprises the definition of the particular characteristics (subconcepts). Finally, all the basic concepts and subconcepts are structured to obtain a *descriptive model*. This model combines the concepts in such a way that any commercial systems or device can be described from it.
The analysis of a lot of different PLDs led to the descriptive model shown in Figure 1 [MANDADO 96][ALVAREZ 95].

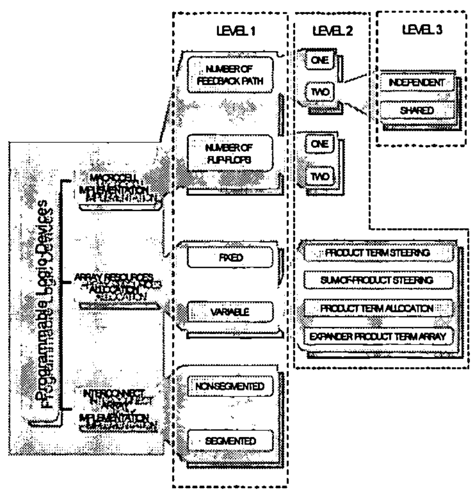

Figure 1: PLDs structure descriptive model.

Although the PLDs descriptive model is very helpful, it can not be analyzed sequentially because it is frequently necessary to come back to previous concepts. This constrains turns *hypertext* into a very useful tool for PLDs analysis.
The principal advantage of hypertext documents is that they are non-linear documents that can link with other documents and software. At the same time they can be combined with powerful audio-visual resources to develop a hypermedia application [TERRY 94]. In the case of PLDs their great hardware complexity demands the use of a lot of graphic information for the better understanding of their architectures.
Taking into account all the above considerations, we developed a hypermedia application oriented to PLDs education. This application introduces the descriptive model of the technology (Figure 1), combining a lot of audio-visual resources to help students during the learning process.

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Integrating Technology into the Curriculum: Strategies and Steps

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It has been argued that technology should not be used to teach without first considering the teaching methods involved [Ehrmann 1995]. Carroll suggested further that to be effective, technology must be fully integrated into the curriculum planning process [Carroll 1997]. This poster session will outline the development and application of such an approach to the integration of a multimedia CD ROM and a presentation package into a first year nursing course. The technology was used to shift the focus of learning from memorizing abstract facts to the application of information in a real life context. The following five questions were used to guide this process: *Why use technology? What technology should be used? How should the technology be applied? What outcomes are expected? Does the technology make a difference?* The five questions will be used to incorporate suggestions for improvement and to make subsequent revisions to the curriculum. The process is iterative and continuous. Consequently it is anticipated that the full potential of the technology will unfold over a period of time.

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Using the Teaching with Technology Instrument (TTI) to Assess Technology Staff Development Needs of Teachers in a School District

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The Teaching with Technology Instrument (TTI) was developed to assess teachers knowledge and classroom usage of technology. It was validated using 155 teachers, and contains forty-six items in three areas: writing and communication, information access and management, and construction and multimedia. Each question requires a Yes or No answer. The TTI was developed to assess the types of technology training a school needs to offer. The resulting printout consists of bar charts of the responses to each of the items. An administrator can turn the printout on its side, and see the school's needs by interpreting the bar charts. By identifying all the items with a low percentage of Yes responses, you can identify areas that need targeted staff development activities. Using an instrument like the TTI will result in more appropriate staff development activities for teachers, and an increase in the effective integration of technology into our schools.

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Kanji Compound Learning System for Supporting Teacher's Needs

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Recently teaches can be easy to get various CAI software, which are sold at bookstores or can be got from educational organizations. It is more effective for students to learn by both CAI and teacher's lecture at a same class. But it is not so simple to incorporate CAI software and a lecture in the same class. There are some problems as follows. As CAI system supports highly individual learning, there is a barrier of practical use at the class. The present technique of CAI is not so perfect and flexible as to add each teacher's necessary functions to a system. So we solve this problem by allowing teachers' customization. Main objectives of CAI incorporation in the class are to reduce the teacher's charge and increase the learner's learning effectiveness. We focus on the kanji compound CAI system for Japanese language.

EXPERIMENTS IN VIRTUAL SUPERVISION

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Abstract: Computer-mediated communication offers the opportunity to teach outside the conventional settings of the classroom, the tutorial or the faculty office. But we know little about the social, linguistic, educational or emotional forms of relationship that are a consequence of virtual teaching. In this paper I will look at the use of First Class conferencing used to create a virtual culture among research students and as a vehicle for supervision/advising.

Delivering Laboratory Instruction Through Interactive Multimedia

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The Marine Estuarine and Environmental Science (MEES) Program of the University System of Maryland is an interdisciplinary and inter-institutional graduate program. The program is designed to access educational and research expertise throughout the 14 Universities, Colleges, and Centers of the System. There are currently 270 students and 125 graduate faculty participating in the MEES Program distributed throughout the State of Maryland. An interactive video network is used extensively for delivering courses and holding committee meetings. Laboratories are important to MEES students because our science relies heavily upon observational, analytical, and numerical studies. To effectively deliver laboratory instruction, we have linked the internet, the web, email, video, and traditional computer-based training in modular format. Within this hybrid computer based training system, each laboratory module emphasizes self-assessment, self testing, application, and discussion. Except for a final examination or practical experience, the learning is enabled and mediated by computers.

A Collaborated Composing System for Musical Education Using Internet and MIDI Technologies

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Musical composition is one of the most important theme in music education. A System based on Internet and MIDI technologies can support the theme. When each student belongs different schools, students can exchange their musical performance using this system.

In this system, two computers, one is called "sender" and the other is called "receiver," work collaboratively. When student performs musical instrument, the sender encodes the performance into MIDI data and transmits to the receiver through the Internet. The receiver receives the data and analyses them, then it plays musical instruments and writes scores.

We try to use the RTP [Schulzrinne et al. 1996] protocol within this system. Since the RTP is a UDP based protocol, it is suitable for real-time transmission. And more, the RTP has facilities to recover against above troubles.

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Implications Derived from a Case Study of Teachers' Understanding and Use of the Internet as It Relates to Curriculum Changes in a Middle School

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We are in the midst of a technological revolution which is impacting education and society. The Internet has profoundly influenced how people communicate, access databases, and share information. Educators should view this revolution and its curriculum implications as important because the changes will affect the very nature of teaching.

In this inductive case study discoveries revealed how middle school teachers understood and used the Internet as it related to curriculum change. The research took place in a natural school setting so that from this, the teachers' real-life, everyday experiences could provide insight into educational practices.

The data demonstrated that the power and hope of the Internet is its daunting ability to allow and facilitate collaborative efforts. These efforts are inherently dependent upon adequate funding of technical and support personnel, strategies pursued in learning about the Internet and technology, and integrating curriculum applications.

Immediate Feedback to Your Cloze Exercise

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Abstract: A weekly grammar and vocabulary multiple-choice, cloze exercise WEB site with broadcast news transcript content provides advanced ESL students with immediate feedback regarding the correctness of their selections. NetForms produced by Maxum Development enables the response to bounce in fdml format from a cgi-based folder in the MAC server to the student within 5 seconds, depending upon connections and distance. Contextualized vocabulary and grammar are selected from a listing of all selected words or grammatical distractors in comprehensive multiple-choice format.

The Activity

Language Center director and staff at BYUH produce a weekly grammar and vocabulary, multiple-choice, cloze exercise WEB site with broadcast news transcript. Selected vocabulary words are chosen with a preference for commonly-used words nestled in matching contextual environment, offered in a multiple-choice listing of all selected words (usually 10-20) in the passage. Grammar study is also multiple-choice, cloze-based, with grammar selected according to the contextual offering and requests of the international student audience for a specific study, typically consisting of articles, clauses, conditionals, connectors, infinitivies/past and present participles, direct/indirect speech, modals & auxiliaries, passivity, prepositions, singular/plurals, tag questions, verb forms, verb phrases, verb tenses, or word forms. The cgi-based (fdml) response provides advanced ESL students with immediate feedback as to the correctness of their selections.

NetForms Source

For creating cgi-based feedback from your MAC server, contact the following.

Maxum Development
820 South Bartlett Road - Suite 104
Streamwood, IL 60107
EMAIL: info@maxum.com
http://www.maxum.com/

IntegratingTechnology into the Foreign Language Teacher Education Program - A Model from the U.S.

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Even though researchers in second language acquisition have not yet fully explored the implications and ramification of using current technologies in the foreign language (FL) classroom, the integration of computer-based technologies into FL curricula shows promising new possibilities for global communication. As a consequence, foreign language departments such as ours should launch a curricular initiative to incorporate a new course into the existing curricula for its teacher education tracks in French, German, Russian, and Spanish.

Based on the changing paradigms in the U.S. educational system, recent research on the efficacy of technology in the FL classroom, general pedagogical concerns, and logistical feasibility, the presentation proposes a theoretical framework for a technology course and identifies crucial technology-related elements to be included in FL teacher preparation programs. Although this presentation introduces and elaborates on a course model geared towards the U.S. educational system, the underlying ideas and concepts are flexible allowing modifications for other cultural, linguistic, and instructional contexts, and the adaptation of emerging technologies.

CORPORATE PAPERS

DISTRIBUTED EDUCATION FRAMEWORKS

A Method for Structuring Distributed Education Development

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Abstract: As the competition for the education dollar increases, educational organizations are reinventing themselves in farther-reaching, more distributed ways. For many, the distributed education direction is both confusing and expensive. This paper summarizes a method, employed by IBM's Pacific Development Centre, to help organizations grapple with rapidly changing education delivery environments. A distributed education framework is a tool used to structure ongoing and continuous development of distributed education solutions. A framework helps to structure the distributed education mission ; such that both management and technical staff understand the strategy using simple models. Once created, a framework can be used to support technology selection, budgeting, and visioning efforts. Frameworks have proven to reduce the cost of development, and to increase the adoption of a common vision, and to reduce the number of products/tools evaluated in the development process.

1. INTRODUCTION

We are undergoing a technological revolution in the delivery of education. In this time of innovation, it is important that educators never lose focus on the processes at work in the education industry. To realize the potential of applied technology in education, we need to move beyond passive absorption of facts to fully engage students in complex and meaningful tasks linked to predefined learning outcomes.

A distributed education framework is a tool used to structure ongoing and continuous development of distributed education solutions. It links the technology available today with the goals and objectives of the learning organization—providing a common point of reference for future decision making or exploration.

The primary objectives of a distributed education framework are to:

- describe current and planned distributed education business as envisioned by the educational organization;
- incorporate available technology components with the educational constructs, process directives, and flexible course creation/delivery requirements;
- describe criteria, principles, and guidelines for selecting technology components within the framework;
- determine and document technology components and processes that are missing, without which the organization cannot effectively offer a distributed education delivery program; and
- provide a common point of reference for ongoing development efforts at both the technical and management levels of an organization.

