DOCUMENT RESUME

ED 454 830 IR 020 809

TITLE	ICCE/ICCAI 2000 Full & Short Papers (Methodologies).
PUB DATE	2000-11-00
NOTE	64p.; In: Learning Societies in the New Millennium: Creativity, Caring & Commitments. International Conference on Computers in Education/International Conference on Computer-Assisted Instruction (Taipei, Taiwan, November 21-24, 2000); see IR 020 792. Some figures contain very small and illegible type.
PUB TYPE	Collected Works - General (020) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Computer Uses in Education; *Educational Methods; *Educational Technology; Elementary Secondary Education; Foreign Countries; Higher Education; Information Technology; *Instructional Design; Systems Development; World Wide Web

ABSTRACT

This document contains the full text of the following full and short papers on methodologies from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction): (1) "A Methodology for Learning Pattern Analysis from Web Logs by Interpreting Web Page Contents" (Chih-Kai Chang and Kuen-Shan Wang); (2) "Courseware Engineering Methodology" (Lorna Uden and Neil Willis); (3) "Defining Educational R&D: A Content Analysis of Journal Articles and Implications for Instructional Technology" replaced with "From Research to Development: A Content Analysis of Journal Articles" (Alex Rath, Shihkuan Hsu); (4)"Design and Implementation of a Chinese Web-Mail System" (Chang-Sheng Chen, Jian-Liang Liu, and Shian-Shyong Tseng); (5) "Facilitating Examples Understanding through Explicit Questioning" (Isaac P. W. Fung, R. H. Kemp); (6) "Organization of the Introductory and Motivational Stage of Activity in a Computer Tutoring System" (Gennadly Atanov, Vladimir Laktiushin); (7) "Relating Telecommunication Training Objectives to SMEs' Actual Needs" (Paola Forcheri, Maria Teresa Molfino, and Alfonso Quarati); (8) "The 'Half-Life' of Knowledge in the University of the 21st Century" (Roger Mundell, Denise Stockley, Jeanette Muzio, Tanya Wilson, Laureen Vickery); (9) "Towards a Model of Using Information Technology in Education for Pre-Service Teacher Education" (Kai-Ming Li, Yiu, Sing Lam, Pak-Hung Li, and Kwok-Leung Wu); and (10) "Traversing the Case Graphs: A Computer Model for Developing Case-Based Learning Systems" (Isaac P. W. Fung and R. H. Kemp). The abstract of the following paper is also included: "The Rhetoric of the Web--A Semiotic Approach to the Design and Analysis of Web-Documents" (Jens F. Jensen). (MES)

ICCE/ICCAI 2000 Full & Short Papers (Methodologies)

Proceedings

Content

▷Full & Short Papers (Methodologies)

▲ HOME

A Methodology for Learning Pattern Analysis from Web Logs by Interpreting Web Page Contents

Chih-Kai Chang and Kuen-Shan Wang
Department of Information Management
Da-Yeh University
Da-Tsuen, Chang-Hwa 51505 Taiwan, R.O.C.
E-mail: chihkai@mail.dyu.edu.tw

As Web-based course become popular, the Web system accumulates a large amount of log data. Because the log data was generated by learners' behavior on the Web-based course, many researchers agree that analyzing the Web log will bring benefits for learners, instructors, and the Web site manager. In general, one record of Web log can indicate "which Web page was accessed", "who access that Web page", and "when the Web page was accessed". Although many interesting results can be derived merely depending on the general Web log, some important meanings of the Web log were not considered in previous researches. In other words, the content, represented by the Web page, is not included in the general Web log. For instance, a Web page may present homework, a discussion article, a section of curriculum, or a grade reports. However, previous research did not consider the represented content of a Web page in the Web log, in which only the file name of the accessed Web page is generally identified. This paper use data mining technology to analyze learners' online behaviors for mining learner's patterns by transforming general Web log to a content perspective. Hence, the methods of previous research still can be used to find the more meaningful results. Most important of all, our methodology finds patterns based on learning behaviors instead of browsing behaviors.

Keywords: **Web-based course, Web log, Data mining technology.**

1 Introduction

As Web-based course becomes popular, various learning activities can be running on the Web [1]. The asynchronous discussion activity, homework assignment and submission, announcement, and grade reports all can be executed on the Web. Because all the learning activities are represented as Web pages, the Web server will accumulate a large amount of log data for every Web page. Basically one record of the Web log can indicate which page was access by someone in sometime. Hence, many researches analyzed the Web server log to figure out users' motivation, users' response, browsing pattern, and the network traffic [2, 3, 4]. Furthermore, analyzing students' on-line learning behaviors and on-line problem solving activities can also discovery meaningful results [5].

There are at least 116 products of Web log analysis for commercial web sites [6]. The technologies used for analyzing Web server log evolve from traffic-based or time-based assessment to user access pattern analysis. For example, Perkowitz uses access patterns to construct an adaptive Web site [7]. Hence, the interested Web pages will be linked and organized as a proper view for every user according his/her access patterns. The *path* concept, users' sequential Web page access records, is important for constructing user access pattern for Web logs. For instance, Stuart Schechter [8] create users' path profile to predicate users' browsing behavior. Consequently, the field of Web log analysis is growing for the purpose of custom services.

Recently, applications of Web log analysis integrate data mining techniques to focus on the customer behavior patterns. It is because the predictive modeling and link analysis operations in data mining techniques can be used to answer questions such as "Which of my customs will prove to be good, long-term valuable customers and which will not?", "How can I sell more to my existing customers?", "Is there a recognizable pattern in which my customers acquire products or use services so I can market to them just-in-time?", and so on [9]. Consequently, we intuitively apply data mining techniques to Web log analysis of an instructional Web site.

For Web-based instructors, their requirements for Web log analysis differ from managers of commercial sites. One of the reasons is as Raphen Becker said, "Because many existing systems are targeted toward commercial webs, the answer is yes, course webs require different systems. One reason is simple: most instructors (and even institutions) cannot afford the commercial products, which are priced toward industry and not towards academia."[10]. Although researchers realize the differences between course webs and commercial sites, the proposed methodology for Web log analysis still inheritance from the Web logs analysis products for commercial sites. For instance, Clio project pays efforts to answer the questions such as "What are the more popular parts of the course web?", "How do readers reach particular pages?", and "Can they quickly reach the pages they want?" so on. Unfortunately, most questions of that kind can be answered by existing Web logs analysis products.

When analyzing Web logs of a course Web, we concern that one encounters what specific problems, which can not be answered by existing Web logs analysis products. In other words, only the learning characteristic of the Web-based learning environment can originate the specific problems. Our previous research focus on providing various summary report for Web instructor to solve that problems, which can not be answered by Web log analysis, from any perspectives [11]. Hence, the questions, which a instructor may ask, should be "What are the meanings of the more popular parts of the course web in learning hierarchy?", "What is the concept that leads learners to reach particular pages?', and "Can learners quickly reach the learning goals by reorganizing Web pages?' so on. In other words, the reports of existing Web logs analysis products should be interpreted to mining the pedagogical meanings by instructors, instructional designers, Web designers, and course web architects. Consequently, it is necessary to propose methodology for discovering learner (not user) access pattern in the Web-based course.

To mining the pedagogical meanings from Web logs, the first requirement is to understand the content of every Web page. In other words, the instructor of the Web course not only need to know 'who accessed the Web page', 'when the Web page is accessed', and 'from where the learner come', but also should know 'what the Web page contains'. However, it is difficult to represent the content of a Web page with symbols. The reason is that the content of a Web page may contain many concepts. Consequently, the first step for understanding the pedagogical meaning is reconstructing the Web pages in the site of a Web-based course by endowing only one topic or concept for each Web page. While breaking a Web page into single concept Web pages, one would find that some concepts are not atomic concepts. That is because a major concept will contain many sub concepts. Hence, the second step for understanding the pedagogical meaning of a Web page is to identify its location within a concept hierarchy instead of its location within the hypertext hierarchy.

The second requirement for discovering learners' learning pattern is to mining sequential access paths on previous aforementioned concept hierarchy. Although there are methodologies to reconstruct navigating paths of users' behaviors on a Web site, that information is not enough for a Web instructor to make some pedagogical decisions. The users' access (behavior) pattern can only help Web site manager improving Web site schema because a Web instructor still can not figure out learners' intention merely by analyzing Web logs without supports of the Web page content. The proposed concept hierarchy presents a feasible style for supports of interpreting the Web page content. After learners' navigating paths on a Web site are transforming to navigating paths on the concept hierarchy, a Web instructor can comprehensive how learners learn from the information of what learners read.

This paper proposes a methodology to mining learners' learning pattern by transforming learners' Web page access sequences to sequences of learning a concept in Web logs. The methodology is supported by traditional web logs mining algorithms, which is designed for discovering users' access pattern on a Web site. This methodology is not used to replace traditional web logs mining algorithms nor is arguing that concept hierarchy is a suitable web site schema. Rather, this methodology presents a framework for integrating traditional web logs mining algorithms with pedagogical meanings of web pages to support Web instructor get more feedback from learners' navigation on the Web course site. Broadly speaking, this methodology contribute to apply traditional web logs mining algorithms to a specific domain in the technical aspect and progress assessment skills in the Web-based distance learning aspect.

2 Illustrative Example

In overview, there are two steps in this illustrative example of detecting learning status. The first step is data preparation. We design a sophisticate structure of a Web site so that we can recognize the content of the accessed Web page. The second steps will find pedagogical meanings from the contents of the preferred Web pages. In this illustrative example, the result of step two will show that learner is not familiar with the learning topic.

2.1 Data Preparation

The required data was collected from the students in an undergraduate course of Perl programming. Perl is a high-level programming language written by Larry Wall. Perl is a very popular programming language for system administrators and CGI script authors. After a brief introduction of Perl, students were asked to study the Web pages extracted from Perl manual. There are three topics in the prepared Web pages. First topic of Web pages demonstrates how to execute the Perl interpreter, called *Perlrun* in Perl manual. Second topic of Web pages explains the Perl model for declaring importing, and calling a subroutine, called *Perlsub* in Perl manual. Third topic of Web pages describes associativity and precedence of Perl operators, called *Perlop* in Perl manual. Consequently, learners' behaviors recorded by Web logs can be recognized by the topic of accessing Web page.

Synopsis and description compose each topic of Web pages. Synopsis is a summary of a topic and generally contains no more than one page. Figure 1 illustrates the synopsis of the Perlsub topic. Description explains the details of a topic in original Perl manual. For illustration, description for each topic was reorganized into two Web pages. In general, synopsis of a topic is prepared for learners who are familiar with that topic. Learners who are learning a topic will prefer the description of that topic. Hence, we can help a learner just in time if he/she is always looking around the description of a topic.

Aforementioned structure is content structure of learning materials. To present learning materials in a hypertext style, a hyperlink structure is required. We use the full connection style to link all Web pages so that learners can navigate to any destination in any Web page.

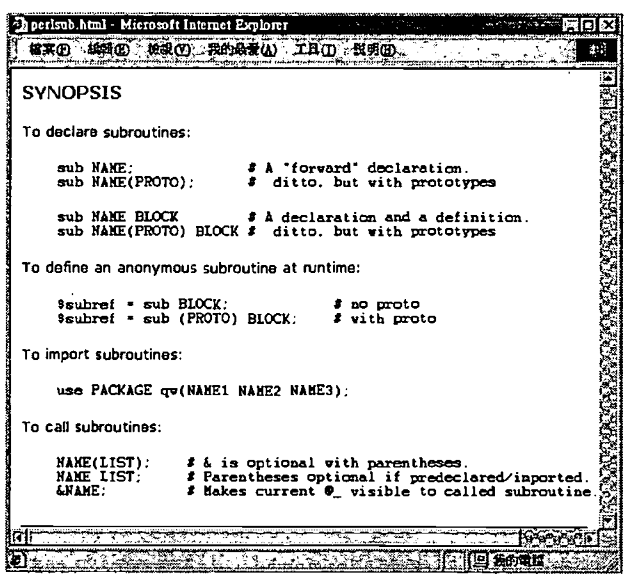


Figure 1. Synopsis of Perlsub.

Figure 2 shows the concept structure of the learning materials on the Web site. The notation P_i indicates the Web pages. Although the overview structure is composed of concept hierarchy and contents of learning materials without hyperlink information, the tree structure above the P_i can be used to interpret the content in the page. For instance, the P_1 belongs to concept synopsis, which is the partial content of the Perlrun topic.

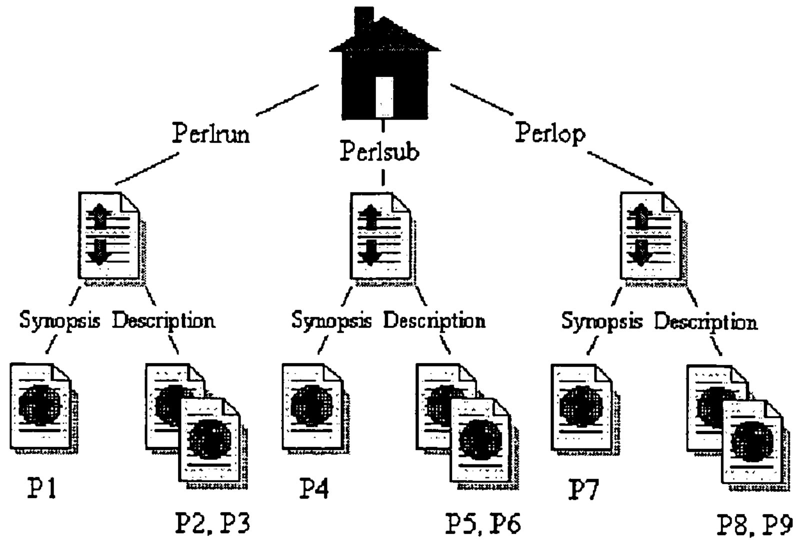


Figure 2. The concept hierarchy of a Web site.