As an education solution provider, the IBM Pacific Development Centre fields requests from a variety of organizations pursuing distributed education strategies. Most organizations find themselves asking questions such as:

- *Is there a framework that an organization could use as a basis for discussion and development in the evolution of a distributed education vision?*
- *Which technology components should we evaluate now, and how are these technologies related to the education process as well as other technologies we have in place today?*
- *Are there technology infrastructure components which are common to all or most distributed delivery methods, and if so can this infrastructure be shared by multiple organizations?*

These are exactly the types of questions being addressed by IBM's Pacific Development Centre in cooperation with Universities, Colleges, Schools, and private organizations.

2. BACKGROUND

The framework development process has evolved from a number of internal IBM activities (such as the IBM Global Campus and our ongoing development efforts), as well as through consultation with various external clients.

What started out as a simple method used to categorize and compare the issues confronting organizations considering new education delivery systems, has now evolved into understanding and documenting the distributed education organization itself.

Initially, it was felt that IBM could help capture a current state "snapshot" and map it to a new environment, and a new organizational direction. However, in practice we found that most education environments were changing too rapidly, and detailed technology comparison and analysis was not always possible in the time available. We needed to be able to point various levels of an organization to a simplified model while simultaneously helping to build it. Furthermore, we needed to match overlapping efforts across organizations as there are plenty of opportunities to share and reapply skills, and products, within the Pacific Development Centre and across IBM globally.

One of the guiding principles of the Pacific Development Centre's distributed education framework is that "technology-based learning should complement traditional instruction—not replace it." Computer-assisted, self-directed, electronically-mediated learning may work for most students, but not all. Similarly, it will work for some institutions but not for others.

Pacific Development Centre education framework consultants work with academic institutions to understand where distributed learning is the most appropriate solution, what tools best meet the business model, and how new tools can best be integrated. This is an evolving process, which will continue to change with the dynamics of the education industry. Our experience has shown that this process of establishing a distributed education framework requires between forty to sixty days of effort to complete with contributions from most levels of an academic institution.

3. UNDERSTANDING DELIVERY HISTORY

With respect to distributed education frameworks, the adage "in order to understand where you are going you must know where you've been" rings true. To change any organization, we require an understanding of the business history of that organization: its successes, its failures, and the lessons learned through that discovery process. With the benefit of historical perspective, we can instruct others to follow a new path and encourage the growth required to shift from one paradigm to the next.

In spite of pessimists who suggest that education institutions rarely change, studies show that technology (a constantly changing variable), was introduced into pedagogy well over thirty years ago. A closer look at the history of education delivery systems often reveals a series of intriguing trial balloons and conservative yet evolutionary changes. Where new delivery models have been driven by economic or social backlash these changes have sometimes been radical, even ahead of their time, in some cases.

3.1 FRAMEWORK APPROACH

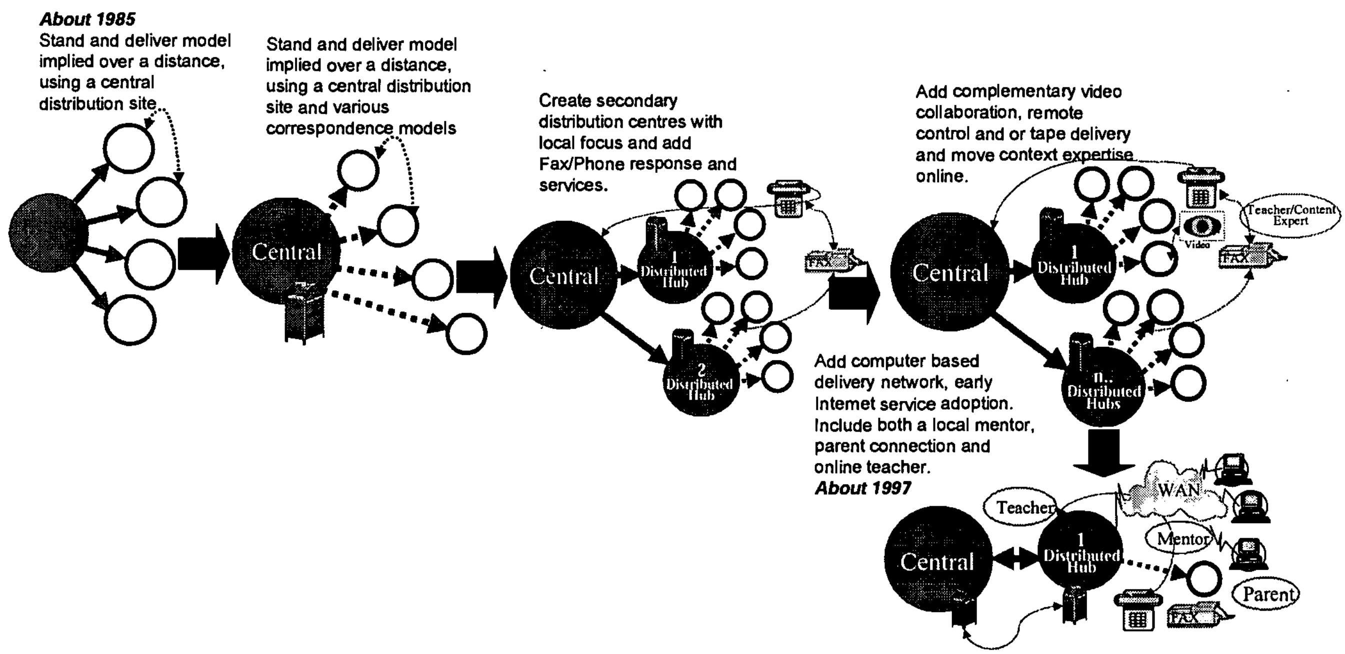
This framework methodology relies heavily on the recent education delivery history of an organization. We track where changes have occurred, how well those changes were adopted, and what shortcomings were observed. We begin our design of a new distributed education framework by assessing past delivery methods and how these delivery models can be conceptually described. This modeling effort shows us that there are distinct themes at work in every distributed education delivery process.

Two immediate observations can be made from the models described in this section: First, there are likely as many delivery models as there are institutions, making for a huge variety of distribution systems; and second, it is clear that although technology has significantly impacted delivery methods, the overall delivery philosophy remains much the same within an institution. We conclude through this analysis, that the principle objective of distributed education is not delivery of information (since technology could have altered that process over the period shown), but the creation of connected communities, where teachers, students, and peers can discuss, debate, and communicate information in an open manner.

For some organizations just considering a distributed education business, the models are much simpler and easier to discover. However, as we evaluate the way people learn, it is clear that it is the history and a culture of learning within that organization which most influences the learning model.

In the following example several models are shown which describe the delivery progression of one organization over the past ten years.

Figure 1 - History and Progression (Common Models)



4. UNDERSTANDING THE BUSINESS DRIVERS

The competition for the shrinking education dollar is fierce. Many education institutions are finding that their traditional market is smaller as students discover a plethora of global education options made available by emerging technology. The Internet and private Intranets are two technologies revolutionizing the education industry. The demand and opportunity for Internet based training have led some educational organizations to consider reinventing their entire delivery process, in preparation for the distributed future—partnering with technology companies, other institutions, and their students to help manage this transition.

Technology is clearly a driver in this revolution. Consider the following statistics to understand why education communities are scrambling for an Internet based technology infusion:

- A report by FIND/SVP and Grunwald Associates based on a survey of 2,000 households, reports that almost 10 million children are using the Internet. "This translates to 14 per cent of the approximately 70 million children under 18 in the U.S. Nearly half of the children currently access the Internet from school, and most of them use it for school or homework. "There will be a fundamental shift in the market in late 1998 and early 1999 when more children will go on-line at school than at home."[1]
- In Canada, 4.12 million adults now use the world-wide-web one or more times a week. That's 19.3 per cent of the population, a massive jump from 9.7 per cent in 1996. Use by men jumped 70 per cent, while women's use increased by 182 per cent in the same period. Canadians aged 18-34 doubled their use, while those venturing on-line tripled among the 45-and-older set.[2]

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1 Peter Grunwald, President of Grunwald Associates. 1998, Emerge Online News Service.

2 ComQuest Research, BBM Bureau of Measurement. 1997, Emerge Online News Service.

- In British Columbia, statistics show that almost 7 in 10 people in this western Canadian province use a computer and of those, 72 per cent have been on the Internet. Half of all people in British Columbia have used the Internet at least once. Those on-line are likely to be young, have a steady job, have some higher education, and live in the city. Of those that are on-line, 80 per cent connect to surf the Web, 62 percent use it for e-mail, 32 per cent read discussion groups, and only 9 per cent can be found in chat rooms.[3]

Along with increasing access demands, educational organizations are being pushed to deliver more efficient service, greater and more open access, more effective learning with greater education value and accountability. This is a nontrivial undertaking for any organization, and such drivers have the potential to consume nearly every available resource.

In order to reduce the confusion generated by these pressing demands, we focus the organization around business principles. Principles are attempts to translate technical alternatives into key ideas that can be effectively organized and evaluated. Principles can also be used as a "yardstick" to evaluate how closely a potential technology component meets the needs of the organization. In the following example we establish principles related to Pedagogy, System Functionality, and Technology for *Company X*.

4.1 PEDAGOGY PRINCIPLES

The following is an example of a pedagogy principle:

Principle 1: Education Process First, Technology Second

Technology projects, whether a research project or an application, must be grounded in the values of *Company X*. These values guide our education business— a business of providing distance education and distributed learning. It is therefore essential that selected technologies reflect our educational practice and processes first and the technology itself second in the delivery process.

4.2 FUNCTIONAL PRINCIPLES

The following is an example of a functional principle:

Principle 2: Ease of Use and Delivery

While the organization makes extensive use of technology, and through the effective application of technology has a gained some market recognition, *Company X* is not a "technology organization". Therefore every attempt must be made to ensure technology is easy to use, apply, and support across the environment. To support this principle we must:

- Reduce the cost associated with maintaining a large and diverse group with specific technology skills. This will be done by creating a culture of technological literacy, skills to self-teach new technologies, and to make intelligent technology selection; and
- Apply technology, that improves educational or working experience, without complication. As such, the benefits of any technology must be weighed against any and all costs of the implementation, including training time, changes in productivity levels, user satisfaction, and quality of product.

4.3 TECHNOLOGY PRINCIPLES

The following is an example of a technology principle:

Principle 3: Improve portability and scalability of Applications

Company X will acquire and support applications that adhere to this technology framework. These applications will be portable, allowing for movement across heterogeneous computing platforms with little or no modifications. Client portability is a particular concern for both K-12 and Higher Education, where Mac OS, Windows95, and Windows 3.1 each hold a substantial market share. This concern has begun to be described as the "Single Window Design" where courses and services are made available through an industry-standard browser technology.