2.2 Mining Processes

There are three learning topics in the Web site, denoted as Perlrun, Perlsub, and Perlop. Each learning topic has two sub concepts, denoted as synopsis and description. The word "synopsis" is used to indicate the Web page for summarizing a topic and the word "description" represents the Web pages that explain a topic in detail. There is an index Web page linking every Web pages to serve as communicating interface with learners. Hence, learners can study any topic in any order through the index Web page. Assume that there is a learner who prefers the "description" Web pages of any topic. In other word, that learner is not familiar with all topics. Hence, the logs of that learner' s browsing behavior on the Web site may be like the sequence:

p2, p3. p2, p8, p9. p5, p8. p5, p1. p2, p5, p6

Because learning can happen in any time, only time nearly browsing behaviors will be related in a learning pattern. Hence, the transaction idea, used in database theory, is involved to cluster learners' browsing behavior. The T*i* means a transaction of the learner' s browsing behavior.

T1: p2, p3
T2: p2, p8, p9
T3: p5, p8
T4: p5, p1
T5: p2, p5, p6

The content of every Web page can be interpreted as a pair of topic and representation style. For instance, p2 belongs to topic Perlrun and is a description of the topic. Hence, p2 is interpreted as (Perlrun, description). After interpreting the transaction data of learner' s behavior, the results are follows.

T1: (Perlrun, description), (Perlrun, description)
T2: (Perlrun, description), (Perlop, description), (Perlop, description)
T3: (Perlsub, description), (Perlop, description)
T4: (Perlsub, synopsis), (Perlrun, synopsis)
T5: (Perlrun, description), (Perlsub, description), (Perlsub, description)

Most of algorithms for mining pattern are derived from aprior [12]. We divide the problem of discovering multi-dimension learner access pattern into four sub procedures, that is litemset phase, transformation phase, sequence phase, maximal phase. Hence, we can use the aprior algorithm for mining pattern. We use the illustrative example to depict the four sub procedures. The litemset phase will generate the large-1 itemset as Table 1.

ID	Large-1 itemset	Support
1	(Perlrun, '*')	3
2	(Perlsub, '*')	3
3	(Perlop, '*')	3
4	('*', description)	4
5	(Perlrun, description)	3
6	(Perlsub, description)	3
7	(Perlop, description)	2

Table 1. Large-1 itemset.

The transformation phase use the feasible IDs of items in the large-1 itemset to substitute items in the transaction of learners' behavior. For instance, the (Perlrun, description) in T1 can be substituted by (Perlrun, '*'), ('*', description), or (Perlrun, description). Hence, the set of feasible IDs is {1, 4, 5}. The result after the transformation phase is following.

T1: {1, 4, 5}, {1, 4, 5}
T2: {1, 4, 5}, {3, 4, 7}, {3, 4, 7}
T3: {2, 4, 6}, {3, 4, 7}
T4: {2, 4, 6}, {1}
T5: {1, 4, 5}, {2, 4, 6}, {2, 4, 6}

The problem is simplified to mining sequential patterns after the transformation phase [13]. Consequently, the sequence phase can generate the large-2 itemset and larget-3 itemset as Table 2 and Table 3.

Large-2 itemset	Support
{1, 4}	3
{2, 4}	2
{4, 3}	2
{4, 4}	3
{4, 7}	2
{5, 4}	3
{6, 4}	2

Table 2. Large-2 itemset.

Large-3 itemset	Support
{1, 4, 4}	2
{4, 4, 4}	2
{5, 4, 4}	2

Table 3. Large-3 itemset.

Finally, the maximal phase will find the most meaningful pattern from large-2 itemsset and large-3 itemset. Initially, the union of large-2 itemset and large-3 itemset is used as the result. Then, some items will be eliminated because they are the subsets of some larger items. For instance, the meaning of {5, 4, 4} is more than its subset {5, 4} and {4, 4}. Hence, the large-2 items, {5, 4} and {4, 4}, will not be deleted from the initial result. Finally, some items will be eliminated because they are less meaningful then items in the result. For instance, the {4, 3} will be deleted because {4, 7} implies {4, 3}. Similarly, the {2, 4} will be deleted because {6, 4} implies {2, 4}. The following table illustrates the result.

Maximal itemset	Real patterns	Support
{6, 4}	{(Perlsub, description), ('*',description)}	2
{4, 7}	{('*', description), (Perlop, description)}	2
{5, 4, 4}	{(Perlrun, description), ('*',description), ('*', description)}	2

Table 4. Maximal itemset.

3 Conclusion

The Web-based learning environment offers opportunities to precisely observe learning processes. However, it is tedious for a Web instructor to discovery useful information from the huge amount of Web logs. Traditionally, a Web instructor uses the Web logs analysis products to realize the unusual parts of a Web site. From the pedagogical standpoint, the results of the Web logs mining algorithms are not very useful for figure out learners' learning process because the contents of Web pages are not considered. This paper proposes a methodology to mining learners' learning pattern, which is related with the Web page contents, from Web logs. The methodology uses Web logs mining algorithms, which is used in Web logs analysis products, and the concept structure embedded in Web pages to mining patterns with pedagogical meanings, so called learning patterns. In our opinions, this methodology presents a framework for integrating traditional web logs mining algorithms with pedagogical meanings of web pages to support Web instructor figure out learners' navigation on the Web course site from the concept hierarchy perspective. Consequently, the approach presented here may be not only a feasible application of traditional web logs mining algorithms, but also a possible direction of Web-based learning assessment research.

Acknowledgements

This project is supported by the National Science Council in Taiwan under contract number NSC 89-2511-S-262 -001.

References

[1] C.K. Chang and G.D. Chen. Constructing Collaborative Learning Activities for Distance CAL Systems. Journal of Computer Assisted Learning, Vol. 13, No. 1, pp. 2-15, March 1997.

[2] R. Fuller and J. de Craaff. Measuring user motivation from server log files. In http://www.microsoft.com/usability/webconf/fuller/fuller.htm

[3] T. Sullivan. Reading reader reaction: A proposal for inferential analysis of web server log files. In Proc. Third Conf. Human Factors on the Web, Denver, Colorado, June 1997.

[4] Sun, C. T. & Ching, Y. T. (1995). Hypermedia Browsing Pattern Analysis. International Journal of Education Telecommunications, 1(2-3), 293-308.

[5] Jihn-Chang J. Jehng. Exploring Learning Potentials in Network-enhanced Learning Environment. In Proc. of ED-MEDIA 99, Seattle, Washington, USA, 1999.

[6] Internet Product Watch (1999). Internet Product Watch: Analysis Products. Online document at http://ipw.internet.com/analysis/index.html (accessed March 25, 1999; no creation or modification date available).

[7] M. Perkowitz and O. Etzioni. Adaptive sites: Automatically learning from user access patterns. In Proc. 6th Int. World Wide Web Conf., Santa Clara, California, April 1997.

[8] Stuart Schechter, Murali Krishnan, Michael D. Smith, Using path profiles to predict HTTP requests. Computer Networks, (30)1-7, pp. 457-467, 1998.

[9] Peter Cabena, et al. Discovering data mining: from concept to implementation. Prentice-Hall, Inc.

[10] Raphen Becker, Kevin McLaughlin, and Samuel A. Rebelsky. Project Clio: Tools for tracking student use of course webs. In Proc. of ED-MEDIA 99, pp. 981-986.

[11] C.K. Chang, G.D. Chen, and Kou-Liang Ou. Student Portfolio Analysis by Data Cube Technology for Decision Support of Web-Based Classroom Teacher. Journal of Educational Computing Research, Vol 19(3), 307-328, 1998.

[12] Rakesh Agrawal, Heikki Mannila, Ramakrishnan Srikant, Hannu Toivonen, A. Inkeri Verkamo: Fast Discovery of Association Rules. Advances in Knowledge Discovery and Data Mining, pp. 307-328, 1996.

[13] Rakesh Agrawal and Ramakrishnan Strkant, Mining Sequential Patterns. ICDE, pp. 3-14, 1995.

Courseware Engineering Methodology

Lorna Uden and Neil Willis
School of Computing, Staffordshire University,
The Octagon, Beaconside, Stafford, ST18 0AD, UK.
Phone: +44 (0)1785 353276
Fax: +44 (0)1785 353497
E-mail: L.Uden@staffs.ac.uk

The design and development of effective courseware is complex process involving many forms of expertise. Several disciplines such as instructional design theories, software engineering principles, human-computer interaction and multimedia are involved. It is not always feasible for a novice to be familiar with such a range of expertise. A methodology integrating all of these various disciplines is urgently needed. The Courseware Engineering Methodology (CEM) has been developed by the author to guide novices to design effective courseware, based on the integration of the various disciplines. CEM has been used successfully by over seventy students at an UK university to develop their courseware in the last few years. This paper describes the CEM development process. The CEM process consists of four models. The pedagogical model concerned with the pedagogical aspects of the courseware; the conceptual model, dealing with the software engineering aspects of the design; the interface model relating to the interface of the courseware, and the hypermedia modelling that deals with the navigational issues of the courseware. Each of the models will be briefly reviewed. The paper concludes by stating the benefits of using a modular approach to courseware development and reuse.

Keywords: **Pedagogical Model, Conceptual Model, Navigational Model, Interface Model.**

1 Introduction

Computer technology offers great potential as a valuable instrument in teaching and learning. However, the impact of its use in education is not very impressive. One of the main problems attributed to this disappointing fact is that developing effective courseware is not trivial. Although there are tools that minimise the computer-related knowledge required, they are merely implementation tools. Successful designers need to understand both the subject upon which lessons are based and the principles of instructional design and learning theories. On top of these are the issues of software engineering principles, human-computer interaction and hypermedia involved. It is rare that a novice would possess such a wide range of expertise. A methodology is urgently needed to enable novice designers to design and develop effective courseware. The different types of expertise need to be integrated and transformed from one form to another in order to maintain a seamless transition. This is necessary because courseware development consists of several phases. The task of courseware design extends from the analysis of the domain knowledge to be taught, to the development and delivery of instructional materials.

1.1 Problems with the traditional approach

There are many problems associated with the traditional approach to courseware development, among which are:

- a lack of prototyping facilities to allow early evaluation of the lesson;
- a lack of separation of the various components of the development process;

- a lack of support for reuse;
- a lack of a method for interfacing and hypermedia modelling.

In order to overcome these limitations, an engineering approach to courseware development is desirable. The methodology should be based on sound principles from the various necessary disciplines that have implications for effective courseware. To be effective, it should contain design principles and guidelines, which can help designers, in particular novices, in the various phases of the courseware development process. The Courseware Engineering Methodology (CEM) has been developed specifically to help novices to develop courseware.

In order to evaluate the methodology, CEM was used by over seventy student designers over a period of three years in the Instructional Software Design (ISD) module at a UK university to develop their own courseware.

2 The CEM Development Process

Because courseware development is such a complex task, it is not possible to cope with handling all requirements at once. In order to reduce the complexity, a model-based approach is taken in CEM for courseware development. By allowing the development of courseware with a number of different models, designers are allowed to focus on each aspect of the courseware one at a time. Each partial model is an abstraction of the system, which enables designers to make the necessary decisions at each level in order to move closer to the final model.

Model-based design facilitates the principles of decomposition, abstraction, and hierarchy. It also allows designers to describe the application in an implementation-independent way. Besides the model-based approach, the methodology adopts an evolutionary prototyping process for its development. In addition, there is a separation of the domain from the instructional strategies. For hypermedia courseware such as the World Wide Web, there is navigation modelling to structure the hypertext links and contents. There are four main models involved in CEM. These are the pedagogical, conceptual, navigation and interface models; each dealing with the various aspects of the development process.

2.1 Iterative Incremental Development

Counter to the traditional linear model of courseware development, iteration and incremental development is at the heart of CEM. Incremental development, in this context, is a process that involves continuous integration of components into the system' s architecture to produce releases, with each new release embodying incremental improvement over the other [2]. An overall system architecture is established early in the process to act as a framework. System components are incrementally developed and delivered within this framework. User feedback from delivered components can affect the design of components scheduled for later delivery. An iterative incremental development is based on successive enlargement and development of a system through multiple development cycles of analysis, design, development and evaluation. Each cycle tackles relatively small sets of requirements and the system grows by adding new functions within each development cycle. This approach offers the benefit of allowing requirements to be adjusted to match changing user needs as the product proceeds.

CEM is an iterative and incremental design approach, based on the construction of a sequence of models, which begins from analysis and continues through implementation. It thus produces a seamless transition from abstract pedagogical model to concrete courseware design, allowing for a clean traceability between models. This means that objects in one model can be traced to objects in another [7]. Development in CEM is also architecture-centric. The process focuses on the early development and baselining of courseware architecture. Having a robust architecture in place facilitates parallel development, minimises rework and increases the probability of component reuse and eventual system maintainability. This architectural blueprint serves as a solid basis against which to plan and manage component-based courseware.

The development process of CEM consists of four main phases, which are known as the macro phases. These are (a) inception; (b) elaboration; (c) construction; and (d) deployment. Associated with these phases are models and subprocesses.

2.2 Inception

During the inception phase, the organisational rationale and scope of the project are established. The inception phase includes the investigation of alternatives and planning. Central to the inception phase is the conceptualisation process. Conceptualisation is the process of coming up with an idea for a system along with a general idea of its requirements and form. It is the process that determines the system to be built and its high-level outline and structure, based on the organisational needs and the technology.

Because this process may unearth ' needs' that either should be, or cannot be met by instruction, part of the process includes filtering out the learning needs. Since more learning needs may be discovered than it is desirable to address, another part of the process is to analyse all such needs and establish priorities. When conceptualisation is performed, it contains its own conceptualisation, analysis, design and implementation phases of development. Throw-away prototyping is what is used to carry out the conceptualisation process. The prototype is created to aid understanding of the problem and requirements. Outputs from this process may include a statement of the problem, resources, budget, alternative organisational needs, scope of the project and core requirements for the system.

2.3 Elaboration

The designer so far has only a vague idea of requirements. In elaboration, more detailed requirements are collected, high-level analysis and design are performed to establish baseline architecture and a plan for construction is created. Several processes are involved in the elaboration phase. These include use case modelling, learner analysis, environmental analysis and domain analysis.

2.3.1 Use case modelling

A good technique to improve understanding of requirements is the creation of use cases - narrative descriptions of domain processes. One of the biggest development challenges in courseware development is building the right system: one that meets the users' needs at a reasonable cost. Use case modelling is one of the most widely used analysis techniques for object oriented development [2][7]. The use cases are goals that are made up of scenarios, which in turn consist of a sequence of steps to achieve the goal. Each step in a scenario is a sub, or mini, goal or use case. Each sub goal requires another use case (subordinate use cases) or an autonomous action that is at the lowest level desired by the use case description. Use cases and scenarios work on many levels in CEM. During the elaboration phase, it is useful to write the most important and influential use cases in the expanded format, but the less important ones can be deferred until the construction cycles in which they are being tackled.

Use cases model the functionality of the system as perceived by the actors. Actors are users of the system in a particular role. They may be people, computer systems or processes [7]. The use case model captures the behaviour of a system or a class as it appears to an outside user. The purpose of a use case is to define a piece of coherent behaviour without revealing the internal structure of the system. Each use case represents an orthogonal piece of functionality whose execution can be mixed with the execution of other use cases. Use case modelling in CEM helps with three of the most difficult aspects of courseware development: capturing requirements, planning iterations of development and validating systems. For a detailed description of *use cases* refer to Jacobson, Christerson, Jonsson and Overgaard [7]. Thus, *use cases* describe how people interact with a system in the context of working toward some goal.

In order to deal with the different formats in which use cases are used in the courseware development process, use cases can be either ' essential' or ' real' [8]. An essential use case describes the process in terms of its essential activities and motivation. High-level use cases are always essential in nature, due to their brevity and abstraction. Essential use cases are often created during early requirements elicitation in the elaboration phase in order to more fully understand the scope of the problem and the functions required. In contrast, a real use case concretely describes a process in terms of its real current design, committed to specific input and output technologies. Use cases dealing with the interface aspects of design are generally real use cases.

The system functions identified during the elaboration phase should all be allocated to use cases. In addition, it should be possible, via the cross-reference section of the use cases, to verify that all functions have been allocated. Ultimately, all system functions and use cases should be traceable through implementation and testing.

2.3.2 Learner analysis

It is important during this process to define the 'target audience' accurately and in sufficient detail to make design decisions. Determining the characteristics of the students will help to determine where the instruction should begin. Learner analysis begins with a clear definition of the target population. It ends with an identification of those characteristics of the target population that are likely to influence the design, delivery and utilisation of instruction. The output for this process is a chart containing the profile of the users who will be using the system.

2.3.3 Environmental Analysis

The purpose of this analysis is to analyse the context, that is the target environment in which the courseware will be delivered. In order to get a survey of the context features and constraints, it is necessary to interview customers/sponsors to obtain necessary information.

2.3.4 Domain Analysis

Use cases are not the whole picture in the elaboration phase. Another important task is to come up with the skeleton of a conceptual model of the domain. A domain is a representation of concepts in a subject matter. Data modelling is adjunct to use case modelling. The goal of domain analysis is to obtain a basic understanding of the topic and tasks used in the requirements identification.

In traditional courseware development, the domain knowledge is intertwined with the teaching knowledge, both being contained in pre-stored frames and fixed sequences. In CEM, domain knowledge is separated from instructional strategies. This gives rise to a more flexible and adaptive system for the reuse of domain knowledge and instructional strategies. A subject domain is an area of content to be learned. The outcome of domain analysis results in a structure of a subject domain to be learned. Domain concepts (i.e. types) are represented as objects, whilst links are used to denote relationships which may exist between them. The notation that has been chosen to represent the objects and links of the domain is a subset of the Unified Modelling Language (UML) notation [2]. The output from this process is a domain model that consists of topics, sets of topics and structures.

2.4 Construction

The construction phase consists of many iterations in which each iteration builds production quality courseware, tested and integrated, that satisfies a subset of the requirements of the system to be built. Each iteration contains all the usual life cycle of analysis, design, development, testing and evaluation as shown in Figure 1. This is the micro-process level of the CEM development.

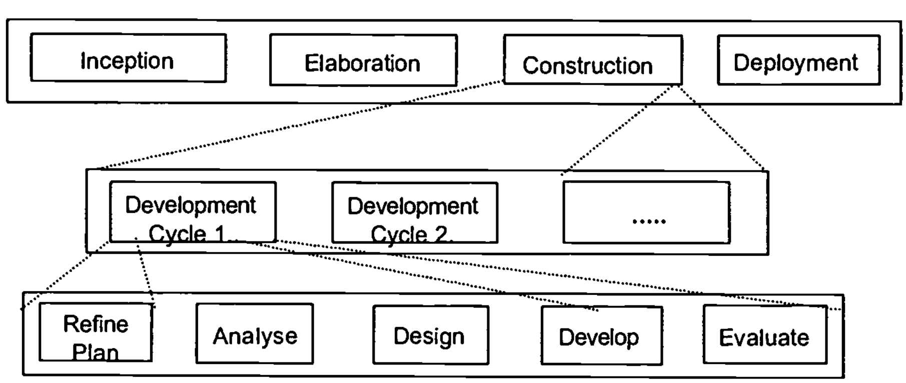


Figure 1 Iterative Development Cycles

2.4.1 Analysis and Design

The analysis and design processes in the construction phase are concerned with the design of the pedagogical model. So far, only the topics from the domain to be taught have been analysed. There is still some information missing, although the learner analysis has been addressed. It is now necessary to examine the prerequisite skills and knowledge that must be mastered for a student to achieve the goals or objectives of learning. Instead of rushing to write the courseware lessons, designers should first spend some time in determining exactly what learners must acquire in order to reach the goals or objectives. In order to analyse exactly what learners have to learn for the objective or goal, it is first necessary to identify the type of objective of the learning.

According to Gagné [4], there are different learning objectives, each requiring different analysis and instructional strategies. To help designers in identifying the right type of learning outcome, a Courseware Learning objectives (CLO) has been developed. CLO is used by designers in CEM to identify the learning objective, analysis method, and instructional strategies to be designed.

2.4.2 The pedagogical model

The aim of the design process during the construction phase is to produce the pedagogical or instructional model. This involves objective definition, assessment definition and instructional strategies definition. The objective definition describes the learning outcomes of the intended courseware. Once the objectives have been defined, the optimum sequence of the instruction is determined. Having defined the learning objectives, the next process is to decide how learners' attainment off the objectives will be measured or tested. Development of assessment follows the objectives definition. Assessment of learning is a crucial part of an instruction process. There is a need to assess student performance to determine whether the newly designed courseware has met its design objectives. There are various types of tests available in CEM to assess students' performance. The decision on what type of testing to use is determined by the purpose of the course, the students' needs and the skills required. Guidelines are provided in CEM for designers to choose the most appropriate tests for their learning objectives.

The writing of instructional strategies follows the assessment definition. Instructional strategies to be used are determined by the type of learning required. The CLO is used to assist designers in determining the most appropriate strategies to be used for the particular type of learning. Once the instructional strategies are defined, the design of instructional messages can begin. This completes the design process and the output is the pedagogical model, a blueprint of the courseware to be developed. The pedagogical model produced so far is independent of any medium or vehicle of instruction. It may be used to deliver on any chosen medium.

2.5 Development process

The next process in the construction phase is the development process. It consists of three subprocesses: conceptual modelling, navigation modelling and interface modelling.

2.5.1 The conceptual model

To be useful as input to a computer, the pedagogical model needs to be transformed into concepts and notions acceptable to a computer. One of the limitations of traditional courseware is that development is performed independently of other phases, there is no means of integration and reuse. In CEM there is separation of domain from instructional strategies and also there is complete integration of the conceptual model, the navigational model and the interface model, providing a seamless transition between the three.

The pedagogical model is transformed in CEM into a conceptual model that can be input to a computer by using the object-oriented Unified Modelling Language (UML) notation [2]. UML is a graphical language for visualising, specifying, constructing and documenting the artefacts of a software-intensive system. The pedagogical model developed is transformed into the conceptual model using classes, relationships, and sub-systems. The object-oriented approach is chosen because it provides a natural framework for modelling the subject domain of the courseware application. In addition, it supports reuse and design patterns [5]. In order to show the lesson structure in the conceptual model, activity diagrams are used instead of flowcharts. Activity diagrams are a graphical depiction of the lesson, showing what happens under all possible circumstances.

2.5.2 The navigational modelling

Navigational modelling is the second step of the development process. This step is particularly relevant if hypermedia or the web is used as the authoring platform. One essential distinguishing feature of hypermedia courseware applications is the notion of navigation, in which users of an application in this domain navigate in a space made out of objects. In CEM, the navigational model is built over a conceptual model, thus allowing the construction of different models according to different users' profiles. The navigational design is expressed in two schemata, the navigational class schema and the navigational context schema. The navigation class schema gives a snapshot of the navigation structure. Once the navigational classes have been decided, it is necessary to structure the navigational space that will be available to users. In CEM, this structure is defined by grouping navigation objects into sets called contexts. The main structuring primitive of a navigation space is the notion of navigational context. A navigational context is a set of nodes, links and contextual information. It provides a consistent way to specify the navigational aspect of the design.

The navigational structure of the courseware application is defined in a context diagram known as the navigational context schema. The dynamic aspect of the hypermedia courseware is defined in CEM using navigational charts. Navigational charts are a type of statechart [6]. A navigational chart is basically composed of navigational objects, states and transitions. The last step of the development process is the interface modelling. Although interface design is a crucial part of courseware development, this step is rarely mentioned in the courseware development literature[1]. Storyboards are developed instead. A good software design avoids unnecessary dependencies by separating the interface from the rest of the system and dividing it into several loosely coupled parts. An abstract interface approach is used in CEM to describe the interface modelling. The idea of an abstract interface design is to separate the underlying semantic information of a courseware domain from the various ways of presenting the information to learners (user interface). This allows the building of different interfaces for the same navigational model, leading to a higher degree of independence from the user-interface technology.

2.5.3 Interface modelling

The Abstract Data View (ADV) design approach is adopted in CEM to describe the user interface of a courseware application [3]. A typical application using ADVs would have a set of Abstract Data Objects (ADOs) managing data structures and control within the application and a set of interface objects (instances of ADVs) managing interface aspects of the application such as user input and system output to the user. ADV charts are used to express the dynamic aspects of the interface. They are the interface expression of navigational charts; i.e. they express transformations at the user-interface level. The overall application behaviour of the hypermedia courseware is completely specified by defining the way in which external events affect both navigation and the interface appearance of the application. The navigational semantics specify the 'internal state' of the application and how it changes during the navigational process. The effect of each external event in terms of the transformations occurring in the interface must be shown. This is shown by using ADV charts that show the possible states and corresponding transitions of each ADV event in order to understand the way in which individual interface components behave when reacting to external events. An ADV chart is composed of ADVs, states, attributes and transitions. Nesting of ADVs allows designers to show the aggregation structure of the interface objects. The use case is then built and tested, making sure it is working.

2.6 Evaluation

Evaluation is the last step in the construction phase of CEM. Lessons are evaluated for their overall quality, their applicability to a curriculum, performance and usability. Another purpose of evaluation is to assist in lesson development and maintenance. Although evaluation is discussed as the last step of the development process, it should not be assumed that evaluation is merely the last step in CEM. On the contrary, evaluation is part of an iterative cycle of designing, evaluating and revising. It is carried out in all of the processes involved. There are two types of evaluation measures in CEM, which measure the students' performance and lesson effectiveness. CEM provides a very detailed and comprehensive plan for formative evaluation of the courseware produced. The three steps involved are quality review, pilot testing and field-testing. During quality review, the materials developed are reviewed to assess the content, appearance and attention to good instructional practice. The main objective of pilot testing is to analyse the effectiveness of the learning process involved with students, and use of the courseware product. Field-testing is validation of the lesson - checking how well the lesson works in the real instructional setting. It is only after full and thorough evaluation that the courseware can be released for deployment.

2.6.1 Summative evaluation

The case studies showed that CEM does provide a development methodology that is easily implemented by novice designers. In order to evaluate the effectiveness of the courseware applications produced, they needed to be used by the school children of the schools that commissioned their development. Feedback from teachers and children of these schools revealed that the courseware produced were very useful.

Post-tests were given in order to evaluate the school children's understanding of the chosen subjects. The results of these tests showed marked improvements in the children's performance of their respective subjects.

2.7 CEM Evaluation

The primary goals of CEM are to assist in the courseware development process and to increase the quality of the courseware product. In order to determine the usability of CEM, it is necessary to evaluate these two goals. The most appropriate research method to evaluate the methodology is the Developmental Research Method [9]. Developmental Research is the systematic study of designing, developing, and evaluating instructional software programs, processes and products that must meet the criteria of internal consistency and effectiveness.

Two case studies were used in the evaluation of CEM that include descriptions of the actual design and development process by novice designers in the creation of a particular product. The main data collection methods used were surveys, in the form of written questionnaires, and interviews. An instructional software design (ISD) module was offered as part of the final year programme for students at the university in 1996 and 1997. There were twenty-five students in 1996 and thirty-one in 1997. In addition to these students, there were also twenty students who were not taking the module, but who used CEM as the methodology for their courseware design method for their final year projects. As part of the instructional software design (ISD) module, students were required to develop a substantial piece of courseware to be evaluated by target learners. These students were taught several courseware methodologies. All but one, who chose Gagné's methodology, chose CEM to develop their courseware products. None of these students had any previous experience in courseware production. Among the cohorts of students, approximately half were female. Their backgrounds, experience and cultures varied widely including Chinese, Indians, Greeks, French and English. Students were allowed to chose their own authoring tools from Authorware, Macromedia Director, Visual Basic, HyperCard, HTML, Java and C programming. Evaluation of the methodology by questionnaires and interviews revealed that all students found CEM very useful and they were able to follow the guidelines in helping them develop their respective subject matter, different types of learning and tools chosen. A full report of the evaluation is available from the author. The courseware produced included subjects such as biology, mathematics, history, geography, networking, programming languages, cookery, chemistry, physics, etc.