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[3] Angus Reid, 'The penetration of the Internet in British Columbia', study completed in December 1997, reported in February 1998, Emerge Online News Service.

5. DOCUMENTING THE FRAMEWORK

Once we understand current education delivery strategies and what processes need to be more effective, we can conceptualize a new delivery model for *Company X*, that combines the lessons learned with current organizational values. We attempt to determine the essential delivery components and how these components interrelate with our delivery process. The result is a conceptual model that conveys the spirit of the planning process, future direction, and the interrelationship of the people addressed in the model.

5.1 TYPICAL FRAMEWORK

A typical framework model will have at least six primary components depending on the organization and delivery drivers. The original IBM Global Campus Framework (Figure 2) created in 1996 combined ten major components, which has evolved into the six component model shown in Figure 3.

Figure 2 IBM Global Campus Framework

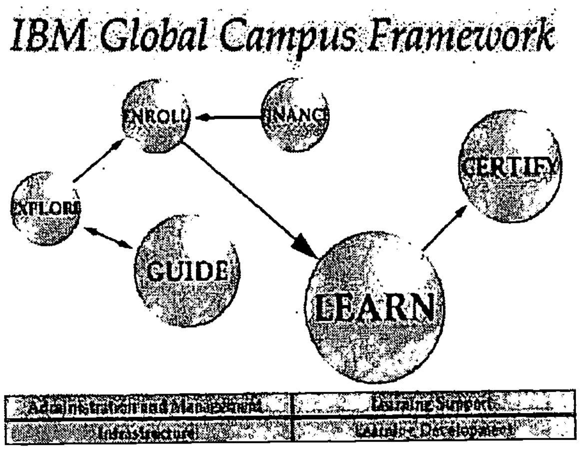
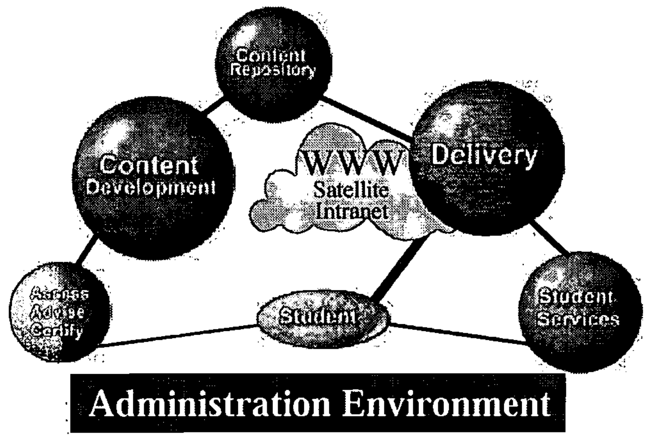


Figure 3 PDC Framework



5.2 FRAMEWORK COMPONENTS

Each component must be clearly defined. The functional areas described in the PDC Framework closely reflect software/hardware developments in the education market. Of the five functional areas shown in this model, four— Content Development, Content Repository, Delivery, and Student Services— seem to appear in nearly every framework. These components have detailed descriptions and process relationships that are not described in this document due to space constraints.

Once a framework definition is established, it is important to communicate the direction as widely as possible. We have found that a collaborative web site works well for this activity and allows the most amount of feedback across the organization.

5.3 COMPONENT EXAMPLE

The following example describes some of the characteristics of a typical component. Application areas associated with this component are defined and linked to existing delivery processes. Each component contains specific application sets, which are then mapped to standards, products, and tools available in the current marketplace.

Data Structure, Content Storage, Data Management, Rights Management, Search and Access, Content Synthesis, Digital Library.

5.4 REMAINING PROCESSES

With the completion of the framework model, the organization can begin the process of integrating the model into the working environment. We have been continually surprised by the number of applications for these simple models when used to convey education direction within an organization. For example, when we used a framework as part of an Intranet discussion database, we found that both management and the development community made use of the model quite quickly. Some users copied the first bitmap image into their working papers, prior to making a funding request, to clearly describe what they were working on to management.

The framework consists of a number of parts other than the component model itself. Used as a project planning tool, the framework should see several other essential planning steps documented. Additional steps include:

- Mapping existing and proposed applications to the model;
- Establishing technology standards checklist by component;
- Establishing performance measures for business change;
- Listing technology and process gaps;
- Business model/case for deployment;
- Estimating the cost of development by component; and
- Testing and Integration planning.

Each of these activities can be as detailed as resources and time permit.

6. CONCLUSIONS

Having completed several framework strategies within our customer base, the Pacific Development Centre has drawn the following conclusions about the process. They are:

1. There are many confusing and often complex approaches for distributed education delivery in use across the education industry. In order to reduce confusion and risk, it is valuable to conceptualize the desired delivery process in the form of a framework, prior to embarking on a new delivery paradigm.
2. A method, which conceptualizes the distributed education mission in simple models, can help to translate the vision across an organization very quickly. The sooner everyone adopts the vision, the sooner the organization can stake its claim in our high competitive education marketplace.
3. A framework can reduce overall development cost for organizations attempting to implement an end-to-end distributed learning system. This is accomplished by focusing development effort on a common vision, by reducing the number of products and tools evaluated in the development process, and by early recognition of gaps and missing components.
4. Some components of the distributed education framework are common to most organizations. This presents a new partnership opportunity for similar organizations, where joint funding of a project can lead to wins for both parties.
5. All of us have something to learn, as well as something to teach. If only used as a common reference point, a framework allows us to demonstrate and possibly share common visions and skills. As current technology skills are often at a premium, organizations with similar reference points can quickly see the opportunity to share skills and experiences. This has both cost reduction and effectiveness benefits for the education organization.
6. Technology is a rapidly moving target. If the educational organization leads its distributed education mission with trial technology balloons, they risk losing the pedagogy in the medium. The full spectrum of education and training requires that we fully utilize the strengths of network computing, education processes, and the growing range of skills within the industry, to provide an effective distance learning solution. This development process must remain stable yet highly flexible, adapting to a rapidly changing education market and technology evolution. The framework method allows organizations to regularly revisit processes and functional components as technology opportunities present themselves.

7. REFERENCES

[IBM 1996] IBM Global Campus is an IBM education and training strategy for educational organizations and can be reviewed at http://ike.engr.washington.edu/igc/ and http://www.training.ibm.com/ibmedu/announce/frame.html

[Open Learning Agency Of BC/IBM, 1998] The Open School, Distributed Education Framework -Joint IBM/OLA strategy for distributed education delivery March 1998.

PANEL PAPERS

Playing the MOOstage: Theatricality As/In Interactive Online Environments

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When Shakespeare wrote "All the world's a stage/ And all the men and women merely players" (*As You Like It*, circa 1600) he could hardly have known the stages human beings might inhabit at the end of the 20th century. Close to four hundred years after Shakespeare wrote those lines, the stages on which men and women play are no longer limited to physical platforms in large rooms or open air spaces. The advent of radio, film, and television brought stages for mass transmission of human players in action, and the development of networked computers added cyberstages as arenas on which women and men might play. One such powerful stage is the synchronous MOO environment, about which Shakespeare's descendant might write "All the MOO's a stage since all the men and women are player objects."

MOOspaces and interactions are inherently theatrical. Like a stage set, each room is designed and filled with objects intended to create an atmosphere that colors the interactions and possibilities within it, establishing a context for the action that occurs there. Like a theatre production, each interaction is comprised of a set of performed words and gestures that creates the character a player wishes to inhabit. Further, as the players define their characters through descriptions, moods, and entrance, exit and other messages, they inform their interactions with elements that create textual costumes. Defining MOO as a theatrical environment foregrounds the interactions in the space as collaborations: collaborations between the players and the characters they inhabit, between the participants and the environment, and between the participants themselves. In turn, viewing MOOspace as theatrical allows us to utilize MOO as a means to explore the nature of the interactions that take place there through what A.J. Austin called the performative. This concept of a semiotic action that constitutes rather than expresses being is particularly effective in an environment where the central referent for an individual is the written speech displayed on the screen rather than the physical body generating the words. One educational benefit of the newly developing field of theatre production in MOO is that it provides an opportunity to examine instances of intentional performativity. Creating a performance in MOOspace illuminates the similarities between identity-formation (as opposed to expression) through speech, gesture and costume on a literal stage and the means utilized to do the same in social interaction on the MOO stage.

The many ways that theatre in MOO differs from production on traditional physical stages necessitate the creation of new conventions for performance. The means by which spectators perceive setting, costume, dialogue, plot, and character are primarily through reading text onscreen, although some MOOs do contain graphical elements. This locates the experience of MOO theatre somewhere between that of reading a novel and watching a traditional theatre production with one crucial difference. In few other situations does the spectator, by virtue of the environment, have the opportunity to interact directly with the performers and the performance space. Interaction between performer and audience is at the heart of the theatrical experience. Traditionally, a distinction is made between theatre and film because filmed performers cannot respond to any stimuli provided by their audiences. In the theater where audiences are generally separated from performers by their physical location in seats facing the stage and by the darkening of the auditorium, spectators' communication with performers is limited to laughing, clapping, or shouts of encouragement. The nature of MOO interaction extends the notion of communication between performer and audience. In MOO environments, a player's presence is made known by the action of typing to communicate. MOO spectators can log in and be completely passive during a performance, simply reading their screens, or use the emote command to laugh or clap--an experience analogous to that of a film or traditional theatre. But MOO provides a performance environment in which the separation of actors and audience is sharply reduced; those accustomed to the interactivity of MOO expect opportunities to directly participate in exchanges held there. Thus, in the traditional sense of an audience shaping a performance with reactions, MOO creates unique possibilities for collaboration between actors and spectators that directly effects the experience. A MOO is created not only by those who interact there, but by those who design, decorate, and program the room objects. The theatricality of these objects distinguishes MOOs from the literal enactment of daily life and establishes them as a stage set upon which players interact and the play, as such, occurs.

Cyphertextual MOOrauders: Reading with Others, Writing in Time

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In recent years technology has enabled educational interactivity in exciting ways. Examples include hypertext, WWW, email discussion lists, newsgroups, chat rooms, IRC, and audio/video conferencing, among others. Clearly when texts are interactive, new modes of teaching and learning evolve. Interestingly, with respect to reading and writing, we often still perceive interaction in passive ways. That is, we often view interaction as one-sided or asynchronous, just one step beyond simple reading of a printed text. We interact with buttons or links on a webpage. We navigate through a hypertext. We send and receive asynchronous messages via email. MOOs are, however, enabling us to reconceive interactivity. The MOO's potentiality, i.e. its untapped time/space integration of interactivity and collaboration among individuals and the MOO environment itself, beckons.

In the MOO, the player (who is at once writer and reader at the same time) negotiates a number of modes of interactivity at the same time. That is, much like we understand multi-tasking in a computer environment, where we navigate between and among various windows and processes, MOO persona toggle between modes and roles. Part real-time, part asynchronous, from writer to reader to writer, actors are acting a part or emoting an action or feeling. Not only this, but MOO client programs (and some inMOO telnet gateways and interMOO communication channels) enable players to multi-task on a number of MOOs simultaneously (with the same number of inMOO modes of real-time and asynchronous activity going on in each MOO). Across domains and time, MOO players inter-act and inter-talk while at the same time paging players in other rooms, in other MOOs--all of which is interspersed with composing, programming, editing, mailing, and other multiactive, interpassive writing and reading with other multi-communicating players, bots, programs, and morpho-logical, cyphertextual beings.

Thus, our presentation aims to split open the question of interactivity by discussing synchronous publication in MOOs and how writers of texts 'published' in MOOspace are writing 'in time'; and readers of texts in MOOspace are reading 'with others,' including the author(s)--a combination of reader, writer, and MOO environment that we call "cyphertexts." In addition, we consider the implications of redefining interactivity across a "working" model known as multi-tasking, carrying the reality of multi-active modes over into cyphertextual spaces in MOOs. As publishers of synchronous texts, and as authors of synchronous texts, we seek to unmask textual interactive marauders by rethinking the nature of interactive reading, writing, and publishing via the notion of cyphertext.

Collaborative Virtual Space: Pedagogy and the Presence of Others in MOOs

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Educational technology has changed dramatically in recent years, and the use of networked technologies in particular has altered how we conceive of technology as a pedagogical tool. However, even today, with the Internet and the World Wide Web, technology only infrequently increases students' interaction with one another and with the instructor. This limitation with respect to educational technologies is perhaps best seen in distance education programs. Distance education has found many ways to make curricula flexible and to deliver material despite geographical and scheduling obstacles. However, many distance education technologies, such as compressed video and telephone bridges, allow primarily for interaction from the instructor to the student or the student to the instructor. Rarely do such technologies facilitate student-to-student interaction and collaboration. Courses based on the World Wide Web are striving to overcome these limitations, and with everything from CGI submission forms for questions to Web-chat, such classes are able to effectively bring interactivity back into the educational process. However, as distance education initiatives grapple with the challenge of providing a complete education to far-flung students, they find themselves facing the simple fact that it is easier to move a knowledge-based class (such as a programming course) over distance than a discussion-based class (such as a literature class).

Humanities disciplines base much classroom activity on the notion of interaction, and this is perhaps why humanities disciplines have been among the first to see the educational possibilities of the more interactive technologies available. In particular, MUDs--and their end-user programmable relation, MOOs--hold increasing appeal for teachers. MOOs are based on collaboration and interactivity; like any networked classroom equipped with synchronous communication software, a MOO creates an environment where participants create and contribute to multiple discussion threads. Computer-mediated-communication, whether on a LAN or across a WAN such as a MOO, allows for increased amounts and kinds of discourse, not to mention modes of collaboration.

Participating in a MOO is by definition a collaborative activity. Whether by writing with others through conversing and storytelling, or by manipulating the database through examining objects and exploring rooms that someone built and described in a previous visit to the virtual world, a MOO participant always and constantly confronts the presence of others. These synchronous and asynchronous collaborations with other participants are collaborations with other writers, and it is the importance of this textual "other" that stands to teach us so much about how users collaborate and interact effectively in MOOspace.

The pedagogical effectiveness of collaborative learning has been addressed for the past several decades. The text-based environment of the MOO urges us to consider such research in conjunction with the work done by writing theorists on the importance of writing and reading. That is, writing is a component of the process of self-definition, and writing theorists from a variety of perspectives have examined how composing allows the writer to work through and among versions of the self. This dynamic of "writing the self" becomes literalized in the MOO environment. Online, a participant decisively constructs a persona, and then moves that characterization of the self into interactions with others. This self is necessarily a social one; since the MOO is by definition a collaborative environment, writing in a MOO is necessarily a collaborative act, and MOOing is collaborative writing.

There are clearly more and less successful versions of MOO collaboration, most of which hinge on the kinds of interactions users have. As in any CMC exchange, MOOing can lead to a variety of educationally ineffective moments. This paper takes the position that narrative theory provides a useful way to consider the relationship between reader and writer, and thus MOOer and MOOer. The presence of others in printed text provides a departure point for considering how we might assess our responsibilities as writers in online environments. By theorizing the nature of collaboration and interaction online that is predicated on the presence of others, we can begin to understand how it is that users learn to MOO in productive ways, and, consequently, how we can best adapt such virtual worlds to educational uses. Particularly, as MOOs evolve into more graphical formats (and those MOOs with web interfaces are already text/graphic hybrids), a detailed theoretical understanding of interaction and collaboration in virtual space is necessary in order for the design of emerging virtual environments to be as pedagogically productive as possible.

Cross-Cultural Awarenets

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Abstract: The panel discussed the personal dynamics of global Internet partnerships. The presenters of this session served as facilitators for their students from Germany and Turkey who participated in eight-week worldwide communication Internet projects over the past few years. The application of global computer networks is breaking new ground in education, utilizing flexible learning techniques, and importing an international dimension to the classroom. This presentation concentrated on the development, organization, and assignments of the project. It also focused on the learning gains and reactions of the student participants.

Historical Overview

Over the past three years, the three presenters have been involved with the Cross-Cultural Explorations and Dialogue Project (CCED) organized by the University of Tartu in Estonia. CCED is an eight-week Internet-driven project involving university teams from around the world. Students involved in the project utilized new and innovative learning techniques as they corresponded via e-mail and Internet Relay Chat. This added a new dimension of reality to their communication as they interacted with peers and colleagues at universities in Peru, Estonia, Japan, Bulgaria, Spain, and other countries. Students overcame the barriers of time and distance limitations in learning as they expressed their opinions at will to others around the globe. The project additionally encouraged student autonomy by inviting student input throughout the duration of the project.

Panel Content

Objectives of CCED

The objectives of the CCED were to:
1. communicate with university students around the world;
2. promote participation in communication networks and foster international cooperation and understanding;
3. understand the fundamental charactersitics and applications of electronic communications technology; and
4. collaborate as a team on problems, ideas, and issues, and then respond with a team consensus using the Internet.

Summary of the Project Syllabus

The project contained a series of assignments designed to help students explore their prejudices, cultural misunderstandings, stereotypes, and misconceptions. All students subscribed to a group mailing list where weekly assignments were posted. Students first discussed the assignment in their group and then presented the results of their discussion, views, or questions to the other groups via an e-mail message. Students were also given the opportunity to voice their individual response, or related concerns to others in the project via a separate open-discussion type mailing list. Students were challenged to respond to prejudices and misconceptions about themselves and also voice their conceptions of other cultures.

The culminating activity of the project was an on-line conference via Internet Relay Chat. Here students participated in a cultural simulation simultaneously. They were also given the opportunity to put into practice some of what they had discovered over the previous weeks of the project.

Learning Outcomes

Different methods of evaluation of this project were used. Students engaged in a debriefing session within their group. Here they were able to comment on what they learned from the communication experience and evaluate Internet learning. Debriefing helped students synthesize the knowledge gained during the project.

Another way of viewing the learning was the analysis of the comments of various participants in the project. Such analysis showed that students became more autonomous in their learning by offering topics for discussion and engaging in more natural and authentic conversation. They were also able to formulate conceptions of their own cultures which allowed them to more easily comprehend the similarities and differences of the other cultures involved in the project.

The project offered more than just a cultural awakening. It provided students with greater control and initiative in their language learning. As described in [Warschauer, et al. 1996] students were able to initiate conversations and discussions with other students any day or any hour resulting in increased student-to-student interactions. This resulted in greater student enthusiasm, motivation, and dedication to the project. The project evolved and took shape due to their efforts. It was a product of their creativity, not a pre-conceived curriculum or course syllabus. It provided an authentic forum for the interpretation and application of their new ideas.

These projects further provided a variety of other benefits: equal access to learning for all students, development of writing skills in their second language, new and better means of learning (the collective experience) increased cultural sensitivity, understanding of the commonality of the human experience, self-reflection, and the understanding of the fundamental characteristics and applications of electronic communications technology. See [Warschauer, et. al 1996] for further information on these findings.

Literature References

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Acknowledgments

The members of this panel are deeply indebted to Cross-Cultural Explorations and Dialogue Team of the Active Learning Center of Tartu University, Estonia for the creation and dissemination of this project.

Scaffolding Constructivism in the Learning of Complex Knowledge: International Perspectives on the Design, Use, and Evaluation of Advanced Technological Learning Environments

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Overview of Panel Topic

A variety of substantive issues confront education with respect to helping students learn increasingly complex knowledge mediated by various emerging and existing technologies. How can students acquire and maintain deep understandings about difficult topics? How can a wider range of students be successful at learning? How can we better prepare students to use and apply their acquired knowledge in new situations and contexts? How can we appropriately evaluate enhanced technology mediated learning outcomes both for individual students and for large-scale assessment purposes?

This panel will involve position statements and a discussion by researchers who have been investigating issues and questions such as these. Broadly viewed, these varied research programs have explored such questions from a constructivist framework in which new approaches for the design and use of learning environments have been informed by current socio-cognitive learning theory and the creative utilization of the affordances of existing and emerging technologies. A distinguishing aspect of these projects has been the delineation of ways technologies can flexibly scaffold learners as they are involved in activities such as acquiring information; finding, conceptualizing, and solving problems; communicating ideas and findings; and so on. Such scaffolds include tools for representing models and ideas; reifying tacit knowledge of experts; interconnecting knowledge in multiple representations; encouraging articulation and reflection; and supporting "expert-like" or "intelligent novice" approaches while students conduct open-ended projects and inquiries.

This panel took the general format of discussing *lessons learned* by the participants who have extensive experience with innovative approaches to designing and using educational technologies. During the first half of the session, each panelist briefly discussed aspects of her or his research that informs perspectives related to questions above. Audience questions and a discussion were conducted during the second half of the session.

Panel Position Statements

Considerations for Complex Learning

Heinz Mandl, University of Munich, Germany

There are a number of factors that must be considered for complex learning. First, there must be appropriate support for complex learning. In accord with proponents of situated learning models (Cognition and Technology Group at Vanderbilt, 1996), we plea for more attention towards developing appropriate means of instructional support for situated learning environments. In principle, this support can take various forms: scaffolding provided by a teacher or a more capable peer; preparing lesson with teacher presentation, etc.