3 Conclusions

CEM differs from traditional courseware in many ways. It incorporates carefully selected state-of-the-art techniques from software engineering including object-orientation and use cases. It also provides guidelines and methods for hypermedia and interface development. The various techniques and methods are integrated from various required disciplines within a framework of inter-related models. The modular approach enable designers to focus on particular aspects of the development process one at a time. Within the methodology there are many specific advances including the development of courseware learning objectives, the use of conceptualisation for needs analysis, separation of domain from instructional strategies, the modelling of hypermedia courseware applications, support of reuse through design patterns and interface modelling. Evaluation of CEM by novice designers has demonstrated its value.

References

[1] Alessi, S.M. & Trollip, S.R. "Computer-based instruction: methods and development", Prentice-Hall. 2nd Edition, (1991).

[2] Booch, G. Rumbaugh, J.& Jacobson, I. "The Unified Modelling Language User Guide", Addison-Wesley, Longman Inc. (1999).

[3] Cowan, D.D. & De Lucena, C.J.P. "Abstract Data Views: an interface specification concept to enhance design for reuse", IEEE Transactions on Software Engineering, 21(3), 229-243. (1995).

[4] Gagné, R. M., "The Conditions of Learning", Holt, Rinehart & Winston, 4th edition, (1985).

[5] Gamma E., Halini, R., Johnson, R. & Vlissides, J. "Design Patterns: Elements of reusable object-oriented software", Addison-Wesley, Longman, (1985).

[6] Harel, D. "Statecharts: A visual formalism for complex systems", Scientific Computing Programming, Vol. 8., 231-274 (1987)

[7] Jacobson, I., Christerson, M., Jonasson, P. & Overgaard, G. "Object-oriented Software Engineering: A use case driven approach" Addison-Wesley, (1992).

[8] Larman, C. "Applying UML and Patterns: an introduction to object-oriented analysis and design", Prentice-Hall, (1998).

[9] Richey, R.C. "Research on Instructional Development", Educational Technology Research & Design, 45(3), 92-100, (1997).

From Research to Development: A Content Analysis of Journal Articles

Alex Rath* and Shihkuan Hsu**
** Shih Hsin University, Language Center,1 , Alley 17, Sec. 1, Mucha Rd., Taipei, Taiwan 110*
Tel: +886-2-22368225 x316, E-mail: rattle@cc.shu.edu.tw
*** National Taiwan University, CTE, 1, Sec. 4, Roosevelt Rd., Taipei, Taiwan 106*
Tel: +886-2-23692364 x214, E-mail: skhsu@ccms.ntu.edu.tw

While the goal of educational research is to improve the field of education, most of the material used in the field is not necessarily developed from research. While most of the researchers in the university study the theory and practice, it is the textbook publishers and computer companies that make the tools available for schools and teachers. The disconnected and fragmented process between research, dissemination, development, and production not only wastes the effort and resources put forth in research and practice, but also hampers the development of the field of education. Using the method of content analysis, the authors examine the connectivity of educational research and development reported in a highly regarded professional journal over the past two decades. The results found that over 80% of the research studies presented only parts of a full-fledged R&D process: Theory, research, development, funding, and dissemination. Among them, about 40% of the articles addressed both research and development. It is argued that although the full-fledged R&D is a crucial process to enable the transformation of good research into quality practice, it has not received enough attention in the field of education. Implications for educational technology are particularly discussed.

Key words: **Educational Research, Research and Development, Content Analysis, Instructional Technology, Information Dissemination**

1 Introduction

The separation of research and development has long haunted the field of education. The professional approach to creating new instructional tools in the academic realm starts with educational research. The corporate instructional tool developers reiterate that the process starts with research. Theoretically, the process includes three stages: (1) research and development (also called R&D), (2) product development, and (3) production Dumbleton [1]. In actual practice, very little of the research makes it out of the lab and becomes widely used in practice. At the same time, corporate developers of instructional technology or curriculum material invest little in educational research. To go beyond personal observations and anecdotal evidence, a method is invented to examine the level of full-fledged R&D available in professional journals that are widely circulated in educational circles. The research question was: What amount of full-fledged R&D that includes theory, research, development, funding and dissemination was published in the *American Educational Research Journal*?

2 Method

In this study, the method of content analysis is used to evaluate the level of educational R&D reported in journals. Content analysis, or bibliometric analysis, includes evaluation of macro-trends such as dissemination as well as microanalysis such as the nuance of a single line of text. Ample precedent exists to use content analysis to evaluate the state of educational R&D. Articles in *AERJ* and other journals have been analyzed in order to understand R&D productivity, university productivity, faculty productivity, program quality, methodological quality, journal content, and journal rhetoric. Therefore, analysis of articles in *AERJ* provides a measurable indication of the extent that full-fledged educational R&D is published.

Random selection produced a dataset of *AERJ* articles (N=278). About 40% (n=116) of the papers directly and indirectly related to instruction. Of the articles, 74 indirectly related to instruction and were eliminated. Excluding all articles unless they were directly related to instruction produced a small subset, comprising about 15% (n=42) of the sample, which were analyzed in this study. Articles were coded according to five components: Theory, research, development, funding, and dissemination. The range is 1-5, where 1 indicates only one part of the R&D process was included and 5 indicates that all five parts were found in the article. The mean number of R&D components reported in the instruction articles (n=42) was 3.36 and the standard deviation was 0.98.

3 Results

Content analysis was used to determine the extent to which theory, research, development, funding, and dissemination appeared in the selected articles. Evaluating the elements separately showed the frequency of R&D components. All 42 articles (100%) presented research. Thirty-one articles (74%) achieved dissemination. Twenty-nine articles (69%) reported funding. Twenty-one articles (50%) discussed theory. Of all the parts of R&D, development was the lowest frequency. Only 18 articles (43%) presented educational development. This was not surprising. Many articles were efforts to see that was happening in classrooms and with individuals, and there were many tests of theory.

The next step in describing the articles on instruction is to determine how many R&D articles combined all five parts. Of the 42 articles on instruction, the complete R&D process was clearly observable in only five (12%) papers. These papers were published in 1964, 1971, 1990, 1996, and 1997, suggesting that the more recent papers have slightly better coverage of the R&D process. Fourteen (33%) of the articles contained four components of R&D. Fifteen (33%) of the articles contained three components. Seven (17%) of the articles contained two components. One article (2%) had just one component.

By combining the two top categories, a new way to interpret the data emerges. The articles in the top two categories, articles with five and four parts of the R&D process, 45% (n=19) can be described as more developed studies than the articles with one, two, or three parts. It is interesting to note which component was missing in the articles which reported four parts. The missing component was theory, 42% (n=6), development, 42% (n=6), funding, 8% (n=1), and dissemination, 8% (n=1), respectively. There is a pattern emerging: research, funding, and dissemination.

A characteristic paper format emerges which has theory, research, and dissemination. Researchers are testing theories. Combining the three part and four part papers, which includes 69% of the articles (n=29), demonstrates the emphasis on educational theory and educational research. The pattern of what is included and what is missing appears when ranked in order of frequency. The four part studies present, in order of frequency, the following components: research, dissemination, funding, theory, and development. The three part studies present, in order of frequency, the following components: research, dissemination, funding, theory, and development. In other words, both three and four parts studies have the same pattern. They are most likely to do research, achieve dissemination, get funding, use theory, and complete educational development. Educational development is last on the list of R&D components presented in nearly seven out of ten *AERJ* articles. When funding and dissemination are dropped, the following pattern emerges: theory and research.

4 Conclusions

The incomplete R&D program is an unfulfilled opportunity. When numerous programs are unfinished, and the results are not fully disseminated, the investment is marginalized. When the knowledge from the incomplete program is not added to the knowledge base, overlap will occur and resources will not be put too good use. Teachers and administrators need choices, and only full-fledged R&D will give them a selection of programs for their schools. Corporate developers, like schools, need educational R&D. With such a limited number of full-fledged R&D articles in *AERJ*, it is possible that education professionals are missing an important opportunity.

References

[1] Dumbleton, J. H., "Management of high-technology research and development", Amsterdam, The Netherlands: Elsevier Science Publishers, 2nd Edition, (1989).

Design and Implementation of a Chinese Web-mail System

Chang-Sheng Chen*, Jian-Liang Liu and Shian-Shyong Tseng****
Department of Computer & Information Science, National Chiao-Tung University
1001, Ta Hsueh Rd., HsinChu, Taiwan 300, R.O.C.
Tel: +886-3-5731721 Ext.56605
Fax: +886-3-5721490
**E-mail: cschen@cc.nctu.edu.tw*
***E-mail: jlliu@cis.nctu.edu.tw, sstseng@cis.nctu.edu.tw*

E-mail is one of the most popular services on Internet. Fast message transportation, good GUI designs and enhanced localization capabilities in end-user environments are the key factors. However, there still exist some addressing problems for many users since it is based primarily on the ASCII character set. For those who do not know English well, ASCII set is hard to memorize and is prone to making errors. As more users joining the Internet, this kind of problems should not be ignored. Especially, these become major problems for students and teachers in primary/secondary schools. Currently, many approaches are proposed to support the Chinese and/or multilingual DNS name resolution. However, according to our study, most are designed to support URL addressing with Chinese characters in between. Few if any works on the e-mail addressing issue. This paper presents a description of our experimental system, which supports localized Chinese e-mail address mapping by using the LDAP directory service. In the future, if there is any standardized multilingual addressing scheme available, it could be incorporated into our system. The same user interface could still be used. With minor modifications, the same approach should be easily adapted for utilization in other language system.

Keywords: **Chinese, LDAP, URL, web-mail**

1 Introduction

E-mail is one of the most popular services on Internet. Fast message transportation, good GUI designs and enhanced localization capabilities in end-user environments are the primary keys. Most people would like to communicate with each other via their native language(s) if possible. By the efforts of computer scientists, most of us could write and read e-mail contents in local language today. However, as to the addressing part, that is another story. There still exist some addressing problems in internetworking for many users because they are based on the 7-bit ASCII character set. For those who do not know English well, ASCII character set is hard to memorize and is prone to making errors. With more users joining the Internet, this kind of addressing problems should not be ignored.

Up till now, there is no multilingual addressing standard, no multilingual registry in gTLD[11], ccTLD on the DNS[7] naming infrastructure. Currently, RFC 1035[7] is the main implementation obstacle. It limits the valid domain name character set to be a subset of the ASCII character set. Furthermore, while using in DNS, all the capital letters and their corresponding little characters are treated as the same by historical reason. These make the non-ASCII addressing still not possible in general.

There are many proposed approaches [10][13][17] to support the Chinese and/or multilingual DNS name resolution. To name a few, internetworking scientists in Asia Pacific region (including China, Hongkong, Japan, Korea, Singapore, Taiwan, etc.), RIPE, etc., are undertaking some IDN projects for developing multilingual addressing environments. However, according to our study, most of the proposed solutions are mainly designed to support the URL addressing with multilingual characters in between. Few if any addresses the e-mail addressing issue.

We had designed and implemented a web-mail system with Chinese addressing capabilities by incorporating the LDAP directory services [3][4]. Conceptually, we could view an ASCII e-mail address as one of the attributes of some user's profile. By storing users' profiles on directory servers, software with directory-enabled capabilities could be easily used to extract the ASCII e-mail information for further utilization. In this way, our system provides a workaround solution for the Chinese e-mail addressing problem indirectly by translating a Chinese name to its corresponding ASCII e-mail address. The same approach could be easily adapted for utilization in other language system.

1.1 Chinese E-mail addressing

Every e-mail message could be divided into two parts: the header and the body. Now the problem to send messages with multilingual characters in the body can be dealt with by using MIME [1]. Before sending, the sender programs encode messages with the MIME standards. The messages are then transported over the Internet to the destinations. At last, they are decoded with MIME enabled clients. However, as for header sections, we still do not have a standard solution for non-ASCII addressing. Up to now, almost all mail client and server software on Internet commu nicate with the ASCII addressing expression only. Could there be any systematic approach (or workaround solutions) for supporting non-ASCII e-mail addresses?

To further describe the main ideas, let us check the three (pseudo) e-mail expressions shown below:

- jsc.cis84@nctu.edu.tw
- Jian-Shyong Chen< jsc.cis84@nctu.edu.tw >
- • • • •< jsc.cis84@nctu.edu.tw>

On the first look, they seem different; however, basically they mean the same thing. That is, jsc.cis84@nctu.eu.tw is the true component for e-mail address routing. However, using LDAP addressing book, the last form with Chinese name could be a good candidate for providing a workaround solution to support multilingual addressing.

1.2 Web-based Environment

WWW browsers have become standard applications for Internet access today. For those who do not have their own computers on working places (e.g. students in school environments), there are some obvious advantages through using browsers to send or receive mails:

- No additional software is necessary. All one need is a browser program.
- The browser programs (e.g. IE, Netscape, etc.), being the most popular software, can often reduce the learning time of users.
- Web-mail systems could be easily adapted for supporting roaming access.

1.3 Mail Routing with Directory Service Support

By putting e-mail addresses with forms like the last one shown above onto LDAP directory servers and through the translation of directory-enabled web-mail systems, we could achieve the goal of communicate with multilingual addressing indirectly. This is promising for many people.

Let us describe the working paradigm shown in Figure1. The mail routing is performed as below.

- The user types the Chinese name of the recipient (for example, "• • • •"), together with additional information (e.g. school name, city name, etc.), through the client mail interface.
- The client then consults the LDAP server to see if there is any one matching the search condition. If yes, all the matched people's information will be returned to the client, and the user can choose the one wanted. After that, the LDAP Server will return the related ASCII e-mail address of the recipient
- Using the returned ASCII e-mail address, the client sends the message to the destination SMTP server.

In principal, there is no need to alter the original mail server routing. It works as before on one condition. That is, if there are distributed LDAP servers on the related sites, with chaining and referral capabilities enabled.

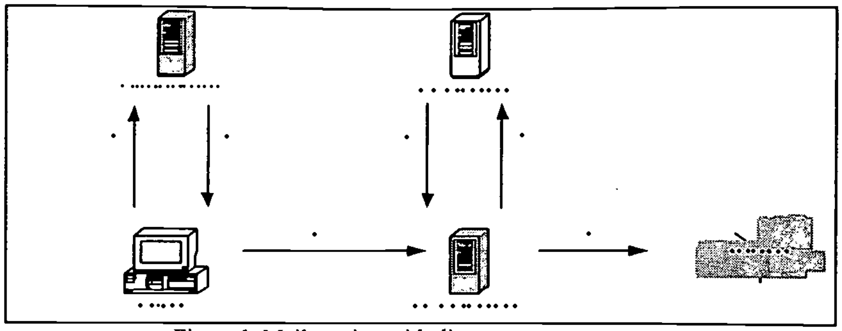


Figure 1. Mail routing with directory server support

2 Related Work

There are several proposed approaches to solve the Chinese URL addressing problem. Three of them will be described briefly in Sec.2.1, Sec.2.2, and Sec.2.3. Interested users are encouraged to visit the related web sites for more details. In Sec.2.4, we will describe the main practical problems of these systems.

2.1 mDNS [13]

The mDNS project is under joint development by researchers in TWNIC, Academia Sinica, and National Central University, Taiwan. The goal is to develop an internationalized DNS system to help the "non-English" DNS architecture to become standardized. mDNS would not effect the existing gTLD or ccTLD. Although the proposed experimental architecture can accept Chinese (BIG5) URL, it is not full Chinese URL. It is necessary to modify the source code of the ".tw" root server; however, it is not necessary to modify the existing client software.

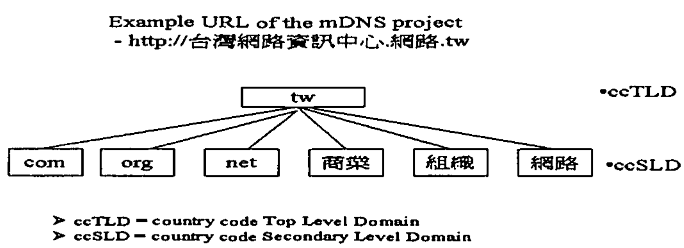


Figure 2. The experimental architecture of the ccTLD ".tw"

2.2 iDNS [17]

The iDNS project is mainly under development by Singapore researchers. As shown in Figure 3, the key component of iDNS is the domain name proxy server, which translates the i18n (internationalization) domain name to the format of UTF-5 and transmits the translated format to the real DNS server. When the iDNS system receives the ASCII domain name, it will consult the old existing DNS system. However, if it receives the non-ASCII domain name, it will be routed to the i18n branch system.

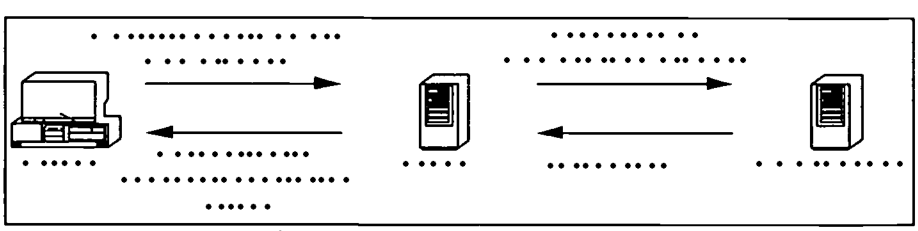


Figure 3 iDNS domain name proxy server

2.3 cDNS[10]

The cDNS project, run by researchers in CNNIC, is developing similar scheme. The main idea of cDNS is the proposed ***DNS forest*** architecture instead of the traditional rooted DNS tree structure. Interested users are supposed to refer to the web site of CNNIC for further details.

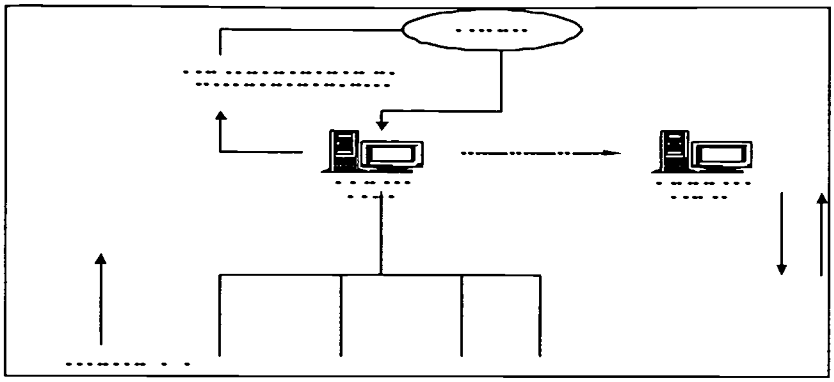


Figure 4 The cDNS architecture.

2.4 Practical Application Problems

Although it looks promising in the first place; however, up to now most of the proxy/caching and mail servers (ex. Squid and sendmail) cannot accept non-ASCII addressing. As mentioned in the introduction section, RFC 1035 is the current implementation obstacle, which breaks all the paradigms. It's nearly impossible to keep compatibility with the current system without modifying the source code of these servers, recompiling and reinstall the systems.

3 Overview of the LDAP Directory Service

It seems that we could not get an immediate multilingual addressing solution without modifying the existing servers all over the Internet. That is why we think that the LDAP enabled web-mail system might be a good workaround solution to try. Before further on, let us make some introduction on LDAP.

3.1 Why LDAP?

Historically, X.500 [3][4] is based on the ISO stack. It is just too complex and hard to implement in the real environments. LDAP [3][4][8][9] is the protocol initially designed as one front end of X.500. Since LDAP can be easily implemented and can be used to exchange information between LDAP servers, standalone LDAP directory server becomes popular gradually. As shown in Figure 5, Desktop PC can access the data of LDAP/X.500 directory server by LDAP protocol.

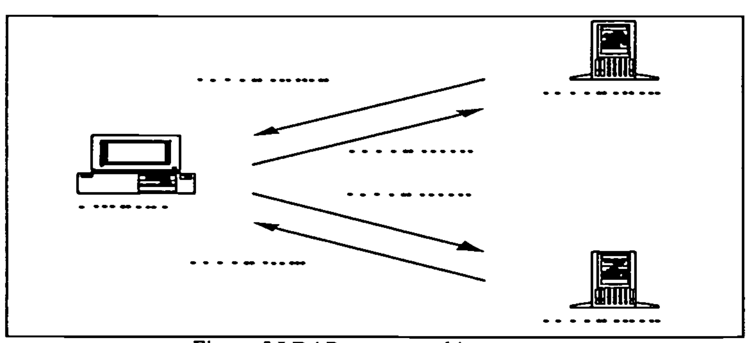


Figure 5 LDAP system architecture.

3.2 How Does LDAP Work?

LDAP stores the information hierarchically, where data is stored as key-value pair. [4][6] Each key will be mapped to one or many values. For example, *cn* (common name) will be used to store user name, mail will be used to store user's email address, etc [2][4]. Every node in the tree architecture of the LDAP directory will be viewed as an object, which has one or many *objectclass* attributes to identify the node. The *objectclass* definition of the system is that it should have what kind of attributes and it is allowed to have what kind of attributes. We also can extend the original *objectclass* by adding the attributes we want. Every node in the tree will be identified by *DN* (Distinguished Name) attribute [4][6]. The hierarchical relationship of the tree can be divided by locality or corresponding categorization. For example, the directory tree could be constructed according to the domain name. From the top level, c=tw (country code), o=edu (organization), ou=NCTU (organization unit) to ou =CIS (organization unit), the information in an example leaf node is a student named jacky, studying in the Dept. of Computer and Information Science. Through the tree architecture, LDAP clients can perform search, delete, modify operations and any site manager can add ACL (Access Control List) mechanism to control the access. [3][4] For more details, interested users are encouraged to read the related LDAP documents listed in the reference sections. [3][4][6][15]

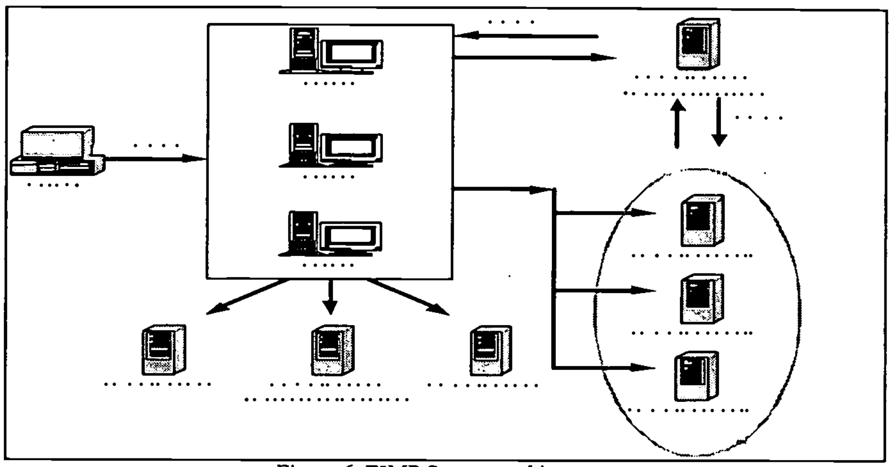


Figure 6. EIMP System architecture

4 Our System Design

We built up an EIMP (Enhance IMP; based on the IMP[12] project) system on a Linux platform [14][15]. The main system components are Apache+PHP(WWW), IMAP+Sendmail(Mail), OpenLDAP(LDAP), etc. We enhance the web-mail system by integrating the LDAP directory service and adding the Chinese naming capabilities. As shown in Figure 6, users can connect the logon server through www browsers and types his/her user name (Chinese or ASCII) and password. After passing the authentication, the LDAP server will return the user's IMAP[14] server location to the logon server. Then it will connect the related IMAP server to retrieve the user' s mail(s). On the other hands, users can send mails through the SMTP server and store their address book information in the database server. Thus, for users wishing to send mail to his friends, even if they do not remember the exact email address, they can still find the email addresses by the help of LDAP servers, as shown in Figure 7.

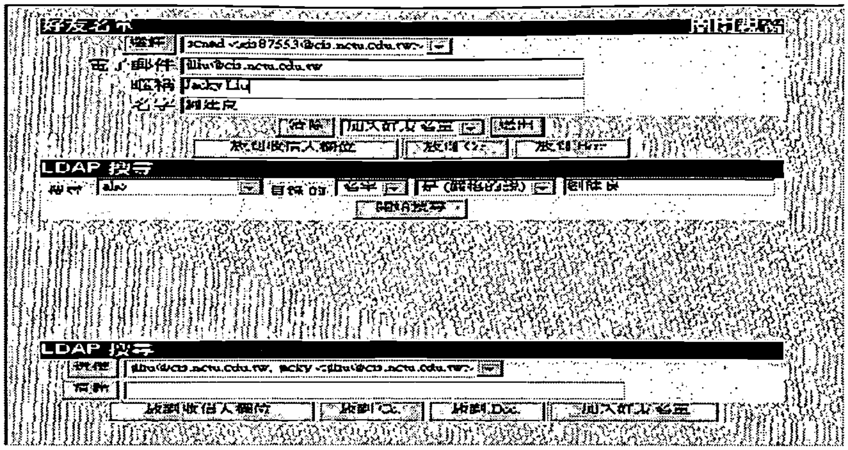


Figure 7. LDAP search screenshot

5 Problems and Discussions

As we know that, although it looks promising; however, up to now most of the proxy and mail servers (e.g. Squid and Sendmail, etc.) cannot accept non-ASCII addressing. Hence, it' s nearly impossible to keep compatibility with the current system without modifying the source code of these servers, recompiling and reinstall the systems.

Non-ASCII communication issues are new hot topics in many research applications. While this is true in the DNS system, similar situation appears on the LDAP protocol suites. As more directory servers have been set up, there are more chances for directory servers to share and exchange their information through chaining or referral [3][4][5]. LDAPv3 addresses the issue by using the UTF-8 [16] encoding, while LDAPv2 use T.61, which lacks the capabilities to handle 8-bit data. Hence, in building distributed Directory server groups, software packages with LDAPv3 ready should be the proper choices.

We choose the IMAP (and not POP3) protocol for serving our mail access since IMAP servers support both the offline and the online modes. Currently, most sites use POP3 as the access protocol since it is simple and usually gives low impact to the system performance. However, as the POP3 protocol operates only in off-line mode, it could not meet the new trend for supporting the e-mail roaming access.

6 Conclusions

E-mail is one of the most used Internet applications today. However, non-ASCII addressing system is still a research issue. Most of the proxy and mail servers (e.g. Squid and Sendmail, etc.) still cannot accept non-ASCII addressing. Internetworking scientists from members at APNIC, RIPE, etc. are undertaking some piloting projects for producing multilingual internetworking standards. However, no one knows when the solutions will be ready. This is not good for primary/secondary school education on most parts of the world.

In this paper, we describe our approach for the Chinese e-mail addressing and authentication problems. We have designed and implemented a web-mail system with Chinese addressing capabilities by incorporating the LDAP directory services. Conceptually, we could view an e-mail address as one of the attributes of some user' s profile. By storing users' profiles on directory servers, software with directory-enabled capabilities could be easily used to extract the ASCII Email information for further utilization. In this way, our system provides a workaround solution for the Chinese e-mail address problem by translating a Chinese name to its corresponding ASCII e-mail address. This should be promising for many people. For example, using such LDAP-enabled web-mail system, primary/secondary school education could benefit a lot since most of the communication activities could be done in their local native language.

In the future, if there is any standardized multilingual addressing scheme available, it could be incorporated into our system. The same user interface could still be used as well. Furthermore, with minor modifications, the same approach should be easily adapted for utilization in other language system.