Second, there is the need to prepare and motivate students for complex learning. Of course, the anchor problem has to be carefully designed so that (most) students will regard it as interesting. This is not, however, sufficient. There are many more aspects that have to be considered. One major obstacle in implementing effective situated forms of learning is the lack of fit between examination demands and complex learning arrangements (Mandl, Gruber, & Renkl, 1993; Renkl, Gruber, & Mandl, 1996). If passing exams primarily requires factual knowledge, why should students be motivated to engage in complex forms of learning? Facts can best be learning by other methods. We strongly believe that in order to motivate learners to actively engage in open learning environments it is necessary for exams to call for the types of skills and knowledge that are fostered by situated forms of learning (e.g., application of theoretical concepts to solve problems). The main point we want to make is that although using complex anchor problems for learning may have some motivating potential there are many more important factors that determine the students' engagement in instructional settings. Therefore, it is not adequate to regard complex learning anchors as quasi-automatically engagement-inducing. The larger context has to be taken into account when learning environments are designed that aim to induce fruitful learning activities.

Third, careful consideration must be made regarding the proportion of learning-relevant and learning-irrelevant activities that are induced by complex learning environments. In complex learning environments, students are usually expected to learn complex things. In order to do so, much cognitive capacity is required and, as a consequence, learning processes are sensitive to distractions by task-irrelevant demands (Sweller, 1994).

Another important consideration is to not to regard learning by problem-solving as the ideal and only way of learning applicable knowledge. For instance, learning by examples can be used to reduce cognitive load; it is not only an effective way of learning, but also a learning mode that is preferred by individual learners (VanLehn, 1996) and that is consistent with basic ideas of the situated learning models. There is some evidence that combining learning by problem solving and by examples is a rather promising approach (Renkl, in press; Van merrienboer & De Croock, 1992). The main point we want to stress is that learning by problem solving is not the best method of learning in all contexts. Other modes of learning should receive more attention in situated learning models.

Environments for Social Constructivist Learning: Theoretical Rationale, Experiences, and Lessons

Yam San Chee, National University of Singapore

Learning needs to be viewed and studied in a broader socio-cultural context if we are to acquire a deeper understanding of the dialectic processes at work in authentic learning situations. In the design of learning environments to support authentic learning, we argue, in principle, that two complementary elements are essential. First, there must be learning activities that provide a meaningful context for experientially grounded learning. These contexts may be real or virtual. Second, there must be the opportunity for meaning making discourse that takes place between members of a learning community. Such discourse will revolve around shared representations (text, images, animations, sounds, and digital movies) that serve as referents for meaning making.

In my position statement, I shall explain why the social constructivist perspective provides a superior and more complete approach to addressing the design of technology to support learning. I shall also trace the evolution of learning environments that we have developed in pursuit of the kind of learning we seek to achieve and evaluate the extent to which our goals have been achieved. The review should provide some useful lessons for ongoing design of learning environments.

Scaffolding the Design Skills of students Through the Use of Web Tools and New Didactics

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Plon Verhagen, University of Twente, The Netherlands
Koos Winnips, University of Twente, The Netherlands

The process of becoming a designer of instructional media-products involves a complex mixture of implicit and explicit insight and knowledge. Some of this can be indicated in terms of objective criteria: How to handle multimedia files within Web-pages, what sorts of computer-related products teachers are most likely to use in the classroom, how to manage the lighting for a video production or a tele-learning session.

But there is a meta-level that is much more complicated. Partly this meta-level relates to insights into how particular learners learn and particular teachers teach, partly to individual creativity, and partly to metacognitive skills, self-regulation and the ability to work productively as a member of a team.

In design education measurement criteria for implicit skills are not available. With the absence of such criteria, how can students be scaffolded towards becoming an expert designer? How can novice design students be scaffolded in becoming an expert when the expert designer can not articulate what it is that makes an expert?

But nevertheless expert designers have developed a style in the creative use of explicit and implicit knowledge. They have a design style that characterizes a specific author.

When learning to become an expert designer explicit as well as implicit design skills should be addressed. Becoming a designer can be scaffolded with the help of design guidelines as they represent both explicit and implicit knowledge in designing. Explicit in that fixed rules of 'good practice' are given. Implicit in that the application of those rules is not fixed and dependent on the use of creative processes. An evolutionary approach is advocated to teach design skills.

By using examples of good and bad practice in applying guidelines the meaningfulness of guidelines will gradually increase. Critical thinking about expert applications of guidelines and application of guidelines in own products will eventually make guidelines more meaningful.

In this presentation research about the presentation of guidelines is presented. Different forms of scaffolding design skills are compared that should eventually lead to self-reliant authorship. The WWW site for our group is: http://www.to.utwente.nl/user/ism/winnips/eigen.htm.

Scaffolding the Transformation of Meaning in Resource-Based Learning Environments (RBLEs)

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Resource-based Learning Environments (RBLE) represent a class of learning systems wherein a range of resources designed for vastly different purposes are used to support the transformation of meaning according to the needs and intents of individual users. The World Wide Web represents the most robust repository of such resources. Individual users access a wide range of resources, many of which were created to support particular functions, in an effort to address their unique learning goals. Collections of resources, in effect, are identified and analyzed to support the construction of meaning for which none may have been created initially.

How, or can, support be designed to scaffold the varied intents and needs of different individuals as they attempt to transform personal meaning from such resources? When usage intent is supplied, scaffolding can be closely linked to the domain under study. When the locus of intent and meaning are uniquely generated, however, scaffolding becomes problematic: the more user-centered the system, the more difficult to anticipate and provide useful scaffolds. The focus of this research involves the design and testing of different types of scaffolding (conceptual, procedural, metacognitive, and strategic) in support of RBLEs. Current progress and examples will be described and demonstrated.

Cognitive Scaffolding in Technological Environments: Promoting Deep and Flexible Conceptual Understandings of Complex Knowledge

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Today globally distributed, network mediated hypermedia between potentially millions of computers via the Internet is not only possible, but also becoming increasingly the norm in thousands of classrooms. But the utilization of these technologies as part of learning environments must confront a central question: Can the affordances of sophisticated hypermedia and network mediated technologies improve student learning of complex knowledge? Unfortunately, a critical review of the current literature on learning with relatively open-ended technological environments, such as stand-alone and network-mediated hypermedia systems, suggests this is not often the case, particularly in domains that consist of complex and difficult to understand knowledge.

The focus of my position statement concerns a program of research that has explored how students can learn difficult scientific knowledge using case-based hypermedia learning with design features based on recent cognitive learning theory and research. In particular, two general design features of this system provide special types of cognitive scaffolding that are intended to promote conceptual change and deep conceptual understanding: (a) represent contextualized knowledge using cases and problems, and (b) reify the deep structure of knowledge with cognitive indexing, expert case-theme commentaries, and mental model visualizations. Also, specific hypermedia learning activities have been developed to take advantage of the affordances of the cognitive scaffolding provided by these design features, such as: cognitive preparation to seed new concepts and to promote conceptual change, knowledge transfer priming to show multiple dimensions of conceptual interconnectedness across cases, and on-line scaffolded problem solving tasks. Previous papers have reported on significant learning outcomes associated with the use of these design features and learning activities. In my panel presentation, I will briefly consider the theoretical and design implications of this research for technological learning environments, both stand alone and network distributed, that are intended to help students deeply learn complex knowledge.

Developing and Implementing a Constructivist Learning Environment: Translating Theory into Practice

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Abstract: An examination of the creation of an effective learning environment for a large undergraduate survey course in meteorology, based on constructivist learning theory. The project reflects conversion of an information transmission model of teaching to an active-student, knowledge-construction learning environment, without sacrifice of class size, utilizing technological innovations.

Introduction

Advancements in our understanding of human learning, shifts in societal requirements of education, and demands for increased economy of schooling have created considerable pressure for large changes in educational practices. These changes have begun with a major shift in instructional philosophy that grounds new and radically different theories of learning. The new theories create a strong challenge for educators to develop instructional materials and teaching strategies that reflect these theories. In this paper an on-going project based on the theory of constructivism is described. This project explores the creation of an effective learning environment for a large undergraduate survey course.

The project involves the conversion of a large meteorology course, in which the information transmission model of teaching was used, to an active-student, knowledge-construction learning environment without reduction of class size. To make this conversion, technological innovations have been used to encourage and support major advances in teaching and learning practices. This effort has required close collaboration among content experts, computer scientists, educational theorists and instructional developers. The challenges and issues encountered along with the educational materials that have been developed are discussed from three distinct perspectives: theoretical, practical, and technological.

2. Theoretical Basis

Constructivist theory holds that learners must construct an internal personal representation of knowledge. The richness and utility of this representation is dependent on the degree to which learners integrate new knowledge with their existing knowledge base. This integration demands the restructuring and change of existing knowledge. Since personal restructuring is required, knowledge cannot be transmitted. Rather, it must be constructed by an intellectually active learner striving to build a meaningful personal representation of experience. The constructivist learning setting is therefore rich and authentic since the context becomes part of the constructed knowledge and serves to enhance the utility of that knowledge, especially when applying it to new situations. In this setting, complexity of the topic is maintained to the greatest extent the learner's maturity permits. Complexity and authenticity maintain the structure of the material to be learned and inherently provide reasons for knowing. Collaborative learning, through which students can share views and strategies, and thus develop multiple perspectives, is encouraged in the constructivist environment. These multiple perspectives provide learners with flexibility and support in reorganizing their knowledge base and contribute to the toolkit of strategies for organizing new experiences. A major goal of constructivist learning is learning to learn, or metacognition, which prepares the learner for life-long learning. Thus, much of the teacher's efforts are directed toward developing skills and strategies for learning. Collaborative learning within a complex learning environment provides rich and varied opportunities for the developing and sharing of learning skills.

3. A Model for Class Management

The Iowa State University introductory meteorology class restructuring has been facilitated by World Wide Web server software (ClassNet, http://classnet.cc.iastate.edu/) which manages Internet class activities. This allows every student to be an active participant in learning activities with easy access to course materials, enhanced communication with the instructor and with other students, rapid feedback concerning assignment evaluations and exams and ready access to their private records of course performance. Although the course enrollment is in the 250-300 range, ClassNet software enables ease of constructing, distributing and evaluating assignments. The assignments involve authentic activities (forecasting), simulated learning environments (Java-based simulations) and more standard evaluations of content understanding (short answer responses).

The course goals have shifted from the learning of science content to also include learning how to learn science. The focus of the course is on the understanding of weather phenomena, and the primary vehicle for learning is an authentic activity where each student routinely predicts weather events and supports their prediction by identifying determining factors. This weather forecasting activity has been very successful in encouraging student participation and in promoting understanding in this course. The forecasts provide a continuing thread of meaningful discussion and motivation throughout the semester.