Acknowledgment

This work was supported by the National Science Council of the Republic of China under Grant No. NSC89-2511-S-009-014. We would like to thank the anonymous reviewers for suggesting improvements and offering encouragement.

References

[1] Freed, N., Borenstein, N. "Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies", RFC 2045, (1996)
[2] Howes, T., etc., "The String Representation of Standard Attribute Syntaxes", RFC 1778, (1995)
[3] Howes, T., etc., "A Scalable, Deployable, Directory Service Framework for the Internet", INET 95
[4] Howes, T., etc., "Understanding and Deploying LDAP Directory Services", Macmillan Technical Publishing, (1999)
[5] José, Rui J.P.; Costa, António; Macedo, Joaquim; Freitas, Vasco, "Providing multiple external views on directory user interfaces" in Computer Networks and ISDN Systems, Vol 28, No. 4, pp. 543-550, (1996)
[6] Kille, S., "A String Representation of Distinguished Names", RFC 1779, (1995)
[7] Mockapetris , P., "Domain Names--Implementation and Specification" ,RFC 1035, (1987)
[8] Wahl, M., etc., "Lightweight Directory Access Protocol (v3)", RFC 2251, (1997)
[9] Yeong,W., Howes, T., Kille, S., "Lightweight Directory Access Protocol", RFC 1777, (1995)
[10] Chinese Domain Name Consortium, http://www.cdns.org/e-index.shtml (accessed on August 1,2000)
[11] ICANN, http://www.icann.org (accessed on July 1,2000)
[12] IMP@horde.org, http://www.horde.org/imp (accessed on April 23,2000)
[13] mDNS TANet Testing Project, http://mdns.twnic.net.tw (accessed on June 1,2000)
[14] Message Access Paradigms and Protocols, http://www.imap.org/papers/imap.vs.pop.html (accessed on May 9,2000)
[15] LDAP Linux HOWTO, http://www.linux.org/help/ldp/howto/LDAP-HOWTO.html (accessed on May 10,2000)
[16] Unicode - Basic Questions, http://www.unicode.org/unicode/faq/ (accessed on June 1,2000)
[17] Welcome to iDNS , http://www.idns.org (accessed on June 1,2000)

Facilitating Examples Understanding through Explicit Questioning

Isaac P.W. Fung and R.H. Kemp
Institute of Information Sciences and Technology
Massey University
Palmerston North, New Zealand
Fax: +64-6-3502259
P.W.Fung@massey.ac.nz; R.Kemp@massey.ac.nz

This paper describes a novel approach for promoting understanding of examples through explicit questioning. Whether being asked by the teachers or self-motivated, studying worked examples is an indispensable step for learners to acquire domain knowledge. The issue is: how could students use examples in the most effective way? Research findings indicate that the utility value of examples among different groups of learners varies dramatically. Effective learners keep self-explaining the solution statements when studying the examples while less effective learners often take each step of the statements for granted. In order to facilitate better understanding of examples, we propose to question the students explicitly on the examples content in order to stimulate their self-explanations. This paper presents the underlying computer model for generating different categories of questions from specific examples. The questions are subsequently used by a case-questioner to test the students on what they have read.

Keywords: **Artificial Intelligence, Conceptual Graphs, Intelligent Tutoring Systems, Case-based Reasoning**

1 Introduction

This paper presents a novel approach to facilitate the understanding of learning materials through explicit questioning. The notion we put forward in the paper forms one distinct feature of our current project: providing problem-solving advice in terms of relevant worked examples. When mapping out the project specification, there is an issue we are particular concerned with: to what extent the students benefit from the examples remains unknown. In her seminal work [2] Chi discovered the phenomenon of self-explanation among effective learners when they are presented with worked examples. Among this group of learners, they have a strong tendency to explain each example statement to themselves before moving on whereas the less effective learners tend to take the example statements for granted. In a follow-up investigation [3] Chi exploited her previous discovery in the context of learning. Not surprising, when students are deliberately prompted for self-explanation, they have shown a dramatic improvement in acquiring the knowledge. We believe the implication of Chi's study is very significant. Not only do the results shed light on understanding different learning behaviours, but the study also challenges instructors that merely informative examples do not guarantee good learning results. How the students use examples is a crucial factor in determining if they are really helping the students understand the subject domain.

As we are concerned with how the students use the examples presented, we decided not to take the present-and-go approach. Once a case (i.e. a relevant worked example) is retrieved for presentation, a case questioner will be automatically invoked to challenge the student's understanding on the knowledge embedded in the case. The questions generated are not explicitly stated in the problem statement. The rationale of this proposal involves encouraging the students to think more deeply while studying the worked examples. If the students have, in fact, understood the examples or related concepts within the domain, they should be able to answer the questions posed by the system. If not, the questions can trigger their attention towards certain aspects of the problem and stimulate their knowledge acquisition process.

2 Promoting Comprehension through Questioning

When studying worked examples, it is quite common for the students to take many solution statements for granted without trying to dig out the embedded tacit knowledge. Even if the students have the intention, they may lack the knowledge structure to find out the tacit knowledge. To put it simply, the student may know that it is helpful to self-explain the statements, but the problem is explaining what? There is research (e.g. [1], [4] and [7]) which indicates that questioning plays a significant role in understanding narrative text and therefore we argue that the same principle should also be applied in comprehending example solutions. If this argument is valid, one potentially pedagogically fruitful approach to tutoring in terms of providing examples is to question the learners on the content of the examples in a systematic way. Once the example is presented, the students will be asked questions driven by physical principles in order to detect what they know about the example and to help them discover meaningful relationships. To illustrate the argument, we consider the mechanics example shown in Figure 1.

Two blocks A & B are resting on a frictionless horizontal plane as shown. If an external force of 10N is acting on A, what is the acceleration of the blocks and the force of contact between them? (The masses of A and B are 3kg and 7kg respectively).

Solution	Net Force $_{A\&B}$	= $Mass_{A\&B} \times$ Acceleration $_{A\&B}$ *(Applying Newton's 2nd Law on*
:	External Force $_{A\&B}$	*A&B)*
	10	= $Mass_{A\&B} \times$ Acceleration $_{A\&B}$
	Acceleration $_{A\&B}$	= (3 + 7) Acceleration $_{A\&B}$
		= 1 m/s^2
	Net Force $_A$	= $Mass_A \times$ Acceleration $_A$ *(Applying Newton's 2nd Law on A)*
	External Force $_A$ + Contact Force	= $Mass_A \times$ Acceleration $_A$
	$_A$	= 3×1
	10 + Contact Force $_A$	= - 7N
	Contact Force $_A$	
	Net Force $_B$	= $Mass_B \times$ Acceleration $_B$ *(Applying Newton's 2nd Law on B)*
	Contact Force $_B$	= $Mass_B \times$ Acceleration $_B$
	Contact Force $_B$	= 7 x 1
	Contact Force $_B$	= 7 N

Figure 1: A typical Newtonian mechanics example and its solution

When presenting this example, the author must have already made many assumptions regarding the knowledge state of the reader. For instance, it will be assumed the reader knows that the weights of blocks are being cancelled by the reactions from the ground and thus the weights are not included in the calculation; the reader is also assumed to know that the acceleration of the whole system is the same as the acceleration of individual components; and that the external action on A is the same as the external action on the system as a whole in this case. However, these points may not have been mastered by some students. From the perspective of problem-solving, the solution presented is not the only way of tackling the problem. For instance, the contact force on B can be evaluated immediately by relating it to the contact force on A with which is formed an action-reaction pair. Alternatively, the problem can be tackled by solving three simultaneous linear equations with variables a, f_A and f_B which stand for the unknown physical quantities which are sought. This knowledge is not explicitly shown in the solution statements and the students whose self-explanation is less active may miss these knowledge units. Therefore, a fruitful tutorial dialogue can be created by conducting a series of question-answering episodes on the example presented.

3 A Taxonomy for Different Types of Questions

Before asking a question, the questioner must perform two steps: the first is to decide the *content of the enquiry*; and the second is to compose the *style of the queries*. To pose appropriate questions to the comprehender, the question designer must have a semantic category of questions. We have adapted the taxonomy for questions in narrative understanding originally developed in [8] into the context of physics problem-solving, and this is summarized below in Table 1. Note that except for question No.4, all the questions are relevant to the example shown in Figure 1.

CATEGORY	SPECIFIC EXAMPLES IN THE DOMAIN OF PHYSICS
1. Verification	*Is the system in equilibrium?*
2. Disjunctive	*Is force a vector or a scalar?*
3. Concept Completion	*What is FORCE?*
4. Feature Specification	*What does a convex lens look like?*
5. Quantification	*How many external forces are acting on block A?*
6. Causal Antecedent	*What caused the blocks to accelerate?*
7. Causal Consequence	*What are the consequences of the external force acting on the blocks?*
8. Goal Orientation	*In the 4th line of the solution, why are the masses of A and B summed?*
9. Enablement	*The blocks have weights; what is needed to prevent them from moving downward?*
10. Instrumental/ Procedural	*How was the acceleration of the blocks evaluated?*
11. Expectational	*What will be the magnitude of the contact force acting on A, if the mass of B is increased but the external action remains unchanged?*
12. Judgmental	*Do you think the solution presented is the only possible method?*

Table 1: Twelve Semantic Categories in Question Taxonomy (Adapted from [8])

4 Questions Generation

4.1 Based on the Definition of Concept Types

The questions in the categories 1, 2 and 3 are related to the definition of some domain-specific terminology and hence are grouped together. These categories of questions require the comprehender to grasp the definition of the focal content of the questions. For the question "Is the system in equilibrium?", the focus is on testing the readers on the precondition of a system being described as "in equilibrium". The question "Is force a vector or a scalar?" assesses the student's knowledge of the difference between vector and scalar quantities. There are two ways of generating these categories of questions: by *traversing the type hierarchy* and by *projecting* the definitional graph of the focus type into the conceptual graph [9] representing the example [5]. Based on these methods, the following scenarios can be developed. Question: "Why is the system not in equilibrium?" If the student successfully answers the net force acting on the system is not zero, another question can be generated such as "Then how can it be put into equilibrium again?"

4.2 Based on the Chaining of the Graph Nodes

In Newtonian mechanics, there are causes that are well-defined, such as the cause of acceleration being a non-zero net force; the cause of a change in velocity being non-zero acceleration; the cause of a change in position being a non-zero velocity, etc. The whole process of deriving values for unknown variables from available data can be modelled as a node chaining process, a kind of causal chaining. Figure 2 shows two subgraphs that represent the corresponding example statements:

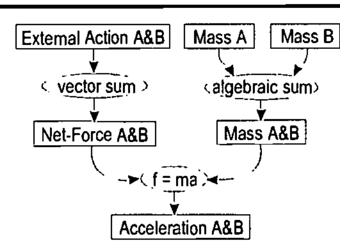
Solution Steps	Corresponding Conceptual Graphs
$\text{Net Force}_{A\&B} = \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B}$ $\text{External Action}_{A\&B} = \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B}$ $10 = (3 + 7) \times \text{Acceleration}_{A\&B}$ $\text{Acceleration}_{A\&B} = 1\ m/s^2$	

Figure 2: Part of the solution steps and its corresponding conceptual graphs

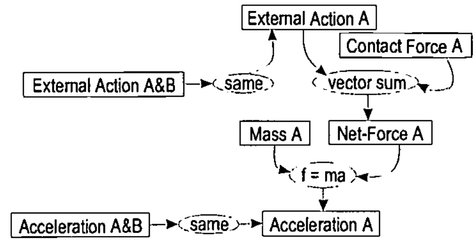
Solution Steps	Corresponding Conceptual Graphs
$\text{Net Force}_A = \text{Mass}_A \times \text{Acceleration}_A$ $\text{External Action}_A + \text{Contact Force}_A = \text{Mass}_A \times \text{Acceleration}_A$ $10 + \text{Contact Force}_A = 3 \times 1$ $\text{Contact Force}_A = -7\text{N}$	

Figure 2 (cont'd): Part of the solution steps and its corresponding conceptual graphs

The graphs shown on the right hand side of Figure 2 provide ample material to generate questions to test students' understanding of the solution steps such as "How was the acceleration of the system evaluated?"; "How many external forces act on the block A?"; "What is the relation between the acceleration of A and the acceleration of the whole system?"; "How was the contact force on B evaluated?", etc.

4.3 Based on Propagating Qualitative Values across the Graph

Regarding the expectational question depicted in the 11th category, one should see that it belongs more to the area of qualitative reasoning (QR) [11] and this kind of question is very common in testing the knowledge of students. A QR technique had been developed in [6] and the following type of questions are successfully generated. "If the external action decreases, what would be the contact force?" "If the bottom of block A is made rough to create friction between A and the ground, what would be the acceleration of the system and the contact forces?"

5 Conclusions

This paper proposes a questioning approach to handling examples, which is intended to stimulate the student's cognitive process of self-explanation. Representing worked examples by CG allows the system to generate different categories of questions during the questioning process. We have shown that definitional, procedural and qualitative questions can all be posed to students for tutorial purposes. Due to space limitation, we have not covered all categories of questions; for instance, feature specification and enablement. At the moment, this part of the work derives only from a computational perspective and lacks empirical support. The next phase of our project is to test posing the questions to students to see if this approach would stimulate self-explanations and subsequently enable them to acquire a better understanding of the subject domain.

References

[1] Anderson, R.C. & Biddle, W.B., "On asking people questions about what they are reading." In G. Bower (Ed.) The Psychology of Learning and Motivation (Vol. 9), NY: Academic Press, (1975).
[2] Chi, M.T.H. et al., "Self-Explanation: How students study and use examples in learning to solve problems, Cognitive Science, Vol.13, pp. 145-82, (1989).
[3] Chi, M.T. H. et al., "Eliciting self-explanation improves understanding" Cognitive Science, Vol. 18, pp.145-82, (1994).
[4] Dillon, J.T., "The multidisciplinary study of questioning" Journal of Educational Psychology, Vol. 74, pp. 147-65, (1982).
[5] Fung, P.W. "Designing an case-based intelligent learning environment in physics with conceptual graphs" Ph.D. Thesis, Dept. of Computation, UMIST, England, (1996).
[6] Fung, P.W. "Generating qualitative predictive problems in a case-based physics tutor" In Proceedings of AI-ED97, World conference on artificial intelligence in education, Kobe, Japan, (1997).
[7] Graesser, A.C. & Black, J.B., "The psychology of questions" NJ: Lawrence Erlbaum Associates, (1985).
[8] Graesser, A.C. et al. "A taxonomy for question generation" Questioning Exchange, Vol. 2, pp. 3-15, (1988).

[9] Sowa, J. "Conceptual structures: Information processing in mind and machine" Reading: MA: Addison-Wesley, (1984).
[10] Trabasso, T., et al. "A model for generating questions that assess and promote comprehension" Questioning Exchange, Vol. 2, pp.25-38, (1988).
[11] Weld, D.S. & deKleer, J. "Readings in qualitative reasoning about physical systems" CA: Morgan Kaufmann Publishers, (1990).

Organization of the introductory and motivational stage of activity in a computer tutoring system

Gennadiy Atanov and Vladimir Laktiushin
Donetsk Institute of Social Education; DISO, Donetsk, 83000, Ukraine;
E-mail: atanov@dongu.donetsk.ua

1 The activity approach in education

From the point of view of modern didactics, the final aim of instruction is not gaining knowledge but forming the way of acting being realized via skills [3]. It may be only done in the process of activity, namely learning activity. In this sense, any instructional process represents guidance, operative management of learning activity. It is management that is mechanism of teaching but not passing knowledge. Learning activity is a product of teaching because it is the aim of teaching. Knowledge is necessary, so far as the way of acting is worked out by means of operating with knowledge. On the other hand, knowledge is formed only in the process of activity []. Thus content of teaching includes subject to mastering and knowledge on which based this activity. From the point of view of organization, activity has three stages: 1) of introductory and motivation, 2) of operation and cognition, 3) of control and estimation.

An action is a unit of activity. The way of acting is a system of operations that provides solving of problems of a definite kind. The way of acting has three functional parts: (1) orientating one that provides preparation the student to activity; (2) executive one providing transformation of the objects of activity; (3) control one that provides check-up of rightness solving the problems and comparison the factual products of activity with desired ones, that is, the aim of activity [2].

Many authors of computer technologies attribute them to the ones based on activity (learning by doing) only because of work specificity with a computer but not because they realize principles of the theory of activity. In accordance with it, projecting a computer tutoring system means, first of all, projecting learning activity, not knowledge. Knowledge is projected after actions. Only on determining actions, it is possible to pick out knowledge providing formation of these actions.

Development of activity my be schematically represented in the following way: *need – motive – aim – subaims – problems – subproblems – actions – operations – product.* The introductory and motivation stage of activity, especially for learning activity, is the most important one because it is the initial stage of activity. It is called to settle questions of "lead-in" of students in activity, their adaptation to future activity, that is, questions of orienting and motivation.

In the orientating part of the way of acting, they pick out two components (Mashbits, 1988). The first one – general orienting – provides picking out those properties and qualities of the objects of activity that are essential for their transformation. The second one – orienting for the executive part – provides working out a plan of activity. Only the executive part of the way of acting providing immediate transformation of the objects is the direct product of the traditional teaching. There is the only way to do this – solving problems.

2 Organization of the introductory and motivational stage

The introductory and motivational stage plays an important psychological and didactical role in teaching in general; while using a computer, its role increases repeatedly. Nevertheless, to meet a tutoring system in which due attention would spare to this stage is a very rare thing. We organized it in tutoring systems in physics [1]. The tasks of the introductory and motivational are realization and understanding by the students: 1) aims and problems of the system; 2) physical character of processes and phenomena, as well as principles of operation of the installations that are the subjects of the system's activity; (3) knowledge necessary to reach the aim put the system. According to the theory of activity, it is operating with this knowledge that leads to forming first skills necessary for solving a particular problem and then the way of acting in aggregate.

The approach of problems that is realized in our systems is based on solving a separate problem whose complication increases that of problems being solved usually. This approach is more preferable from the point of view of activity. Firstly, it allows easily and effective organize learning activity and, secondly, it gains essentially in motivation as presupposes achievement of a practically significant aim. In many systems, this aim is even submitted in their titles, for example, "Hit the Target", "Rescue the Friends", "Render Harmless of the mine", "Determine the material". It is a very effective means to increase motivation, as the student becomes a subject of activity, the main acting person of the events expanded. Various methods of realization of this stage are used, for example, mimicking processes and phenomena, "assembling" installations from their separate parts, discussion their purposes and peculiarities of operating the installations, test tasks of the closed and open types, ones for accordance and ones for correct sequence.

Let us consider as an example systems "Internal Combustion Engine". The aim of it is determination of power and efficiency of an engine in accordance with its constructive parameters. As one can see, the title of this system does not promote increase of motivation because of the lack of the personal orientation. This is achieved by another method. A list of cars with demonstration of their outward appearance is offered to students. Students choose a car that they like and then carry out calculations for the engine of their own car.

Let us describe in what way a test task for accordance is realized in these systems. A "dumb" scheme of an installation without pointers of its component parts is shown on the screen. A list of its component part is placed next to it. Activity of students consists in the following. Separate elements of the scheme are pointed sequentially by chance, and students have to put for each element of the scheme corresponding one of the list. If the title of the pointed component part is determined correctly, another element is pointed, and so on. The determined parts acquire their numbers, and as the result, the "dumb" scheme is transformed into a "live" one. In such a way an orienting support of activity is created.

Further development of the introductory and motivation stage in the system above proceeds in the following way. The system demonstrates work of the engine during a whole cycle with replacement of the piston, opening and closing the exhaust and inlet valves, ignition of a air and gas mixture. Students may start such a demonstration several times independently. Now students see interaction of the component parts of the engine already well known to them, now they unit in their consciousness not simply mechanically but functionally reflecting physics of the processes occurring in the engine.

Subsequent deepening of orienting passes by discussion of what students have seen. It is very convenient to use the so-called active prompts with this purpose. Active prompt is built as a test task of the open type. It represents a phrase, in which a keyword is missed; this word has to be entered by students. If students do not know it, they may address to the system for help, and it will show this word on the screen. In order to keep the students' active position, the system offer the same active prompt repeatedly, and students must enter this already well known word themselves. Examples of active prompts are phrases: "The inlet valve is open when the piston goes down(wards)", "The spark springs up when the piston is at the upper extreme position" (the missed words are in italic). The main thing here consists in not completeness of these tasks but in importance of ascertaining these (and other) facts for forming the orienting base of the future activity.

The elements of the introductory and motivational stage are distributed throughout a system, their task is to prepare students to performing subsequent separate actions. If, for example, there is a necessity of using some formula, it is very convenient to remind it by a test task of the closed type. Students are offered several formulas, and they have to choose the necessary one. If students make mistakes, a short dialogue should be organized so that students could understand the nature of the mistakes. Then the task should be given again, the search of the answer becoming more sensitive. And the answer will be obtained without fail.

If the development of an action demands using exact wording (of laws, principles, theorems, definitions of concepts, and so on), it is expediently to employ a test task for the correct sequence. In the chosen wording, all the words are missed by chance (this does the system), and the task of students consists in that the words must be arranged correctly with the help of the mouse. It is a very creative and constructive work, it thrills, in the first place, because the sense appears little by little. Everyone can reach the sense even if he/she is not familiar with it at all.

References

1. Atanov, G.A., Kandrashin,G.V., Laktiushin,V.V. Computer Tutoring Systems for Science Education Based on the Activity Approach. New Media and Telematic Technologies for Education in Eastern European Countries. Eds. P.Kommers, A.Dovgiallo, V.Petrushin, P.Brusilovsky. Enshede: Tvente University Press. Pp. 75-79. (1997)
2. Gal' perin, P.Ya. Psychology of Thinking and Doctrine about Step by Step Forming Mental Actions. Moscow. (1966) (in Russian).
3. Mashbits,E. Psychological and Pedagogical Problems of Computating in Education. Moscow, Pedagogika (1988) (in Russian).

Relating telecommunication training objectives to SMEs' actual needs

Paola Forcheri, Maria Teresa Molfino, Alfonso Quarati
Istituto per la Matematica Applicata del Consiglio Nazionale delle Ricerche, Genova -Italy
Via De Marini, 6 –16149 Genova, Italy
Tel: +39-010-6475673
Fax: +39-010-6475660
E-mail: {forcheri,molfino,quarati}@ima.ge.cnr.it

The need of studying training measures to help European Small and Medium Enterprises (SMEs) to avail themselves of new information communication technology is generally acknowledged. To be effective, however, these measures must be based on sound knowledge of the context in which they are to be implemented. This type of approach is particularly important for SMEs located in areas experiencing serious industrial decline, where the development of exchanges and co-operation is vital for opening up new opportunities. Accordingly, we carried out a survey to gauge companies' attitudes towards teleconferencing tools so that methodologies could be devised to exploit the potential for growth within SMEs. The survey was based on a series of interviews conducted from late 1998 to early 1999 with organisations reflecting the socio-economic make up of the economy of Liguria, a region in north-west Italy. The results of the survey, that are discussed in this paper, formed the basis for the design of training schemes about teleconferencing tools and applications devoted to SMEs. The activity is framed into the project called Teleconferencing, part of the European Community's ADAPT II initiative.

Keywords: **Telecommunication education, Training in enterprises, Teaching/learning strategies**

1 Introduction

Current socio-economic trends and the shift towards a global market are highlighting the need for companies to keep abreast of the new opportunities offered by Information and Communication Technologies (ICT), whose development has itself been a major factor in market globalisation. Doing so also means gaining awareness of the economic, organisational and company policy issues involved.

In this context, the mastery of teleconferencing tools assumes particular importance. By giving impulse to distance interaction, these tools increase companies' opportunities to control a share of distant markets and to draw on resources spread over a wide area. This is borne out by numerous theoretical and applied studies that analyse the effects of tele-collaboration on the development of new communication patterns and their influence on company organisation [2].

Let's take a look at some of these. [1] examines the pros and cons of desktop videoconferencing from the technological, economic, operational, psychological, and managerial viewpoints, as seen by both the company and the end user. Wiesenfeld, Raghuram & Garud [15] analyse the characteristics of communication means and the impact these have on the way remotely located employees identify with the company's central offices. Kraut, Steinfield, Chan, Butler & Hoag [11] examine how the use of computer networks influences inter-company collaboration (such as that created in a European project) and how the use of those networks for co-ordination alters production output.

Jarvenpaa and Leidner [8] examine problems linked to creating and maintaining a climate of confidence whenever communication is largely conducted via ICT, while Anderson and Kanula [3] study a virtual forum attended by people engaged in lifelong learning, focusing on participation levels and attendees' perception of the forum's effectiveness and value. Email as a tool for supporting company policy is the theme explored by Romm and Pliskin [12], who draw on a set of case studies.

Rosen [13] provides numerous case studies on the use of videoconferencing in large corporations in an effort to stimulate discussion on the integration of collaboration and communication. This is done by analysing the competitive edge that those companies gained and the changes brought about in their way of doing business.

For their part, Schreiber and Berge [14] analyse the advantages and opportunities that teleconferencing systems offer to distance in-service training, reporting a number of cases where the goals pursued arise from a clear company need. Teleconferencing as a tool for lifelong learning is the topic focused on by Kaye [10], who examines in particular the possibilities that this instrument offers for learning in an informal context. Economic issues involved in the use of videoconferencing systems within the education sector is the area investigated by Jacobs and Rogers [7], who provide a detailed analysis of the cost/benefit ratio in a case of trans-European ISDN-based distance learning.

The above-mentioned studies generally refer to large, technologically-advanced corporations with considerable financial resources. However, in today's global market, it is also vital for Small and Medium Enterprises (SMEs) to harness ICT in order to maintain market share. The problem they often face is that they cannot afford the investment needed to cope with increased competition and to get a foothold in new markets. Distance interaction technology offers SMEs useful support in tackling this problem. On the one hand, it fosters collaboration between companies which operate in complementary sectors but are located at a distance from each other. On the other, it permits SMEs to offer their services to large companies both as suppliers and as mediators in local markets they know well. It is widely recognised that if SMEs are to harness the potential this technology offers, they not only require suitable and affordable infrastructure but also need training and technology transfer schemes to help them acquire the necessary competence and know-how ([6], http://europa.eu.int/comm/dg12/publ/globalisation.html).

These kinds of considerations form the basis of the numerous initiatives launched by the European Union and aimed to devise efficient training and orientation measures suitable to help SMEs to cope with innovation in communication.

To be effective, however, these measures must be based on sound knowledge of the context in which they are to be implemented. In this way, they can take account of the company's effective needs, economic situation, skills base, technological potential and cultural heritage. This type of approach is particularly important for SMEs located in areas experiencing serious industrial decline, where the development of exchanges and co-operation is vital for opening up new opportunities. For mainly economic reasons, these companies have little chance to develop competencies and to benefit from distance collaboration.

This is the background our work is set against. In particular, we carried out a survey to gauge companies' attitudes towards teleconferencing tools so that methodologies could be devised to exploit the potential for growth within SMEs. The survey was based on a series of interviews conducted from late 1998 to early 1999 with organisations reflecting the socio-economic make up of the economy of Liguria, a region in north-west Italy.

The activity is framed into the project called Teleconferencing, part of the European Community's ADAPT II initiative. The purpose of the project is to study the potential of network technology, especially teleconferencing tools, in response to the need for intra-company and cross-company collaboration. The project is run by IMA-CNR, who drew up the project guidelines in partnership with eight companies representing a cross-section of the local economy in Liguria.

We shall report here the findings of the survey, focusing in particular on cultural problems hindering the spread of teleconferencing in companies. In addition, we shall propose orientation and training methodologies that help overcome these barriers.

Henceforth, we shall use the term teleconferencing to refer to interpersonal communication systems based on the written word (e-mail, chatting, etc) or on sound and images (videoconferencing).