Part of the class time has been allotted to group assignments and discussions of their forecasting successes and failures. These have been well received by students. Class time is also used to engage students in discovery activities and to promote confidence in each student's capabilities to successfully engage in scientific reasoning. Various collaborative activities are used to draw each student into the construction of hypotheses for explaining observed scientific phenomena or processes. Lectures are used to provide explanations when students have explored, tested and questioned various factors that relate to central course concepts. To more closely integrate theory and application, Java-based Internet simulations were developed, integrated into the curriculum and tested. These have facilitated just-in-time student understanding of important meteorological concepts. The simulations were developed to enable students to explore key concepts that have historically been problematic. These simulations are microworlds in which the student chooses parameters in an attempt to cause specified weather phenomena to occur. Because the main focus of the course involves understanding weather phenomena and the primary activity is forecasting, the heaviest weight in the evaluation of course performance is an authentic assessment of forecasting skill. Each student may submit on the order of 100 forecasts during a semester, but only the best 30 are counted in the final grade. This encourages students to regularly participate in the forecast activity and gives them many opportunities to fail without penalty. The forecast activity is weighted as half of the student's course grade. The other activities (standard exams, use of simulations, standard assignments, group activities during class) make up the remaining evaluation items.

4. Materials Development

The lecture-textbook-objective-test method of instruction does not provide an environment in which learning to learn is adequately supported. Thus, new materials have been developed which require the learner to employ the tools of the discipline to wrestle with authentic tasks. Complex opportunities have been provided for learners to apply and test their developing knowledge and new instructional techniques have been employed to orchestrate this environment.

Materials development for the new learning environment do not rely on traditional instructional development models. The new materials could not be designed to teach the learner the course content, when the goal was to encourage the learner to explore, conjecture, and test ideas. The chosen solution was to develop problem-based simulations that pose scenarios and provide tools with which learners can explore, and that accurately reflect the results of specific learner's actions. The materials have served to set the stage for further learning by revealing misconceptions, raising questions, activating relevant existing knowledge, and alerting the learner to the structure and utility of the material to be learned. They have also provided an authentic environment in which the learner can integrate and apply segments of knowledge acquired independently. A model for developing these materials was not initially well defined. The model that has evolved includes the targeting of difficult concepts, identifying reasons for the difficulty, and creating an environment for learner exploration of the relationships among the essential components. This environment incorporated tasks which enabled the learner to confront the important relationships, and that reflected the results of the learner's thinking. An exemplary environment is seen in Figure 1.

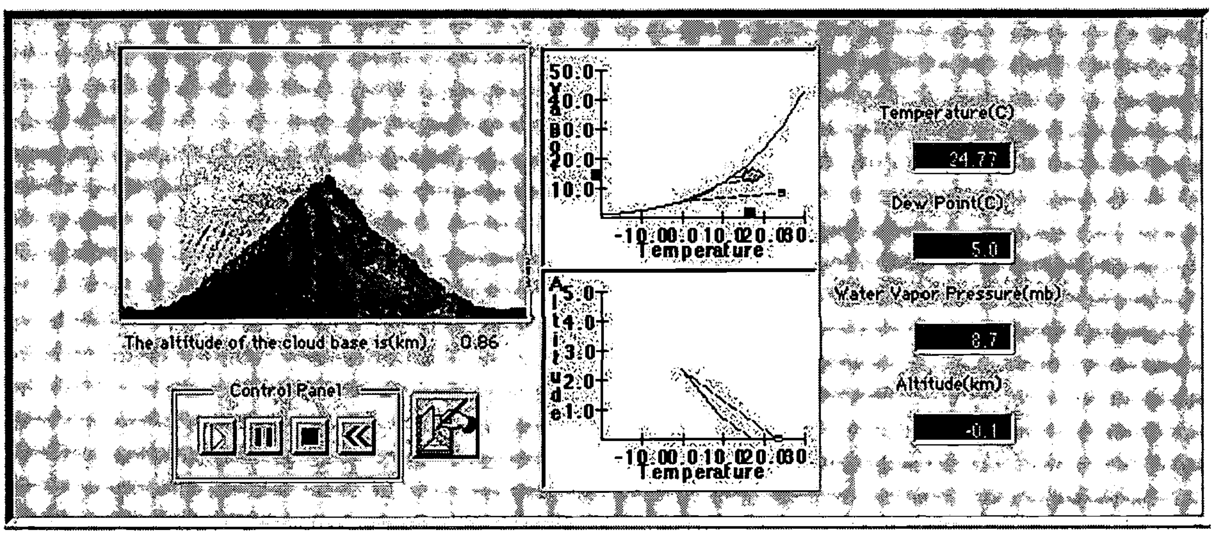

Figure 1. MountainSim, an adiabatic simulation.

5. MountainSim

The purpose of the MountainSim simulation (http://www.public.iastate.edu/~abc/java/mtnsim.html) is to permit students to construct an intuitive understanding of the relationships among temperature, vapor pressure, altitude and precipitation in mountainous terrain. The assignments in using the simulation are to cause cloud formation at a specific height on the windward side of the mountain and to produce a specified temperature differential between the windward base and the leeward base. To cause these effects, students can set the initial temperature and vapor pressure of a parcel of air as it approaches the base of a mountain. The simulation shows the air passing over the mountain, and if appropriate, rain and thunder are produced. Gauges and graphs reveal the critical data and a table of data from the student's runs are maintained. Other simulations have been developed to enable the students to explore concepts involving energy balance, radiation and advection.

6. Enabling Technology

In order to organize and manage the large class a web tool called ClassNet was developed (Van Gorp and Boysen, 1997). ClassNet provides a suite of tools for managing Web-based activities including registration, assignment design, automated evaluation, intra-class communication and grade reporting. Central to ClassNet's design is a growing framework of assignment types including tests consisting of multiple-choice, fill-in-the-blank, Likert, essay, option lists and list question types; surveys; weather forecasts; student evaluations and Java simulations. The assignment framework is extensible, allowing instructors to customize ClassNet to meet their individual class needs while still providing general administrative functionality. ClassNet assignments may also be used to track interactions with computer simulations for later replay by instructors or students. This has proven to be a very powerful utility for research relative to metacognitive and simulation design issues and simulation usage.

The current system supports thousands of students world-wide and is used for assignments such as forecast judging in meteorology, practice tests in geology, personality testing in psychology, simulation tracking in mathematics and student counseling practice in counselor education. Students may access ClassNet anytime from anywhere to take tests, view class progress and see current scores. ClassNet is also capable of reading scores for assignments administered outside ClassNet or for reading tests into ClassNet. The capabilities of ClassNet will be discussed and its use in the meteorology course described during the presentation.

7. Significance

The rewards from these efforts in meteorology are already being realized. This weather forecasting activity has been very successful in encouraging student participation and in promoting understanding in this course. The forecasts provide a continuing thread of meaningful discussion and motivation throughout the course and a context for course concepts.

ClassNet, which was developed to support this course, is serving over 130 other classes. The model for simulation development is being used in other disciplines. It is anticipated that the simulations will be useful via the Internet to other institutions including middle and secondary schools. The strategies for promoting science learning are being studied in an experimental teaching methods course by preservice teachers who are concurrently enrolled in the meteorology course.

This model of student-directed learning—combining information resources, microworlds, discussion, and authentic application—is very powerful and is expected to be a valuable model for distance education. It can remove student isolation through electronic discussion, keeping the discussion relevant and on-target through authentic forecasting and simulated activities. As a model for distance education it would replace the traditional practice of providing "access to information" by providing "access to understanding."

For access to these and other class materials see http://www.public.iastate.edu/~pals/ homepage.html

8. References

Van Gorp, Mark and Boysen, Pete, 1997: ClassNet: Managing the virtual classroom. *International Journal of Educational Telecommunications*, Vol. 3 (3/2), 279-292.

ROUNDTABLE PAPERS

A Vision for Distance Education in the 21st Century

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Abstract: This paper presents an emerging vision of distance education for the future. Critical issues, barriers, and facilitators for reaching that vision are raised, along with strategies for operationalizing the vision. Major areas for further research are addressed equity and access; professional development; learning and the "best fit - best use" for distance education; cost factors; and dissemination. Policy implications are discussed.

Over the last decade, the advancement of technology and school reform efforts, as well as other factors, have paved the way for the rapid evolution of the field of distance education. Distance education has great potential to help shape the restructuring of education in the United States and throughout the world. It can work hand in hand with reform efforts to create learning opportunities for all learners, at any locale, at any time. Learning is not and need not be tied to specific places at specific times. Telecommunications is a vehicle for providing educational opportunities to meet the increasing needs of our diverse society for high quality, lifelong learning. We must develop a vision of distance education in the 21st century which supports high quality educational opportunities for all members of our society, and takes into consideration all the resources we need to accomplish our vision.

In March 1997, the U.S. Department of Education's Office of Educational Reform and Improvement brought together national leaders in the field of distance education and related industries in a Forum to begin to articulate a vision of distance education in the 21st century and outline strategies for operationalizing this vision. The presenters prepared a background paper tracing the evolution of distance education over the last decade to provide common background for the participants of this Distance Education Forum. The Forum itself provided an opportunity for participants to craft and articulate an emerging vision of distance education. Participants addressed critical issues, barriers, and facilitators for reaching that vision. Participants then issued a call to action, describing the essential building blocks needed to reach the vision they articulated. In our presentation at this 1998 World Conference, *A Vision for Distance Education in the 21st Century*, we synthesize the ideas that came out of the 1997 Forum, and add additional commentary to buttress and expand the ideas. The 1998 World Conference presentation will provide an opportunity for expanding the vision for distance education into a truly global vision through active discussion with an international audience.

The education reform movement has led to major changes in classroom roles and organization, with learners taking a far more active role in constructing their own learning than in the past. The vision for distance education moves the learning community beyond the classroom walls. Boundaries disappear, including those of geography, time, location of school, home, community, and work; age, language, culture. As these walls break down and learners become more in control of their own learning experiences, distance education becomes transformed into distributed learning. Distance education and new technologies offer unique opportunities for learner control and individualization. What learners need to know in the 21st century, and how they need to learn and use knowledge, changes.

Distance educators have several choices in addressing the role they might play in advancing educational reform for the future. First, they might ignore the reform movement and use new distance learning technologies to promote old ways of teaching and learning. Second, they might reflect the movement, and provide technological tools and information resources that support existing educational reform efforts. Finally, and most excitingly and appropriately, they might embrace the reform challenge and lead the way by encouraging teachers and students to learn new things in new ways and provide new models of distance education as catalysts for true educational change.

The presentation focuses on efforts to embrace the reform challenge. We describe strategies for using distributed education to support programs and services for diverse populations, as exemplified through a variety of multilingual, multicultural, distributed learning environments and communities. Several successful national and international distance education projects will be discussed, including the Global Networking Project — I*EARN, "DeOrilla a Orilla"; Global Learning and Observations to Benefit the Environment (GLOBE); TEAMS Distributed Learning; MATHLINE®; and Hawaii Network for Education in Science and Technology (HI-NEST).

Forward-reaching distance education endeavors, like any educational undertaking, face both obstacles and facilitators in the implementation process. Some of these barriers include limited time and resources, lack of capacity, high operating costs, and the complex nature of serious, meaningful change. At the same time, there is public demand for cost-effective programs that address high standards for learning. If distance education can be accurately perceived as an important vehicle for equity of access and the achievement of high standards for all students, including life-long learners, it will thrive and prosper.

Our research agenda for the future needs to address these critical issues How will teachers keep current when technologies change almost daily, when national borders and global economics change almost as rapidly? How and what should students learn so they can acquire the skills and knowledge to adapt to the ever-changing requirements of the labor market, the knowledge explosion, and global citizenship? How can we provide equitable access to both formal and informal educational opportunities when our population is so mobile and so many children may be isolated from these opportunities We discuss five major areas for research to answer these questions: equity and access; professional development learning and the "best fit - best use" for distance education; cost factors; and dissemination.

Finally, we discuss some public policy implications and connectivity solutions in shaping the future of distance education, along with the role of government in funding and implementing effective distance education programs.

Compressed Video Classrooms: Instructional Challenges and Strategies

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Introduction

Distance learning is here to stay and now we, as educators must find a way to successfully integrate it into pertinent curriculum. The idea of utilizing multiple delivery systems to best meet the needs of students touches on concerns of scheduling and learning styles as well as student outcomes. There are many types of class presentations available, traditional classroom settings, which may benefit from an occasional assignment posted on the web or student reference information posted for easy access; Synchronous distance learning can offer increased student access to instructional materials and interaction between classes. Asynchronous distance learning can benefit by allowing student more than one delivery style, to ensure all student learning styles are reached. This might mean using email in class, using a threaded discussion or real time chat, having students search for information on a specific topic or posting classroom materials on the web for students to access. These formats are not specific to distance education, but rather can be used to enhance the learning process in any setting by increasing the opportunity for student interaction, making their learning process a more active mechanism.

Instructional Considerations of Distance Education

There are many instructional issues encountered in distance education which instructors are not prepared for ahead of time. Instructors should be aware that even a class which they have taught for years will now require presentation changes and flexibility as well as intense classroom preparation. Things which should be considered are course preparation (the development of a course pack, electronic presentation of lecture material, class schedule); daily classroom preparation (adhering to your schedule, getting students involved, delivering and gathering papers); student interactions (keeping all classrooms interested, getting the students involved with each other); student evaluation (comparing classes and outcomes); student comments (student evaluations of the program or course); sending one class vs. sending a program (issues such as what to do about lab classes and some solutions used in the DMS program at TCC); class schedules and calendars (creating a calendar that works for everyone); and using the Internet to make access easier for students (how can the net make your job easier in a distance learning setting? What asynchronous delivery systems are available for your use?); Many programs, especially in technical fields, are also required to meet accreditation standards which must be considered and planned for. Good instruction can be achieved through a variety of methods and as educators we should set a standard of excellence for our students and communities.

Other issues affect the classroom but are administrative in nature and instructors have no input into them. Instructors in distance education programs should be aware of as many of the issues surrounding the delivery of distance education classes as possible and how they might affect classroom instruction. For example, many institutions do not offer remuneration for efforts put into developing distance education classes such as release time or additional pay for additional class sections. It is important for educators to know not only what is out there for them to use, but what they should expect when they try something new.

Compressed video can be a very dynamic te aching modality and instruction will be more effective with careful planning by the instructor and institution. Using the knowledge gained through the experiences of others can be a very effective tool towards making the transition into a distance education classroom less traumatic for the instructor involved.

Integrating Multiple Delivery systems into the Classroom

Integrating multiple aspects of delivery systems into a class can help increase student learning by encouraging the development of critical thinking skills [1]. Educators can use hypertext links to encourage students to collaborate as they learn about the technology they will be expected to be familiar with in the business community. There are many aspects of the Internet that can be brought into our classrooms. This paper will discuss e mail and the use of the World Wide Web in the classroom.

Courses can use the Internet to gather general information, supplemental information, provide the bulk of course materials or the entire course [2]. We need to plan carefully and choose how our classes can best be enhanced by these additions. Technology should never be added simply to add it, there must be an instructional plan and a desired outcome. Without careful planning classes appear haphazard and the addition of technology is treated like busy work by the students. The addition of the Internet in the classroom should be to increase student learning and interactivity[3]

E mail can provide a easy, flexible link for the student and the i nstructor. It can allow the student access to instructor virtual office hours as well as providing a potential link to fellow classmates for collaborative interaction. On-line testing can, if monitored and designed correctly, provide a means of student assessment effective in distance education, both synchronous and asynchronous. It can also be used as an effective method of student review and continuing education. The last aspect of the Internet that I will discuss is the World Wide Web (WWW). The WWW offers students a tremendous amount of information to utilize. Students can use this information for research, collaboratively in class or with classmates. There are programs which can allow students to surf the web together and discuss findings simultaneously [4] .

Students can be shown how to gather pertinent data from their area of interest off the WWW. They need, however, to be taught how to be selective in this process and how to effectively use search mechanisms. Students can gain a deeper insight into subjects which might offer an otherwise limited exposure to certain topics. Using the WWW as a common ground, instructors can post classroom materials for students to access at their convenience, assignments, tests and review materials. Several software packages can aid in this delivery system.

Advantages of Using the Internet in the Classroom

[1] Alexander, S. Teaching and Learning on the World Wide Web Available at: http://www.scu.edu.au/sponsored/ausweb/ausweb95/papers/education2/alexander/

[2] University of Washington Training Module, The Uses of the Web in Education, Available at: http://weber.u.washington.edu/~rells/workshops/design/uses.html

[3] Sherry, L., Issues in Distance Learning, Available on Line: http://www.cudenver.edu/public/education/edschool/issues.html#abstract

[4] Powwow. Available at: http://www.tribal.com/

As students turn to distance education as a means of attaining educational goals from institutions not in their immediate geographic location educators must find a means of making the required adjustments to provide that education. Distance education is appealing to students because it is student centered. Depending on the educational setting, it can allow a more self paced learning environment, both in time and place of learning [1].

E-mail can be a useful means of maintaining student interaction. Students need to feel a link to both the class and the instructor. Certainly phone calls and an occasional written note or personal visit are very effective methods of student communication, but e-mail can be convenient and cost effective in a distance setting. One thing to remember is that many student do not have previous training in electronic communication and must be given easy to understand instructions. Posting an e-mail link on the class home page can help make student access less stressful.

E-mail can also be a very effective tool for ensuring student feedback on a regular basis [2]. This may include strategies such as journal entries and prompt questions from the instructor or interaction with other students. E-mail can be used as a means of getting students involved with their classmates. This can lead to more involved discussions in a chat format or threaded discussion format as educational patterns become more established. Certainly, in any distance education setting, e-mail is an imperative link between the instructor and the students.

The WWW can have many uses in a classroom, especially in a classroom which has a distance education component. It can be used to make the students at all sites feel they are part of the same classroom rather than isolated from each other. This can be accomplished by making all students go to the same WWW address to gather class information and assignments. It can be one on a more personal level by posting a picture of everyone in the class, so they can learn names and interact more easily with the other students.

Many class items can be posted on the WWW to give students increased access to instruct ional materials. Items which are appropriate to post on a classroom home page include course and instructor information (policies, office hours, textbook and course objectives), a means of class communication (an e-mail link), class assignments and tests (allow a means for electronic feedback or submission of classroom evaluation assignments), classroom materials (lecture notes or outlines and related web pages), demonstrations (to include audio, video or other graphics) and reference materials (beware of distribution of copyrighted materials) [3].

Students are often amazed when they realize the amount of information on the WWW related to their fields. By showing them how to do effective searching on the Internet, or providing them with specific links, the instructor can broaden the learners perspective, giving them a more global outlook to their education and their chosen field. In sending students out onto the Internet to learn about any field, it is imperative that instructors provide students with a guide for evaluating data they might find. Students often don't have the knowledge base required to make judgments on their own early in their education

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[1] Hurst, et al., Assuring Equitable Access: A Distance Learning Vision for Florida Available on Line: http://sun6.dms.state.fl.us/institute/finvis.htm#_Toc391191931

[2] Strategies for Teaching at a Distance: A Series of Guides Prepared by *Engineering Outreach* at the University of Idaho, Available on Line: http://www.uidaho.edu/evo/dist2.html

[3] Strategies for Teaching at a Distance: A Series of Guides Prepared by *Engineering Outreach* at the University of Idaho, Available on Line: http://http://www.uidaho.edu/evo/dist2.html

and should be given some means of establishing the credibility of the information they encounter. The WWW can also be used more effectively if students are given detailed, well planned assignments to complete. This will ensure that they are less likely to deviate from their learning goals.

There are several programs which can help make posting classroom materials easier for the instructor. Programs like Toolbook, QuizPlease, Web Course in a Box, PowerPoint and Front Page all can provide Hypertext Mark-up Language (html) based instructional materials. Toolbook, QuizPlease and Web Course in a Box are all programs which can allow instructors to post testing materials on the WWW. Of the three, Toolbook and Web Course in a Box allow the integration of written course materials, such as lecture or review materials whereas QuizPlease is truly a test generator. Of the three programs, Toolbook is by far the most difficult to learn, but is extremely powerful and once mastered can allow a great combination of online presentation of course materials and testing materials. QuizPlease is extremely easy to use, utilizing a template format to allow the instructor to add questions, graphics or sounds in a variety of testing formats. Web Course in a Box is also quite easy to use. Using a template format it walks instructors through the process of posting a class on the Internet by setting up the course syllabus and outlining the web site. All three programs allow testing, Web Course in a Box does not have the capability to randomize test questions or electronically return test results to the instructor.

PowerPoint documents can be converted into html format and posted on course pages. Interactivity is limited and this is best used for the presentation of simple graphics, and written materials. Front Page is a html editor and can be sued to design course materials for Internet posting or the development of a threaded discussion for classroom use.

Often instructors find that no one program can meet all their needs. Instead each program should be evaluated for classroom needs and used accordingly. I think that each program can be utilized to some degree; PowerPoint to present written classroom materials, Web Course in a Box to develop a new course and organize that course, Toolbook to present more complex course content (either on line or as a stand alone presentation), QuizPlease to add on line testing and Front Page to add a threaded discussion to classroom interaction. Practice and experimentation will decide which program best meets the needs of each instructor and course based on network limitations, cost and flexibility.

Required Resources

In order to utilize the WWW in the classroom or as an alternate delivery system, students must have Internet access. If they choose to take a class via this system it can be made a pre-requisite for them to have this available. Many students take advantage of the computers available in their local school or public libraries. If education is presented in a synchronous manner, students might have to travel to a specific location at a specific time to receive instruction. In this case, two way video conferencing equipment is required at both sites.

Limitations

Stevens, S., Using the Internet in the Classroom Available on Line: http://vbbuslnx1.tc.cc.va.us:80/~eci760/Class7/class7.htm

Asymetrix Learning Systems, Inc. *Toolbook II Instructor*, Available on Line: http://www.asymetrix.com/

McCormack, R. *QuizPlease*, Available on Line: http://www.robmccormack.com/

Web Course in a Box, Available on Line: http://www.madduck.com/

The greatest limitation to using the Internet for any learning is access. Certainly many institutions are requiring students to have a computer but the body of students served by community colleges generally cannot meet that requirement. Public and free access can often be found in public or school libraries. Instructors must remain very aware of copyright infringements and how they present class materials to students. Instructors must be very aware that anything they type is not private and might be viewed by many persons. They are a representative of their institution and therefore should act accordingly. This means that anything they post on the he WWW should have a professional, easy to read appearance for easy use by all students. Poorly designed pages, or assignments which are not carefully planned might discourage students from pursuing other distance education opportunities in the future. Instructors should be cautious about the sound and video clips they choose. These can load very slowly and distract from student learning instead of enhancing the process.

Another limitation that is not always discussed is time. Preparing these c ourse materials take time and instructors should be prepared for that. Generally even the most basic course materials must be altered for use in this setting. Instructional institutions are encouraging the developments of distance education courses, but often allow no compensation for the time and work involved in that process.

Extensions

Perhaps the most promising extension to adding the Internet into our classes is the increased student access and flexibility. Now we can offer students at least partial flexibility in certain classroom assignments. The WWW especially can offer this to students as more educators move to posting class materials for student access. Through careful planning and lesson planning, the WWW can also enhance critical thinking skills of students by encouraging student collaboration and analyzation of web sites and their content.

Summary

The Internet is an exciting addition to the classroom and is a challenge to all educators to meet learner needs. One way to meet learner needs is to make the educational process more flexible. We can do this by providing students a means of gathering classroom assignments, reaching the instructor for questioning or taking tests at their convenience. We can accomplish these goals by integrating the use of e-mail and the WWW into our classrooms. Even a "traditional" classroom setting can add these components in an effort to make the learning process more accessible for students.

E-mail and the Internet can also make distance ed ucation settings more effective in accomplishing student learning by increasing the opportunities for developing critical thinking skills and student access to instructional materials. In order to meet the needs of learners in these alternative educational settings, no one means of instructional delivery is effective. Instructors must explore all resource available to them and choose the ones most likely to meet the goals of their class. E-mail and programs such as Toolbook or QuizPlease are just a few examples of how learning on the Internet can be an effective learning tool.

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Special Interest Groups PAPERS

Student Technology Fees: Administrative and Student Perspectives at the University of Tennessee, Knoxville

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Computers, sophisticated software, e-mail, and Internet access are the new tools of business and education in an evolving post-industrial society where information is power [Weins, 1993]. Those who have access to these new technologies have opportunities to compete in an aggressive marketplace. These technologies permeate virtually every field, and skill in using them is essential.

The rate of change in the information age carries with it major challenges for colleges and universities. Principle among those challenges is the problem of securing funding necessary to establish and maintain the technological infrastructure required to leverage these new technologies in the teaching/learning process [Division of Information Infrastructure, Dec. 1997]. They are also pivotal to the research, public service, and administration of higher education.

Is the key to funding campus technologies the implementation of a technology fee? Colleges and Universities devote massive funds and innumerable hours to integrating computers and the Internet into their curricula [Graves, 1994]. But with decreased funds and increased costs, budgets are strained with the pressure. The use of a student technology fees is an option.

Once a technology fee is in place, how is it implemented? Is used as a simple add-on to enhance current technology, or is it the technology used to transform the teaching/learning process, support challenging research, and aid in public service [Division of Information Infrastructure, Aug. 1997]? What role will students play in deciding how the fund is distributed and how will that presence be represented [Division of Information Infrastructure, Nov. 1997]? Will faculty resources be financed with technology fee funds?

At the University of Tennessee, Knoxville, the Educational and General budget, which is funded largely by state appropriations and student fees, support a number of basic computing and telecommunications services. Included among these services is access to central computing and server facilities, access to online documentation and computer based training courses, access to staffed and unstaffed student computer labs, a limited set of software at no charge, and access to student support services [Division of Information Infrastructure, Aug. 1997]. The state appropriations and basic student fees don't begin to cover the breadth of need involved with implementing and supporting technology on a university campus.

In this case the student technology fee was established on a $12 per credit hour basis, with a $100 semester cap per student. This fee is in addition to a $140 activities fee, tuition, and fees associated with parking and housing. This student technology fee was designed to create an ongoing revenue of approximately $5,000,000 per year [Division of Information Infrastructure, Jan. 1997].

The revenues derived from the fund are placed in a separate account in the office of the Vice Chancellor of Information Infrastructure. It is distributed by the Vice Chancellor of Information Infrastructure with the help of an advisory committee called the Technology Appropriation Board. The board represents members of the Student Government Association, the Graduate Student Association, Academic Affairs, and Information Infrastructure. There is also a Subcommittee, composed of the five student members of the advisory committee and five additional students.

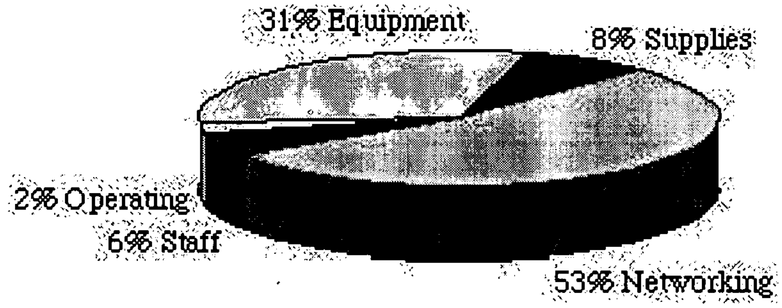

Figure a: Technology Fee Breakdown FY 96-97 [Division of Information Infrastructure, Jan. 1997].

The technology fee at UTK has been designated for several student related service, including [Division of Information Infrastructure, Aug. 1997];

1. Enhanced Network Access On- and Off-Campus
   The capacity and speed of the existing network has been increased to support electronic communication and access to information and will include connectivity for on-campus student housing and all academic departments, including additional ATM switches, T-1 lines, and ethernet connections. Of the 6,839 existing circuits, 5,745 will be upgraded, and approximately 8,972 will be added. All dorm rooms will have network capability, and when complete, the campus network will include 15,811 circuits. Commuter students have access to the campus infrastructure through a high speed modems or subsidized ISDN lines.
2. Enhanced Student Computing Labs
   Computing lab improvements include upgrading equipment on a three-year recurring basis, expanding hours of availability, and increasing the number of seats available. This year 26 labs were upgraded or built. more than 1,000 computers have been purchased since the fee was implemented last fall.
3. Enhanced Student Support Services
   The support line has been expanded to 40 hours per week. Ten hours per semester of statistical support will be made available to all students without charge, and subsequent hours will be charged at a reduced cost of $20 per hour. Additional instructor-based training courses for students have been added. Current classes available for students include; "The Life Preserver" an introduction to UTK Computing, classes on the Office '97 Suite applications of Word, Excel, and PowerPoint, a class on the Web and effective ways of gathering information, and classes offering assistance in utilizing computer software to produce a research paper.
4. Enhanced Software Distribution
   Licensing arrangements will be negotiated for additional software based on student needs. These packages will either be free or offered at a reduced cost. Currently Lotus SmartSuite and Notes are available at no cost to students Software available at a reduced cost includes, Microsoft Office and SPSS.
5. Enhanced Instructional Technology
   One classroom per year will be equipped with 20 student network ports and a faculty computer station with display devices. An additional classroom per year will be equipped for computer-based faculty presentations. Training and support for faculty will be provided. This year 18 departments were given computer projection systems. In 1997, the ITC offered 116 sessions of 25 different courses related to integrating computer and multimedia technologies with instruction. Approximately 1,100 seats were filled by faculty, staff and graduate teaching assistants attending the courses, and post-session evaluations indicated that 99 percent of survey respondents rated the quality of the courses as "very good" or "excellent." Additionally, 57 faculty were awarded 1997 ITC Fellowships and Grants and worked in 27 teams to produce a variety of technology-enhanced course components.

It is obvious that technology is rapidly changing the ways that people conduct business and provide educational opportunities [Weins, 1993]. Students and faculty must try to remain abreast of the technology in order to maintain their competitiveness in the job market [Marcus, 1997]. If colleges and universities fail to provide the opportunity to learn these skills, they risk a decrease in student enrollment as students seek colleges better able to accommodate their needs. As computer technology becomes ensconced in our culture [Weins, 1993], it is in the best interest of colleges to consider the costs and benefits of providing access to technology and to budget accordingly so that they can continue to provide necessary services to students. In the case of UTK, the amount of fee-funded equipment, software and projects has been boosted by unexpected discounts and grants from computer manufacturers and other companies.

Despite the costs of implementing technology at a university like the University of Tennessee, Knoxville, the benefits gained have the potential to increase instructor creativity, increase student interest and learning, and create greater flexibility of instructional delivery.

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OTHER PAPERS

A method of integrating (tele-)presentation and multimedia production

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We explain a new method of integrating three apparently different activities, namely teaching in class, telepresentation, and production of instructional material for offline use into one single task. We call this method *Authoring on the Fly* and distinguish the three different phases of preprocessing, online delivery, and postprocessing. In the preprocessing phase the lecturer prepares slides as colored postscript files using one of his favorite tools, collects pictures and audio- or video-clips in one of the standard formats, prepares animations and simulations, and installs all this course-related material on his computer. In the online delivery phase, the material is presented and orally explained by the lecturer using an electronic whiteboard. The audio and video streams, the whiteboard actions stream, the animations and simulations, that is, all data streams generated during the lecture are then converted into a multimedia document, which can be linked together with other material and thus integrated into an open teaching and learning environment.

In this demo we demonstrate the method and explain all the various tools needed to successfully apply it. It will be shown how electronic whiteboards, the Mbone whiteboard wb and a more advanced whiteboard AOFwb, are used as presentational tools for teaching which allow the loading of slides, pictures, and the start and stop of animations and simulations. Using the multicast facility of wb, a lecture can be transmitted to remote locations via the internet. The two environments aofShell and AOFwb integrate the recording of the audio stream and all whiteboard actions, the seamless conversion into so called AOF documents, and the immediate replay of these AOF documents with the built-in viewer from the personal workstation's desktop.

By using examples from different areas like Computer Science, History, and Chemistry we explain

— how to prepare a lecture for telepresentation,
— the features of the integrated electronic whiteboards,
— the creation and handling of AOF documents,
— how to integrate AOF documents into teaching and learning environments such that they become accessible via standard internet browsers (both on Unix and WindowsNT platforms).

Demos as download packages are available under: http://ad.informatik.uni-freiburg.de/mmgroup.demos. Further information on Authoring on the Fly: http://ad.informatik.uni-freiburg.de/mmgroup.publications.

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