2 The Survey

2.1 Background

Liguria has been seriously hit by the general decline in industry; the reduction in heavy industry in particular has wrought serious consequences, including high unemployment, demographic decline and ageing of the population. The socio-economic transformation underway calls for considerable flexibility, the capacity to exploit innovation and the fostering of exchanges and co-operation in order to open up new opportunities. Thus the region of Liguria represents a good test-bed for studying opportunities and problems regarding the use of teleconferencing technology within companies.

Our survey involved a series of interviews conducted from late 1998 to early 1999 with 41 companies in Liguria that varied in size, both in terms of turnover and staff numbers (see Table 1). Of the total, 20% are from the public sector and 80% from the private sector, and they are spread throughout the four provinces of the region (32% Genoa, 32% La Spezia, 20% Imperia and 17% Savona).

Revenue 1997 (Millions of EURO)	Percentage	Staff members	Percentage
To 2.5	**37%**	To 10	**17%**
2.5 to 50	**49%**	10 to 100	**63%**
Over 50	**15%**	Over 100	**20%**

Table 1. Breakdown of the organisations interviewed according to turnover and staff numbers

2.2 Methodology

The survey was carried out through interviews based on a questionnaire. Staff members from companies involved in the project were consulted during the drafting of this questionnaire to ensure that the language used and the approach to problems adopted matched their way of thinking as closely as possible. The companies themselves carried out preliminary evaluation of the questionnaire.

2.3 The Questionnaire

The questionnaire is divided into four sections.
The first section is designed to identify the type of company in terms of economic structure (public or private, size, field of activity) and its organisation, with special attention to teamwork. In this way it is possible to investigate the relationship between these parameters and the attitude manifested towards teleconferencing tools.

The second section looks at the organisation's level of technological advancement and its attitude towards communication tools. The purpose here is to understand whether and how networking can modify the kind of relationships established within the organisation.

The aim of the third section is to analyse the type and quality of computer tools devoted to information exchange. Investigation centres on the use made of the Internet and on the organisation's attitude towards the Web, with an eye to determining whether the staff is familiar with this tool, the needs the Web may fulfil and possible training requirements (depending on the type of information usually exchanged).

The fourth section focuses on teleconferencing, assessing the degree of knowledge about tools of this kind and determining whether and when the organisation considers teleconferencing useful for its purposes. The point of this section is to study the types of support (methodological, technical, training, orientation, infrastructure, etc) that the organisation may need in order to use teleconferencing effectively.

3 Results

3.1 Type of organisation and group work

Type of organisation. The public-sector organisations interviewed were from the fields of public administration, public services, the health service and state-run industry.
The breakdown of private companies was as follows:

- industry (14%) – steel, photographic chemicals, electronic engineering, parts machining, plant building, construction, olive oil production, floriculture;
- companies involved in port-based activities (17%) – port authority, shipbuilding, container terminals, transport, brokerage;
- service and commercial companies (49%) – gas and water distribution, medical services, company support services, research and training, tourism, logistics, storage, consultancy, wholesaling and retailing. Sectors like port activities, olive oil production, floriculture and tourism are of vital importance to the Ligurian economy.

Teamwork. All of the companies interviewed engage in teamwork, and most (82%) do so on a regular basis; there are no notable differences here between the different types of companies. Teamwork mainly concerns organisation (90%), document and information sharing (63%) and brainstorming (63%). Other significant areas are internal documentation (61%), followed by external relations (59%) and internal messaging, while internal surveys play only a minor role (29%).

Interestingly, given that in nearly half the cases (46%) teamwork involves most of the staff, tools that make collaborative activities more efficient would be extremely valuable for the organisation. Hence it is worth studying the possibility of teleconferencing, at least for some specific situations such as electronic bulletin boards advising recipients about 'technical' events. These may include notification of a circular being received or a service being temporarily suspended. Another instance may be an in-house electronic bulletin briefing all the staff on the main events concerning the organisation. The application of teleconferencing to these situations does not curb interpersonal relationships and has the advantage (even in small companies with a staff of 10 to15) of reducing time wasting, the risk of misinformation and subsequent misunderstandings [1].

3.2 Office Automation

Level of office automation. Computers, in-house networks for management purposes and Internet connections are found in most of the organisations (see Table 1).

	Used	To be introduce	Not to be introduced
Mainframe	63%	5%	12%
Terminals	66%	0%	15%
Personal computers	100%	0%	0%
LAN	63%	5%	15%
Intranet	15%	22%	22%
Internet connection	85%	12%	2%

Table 1: Computer tools used in organisations

However, while PCs are used by the majority of staff members (either for individual work or management applications), the Internet is still only used by a minority (see Table 2).

We can therefore state that while computers have by now permeated corporate life, the same is not true of communication and information sharing tools, although awareness of their potential does exist.

	PC for individu work	Terminals o PC for database management	LAN or Intranet for shared applications	External connection/Internet
More than half	34%	37%	23%	9%
About half	13%	14%	15%	9%
Less than half	53%	49%	62%	82%

Table 2: Number of users by type of tool and kind of use

Use of networking. Networks are widely employed for exchanges between headquarters and branches (14 positive answers, two planning introduction in the short term). They are used mainly for handling administrative/accounting matters and sales orders, for organising production, as well as for structuring and maintaining the network itself.

Far less significant is the level of network use by travelling salesmen (two cases, for transmitting sales and exchanging messages), although the trend is growing (six planning to introduce it for this purpose).

Tele-working from home is equally uncommon, with only two of the organisations surveyed adopting it, and five cases where there has been talk of introducing it. In both of the affirmative cases, tele-working is used for remote network maintenance, and only one of the two companies conducts other activities in this way.

In our view, the answers indicate that network connection is seen as an advantage when it is capable of improving work efficiency without changing work organisation or modifying internal relationships. By contrast, when the introduction of new technology requires methodological innovation or the development of new types of interpersonal relationships, its appeal is not so strong. One fact supports this consideration: although many of the organisations hire external consultants (68% have at least one consultant, 46% more than one), only one currently uses tele-working for this purpose and three are considering it. Clearly, technological innovation demands a change in attitude and therefore requires gradual phasing in, together with training that makes people aware of the impact of new communication tools rather than just illustrating their technical features.

3.3 Networking and communication with the outside world

Typology of dedicated connections and connections to the Internet. Those interviewed appeared to be greatly perplexed by this set of questions, apart from a handful of cases where the interviewee was the head of EDP. To our way of thinking, this shows that the spread of the network has not been matched by a general grasp of network-related concepts. Consequently, training and orientation dedicated to network concepts and opportunities are called for, so that companies understand the kind of network services that might meet their needs.

Companies and the Web. The Web is used somewhat more for gathering information (86%) than for spreading it and for presenting the company on the market (80%). Nonetheless, the response to the question regarding the potential benefits of using the Web shows that companies recognise that the Web is a medium for addressing a wider market (49%) and improving their public image (37%).

In our view, the reason for this lies in cultural and economic factors. Coverage of the Web in the press and electronic media till recently mainly focused on the possibility to acquire information rather than provide it. What's more, while acquiring information is relatively straightforward, providing it entails more complex know-how. Company presentation in the Web's hypermedia format is culturally different from more conventional forms, thus requiring great investment in terms of conception, design and implementation. Finally, the investment and maintenance entailed in information acquisition is fairly low in cost, being limited to getting Web access and covering communication costs. By contrast, information providing is quite costly both in terms of site construction and maintenance.

In order to help companies use the Web as a tool for market presentation, it may well be worthwhile providing implementation methodologies that are in line with company goals. To make information hunting more efficient, it would be useful to give tips about the most interesting commercial sites and advice on search methods.

Advantages, disadvantages, information to include on the site. The main advantages that companies see in the Web are the possibilities for market expansion (49%), for improving public image (37%) and, obviously, for low-cost access to information (49%) (see Figure 1). This response shows that companies now view the Web as a standard means for widespread distribution of information, and the sort of information they envisage providing at their sites matches this vision.

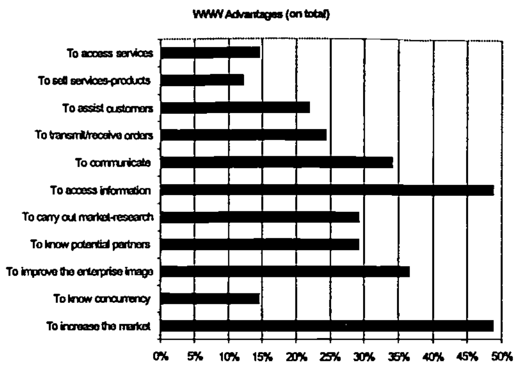


Figure 1 - Advantages of the We

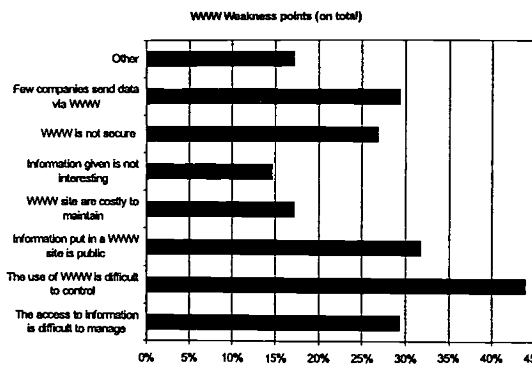


Figure 2 - Disadvantages of the Web

There is far less interest in using the Web for commercial purposes such as placing orders (24%), acquiring information about competitors (15%), product sales and services (12%), or customer support services (22%). This lack of confidence is confirmed by the answers regarding the Web's perceived weak points: lack of security (27%), competitors' access to information (32%), and unwillingness to transmit data over the Web (29%) (see Figure 2).

In our view, a further hurdle to commercial use of the Web is the lack of control over how the user accesses a site (29%). Technological mediation makes it particularly difficult to discern client needs and provide the right response. This, together with the fact that many of the companies interviewed see the Web as a means of serving clients and providing information on products, highlights the economic importance of building web sites that can also offer customer-care services.

An interesting perspective on this problem comes from research into adaptivity concepts, which seeks to construct Web sites that dynamically select the information to be displayed according to the user's behaviour during site navigation [4, 5]. We believe it would be useful to draw companies' attention to these studies, as application of such techniques might give their web sites a crucial edge in marketing and business.

To our way of thinking, there are many factors that contribute to the Web's image as an unreliable commercial tool, most notably: the lack of thoroughly tested sales methodologies; the need to invest both in technology and in the study of new models of sales organisation; the uncertainty of results; the market's suspicious attitude.

A further obstacle to widespread Web use within companies is the impossibility of controlling the use the staff makes of it (44%). This is a major hindrance to the spread of network-based distance communication. The problem is a realistic one, even if psychological restraints exist that allow general use of the Web under acceptable conditions.

3.4 Teleconferencing and interpersonal communication

Analysis of the answers reveals that while e-mail is widely employed, other teleconferencing systems are not so common; what's more, there is little interest in evaluating their adoption in the future and even a certain degree of reluctance to examine the possibility at all (see Table 3).

What lies behind this situation is poor knowledge of teleconferencing tools, as demonstrated by the small number of responses about related benefits and drawbacks. This is understandable, given that networks have only recently reached Liguria's small and medium-size enterprises [9].

	Used	To be introduced	Not to be introduc	No answer
Video-conference	7%	20%	44%	29%
E-mail	85%	12%	2%	0%
Computer conferencing	7%	15%	49%	29%
Desk-top video-conferencing	5%	10%	51%	34%
Chat	2%	2%	56%	39%

Table 3 – Attitude towards teleconference systems

Let's take a closer look at the answers about e-mail's benefits and drawbacks and compare them with those regarding other teleconferencing tools. It must be noted, however, that the comparison can only be qualitative because the number of responses varies depending on the tool in question.

E-mail is considered advantageous in terms of communication potential, lower communication costs, image and innovation. It is relatively straightforward for the staff to use, relies on fairly simple technology and is regarded as highly beneficial. It meets companies' basic need to communicate swiftly in writing, and calls for innovation only in the tool to be used for the task, not the underlying methodology. The technology required is simple and relatively cheap, and what's more in many cases it has already been tested by the company's decision-makers on a personal basis.

In addition, it must be noted that the introduction of e-mail within a company is in itself capable of enlarging the company's market both for reasons of prestige (as the answers reveal) and because e-mail is becoming a standard form of communication parallel to telephone and fax.

Conversely, other types of teleconferencing systems, and particularly those that involve computers, are look upon with suspicion; people are clearly concerned that the perceived drawbacks (complex technology, lack of know-how among the staff, and modest gains) may outweigh the advantages. In our opinion, the reason for this kind of response lies in technological and socio-economic factors.

In technological terms, it cannot be denied that these systems are fairly intricate, apart from chat-oriented ones. This is particularly true for those who are relative newcomers to computer-mediated communication. Employing these systems efficiently presupposes technical know-how within the company and well-trained staff.

From a socio-economic viewpoint, these tools contribute to modify work organisation and methodology, thus entailing a transformation in social relationships. For these systems to be fully exploited, considerable innovation effort is required: the organisation must have the need and the ability to carry through change, as well as the capacity to develop methodological skills. In addition, costs are incurred that cannot be offset either by greater prestige or by access to widely used forms of communication.

It must be added that advanced teleconferencing systems have not yet gained a high profile in popular culture; they have received far less media attention than e-mail and the Web, as their usership remains fairly small.

Despite all this, companies acknowledge that computer-based teleconferencing tools might offer valuable assistance in certain corporate areas (see Figure 3). Furthermore, the boom of outsourcing and the introduction of tele-working will probably have an impact on the development of computer-driven teleconferencing tools. These forms of collaboration have brought various problems to the fore: that of identifying oneself within the organisation, of conveying one's ideas to the interlocutor without misunderstandings, of conducting effective discussion about a written document, a graph, etc.

Considering these factors, we believe that orientation and training programmes are vital in order to help companies understand the potential of these tools, both in operational as well as theoretical terms.

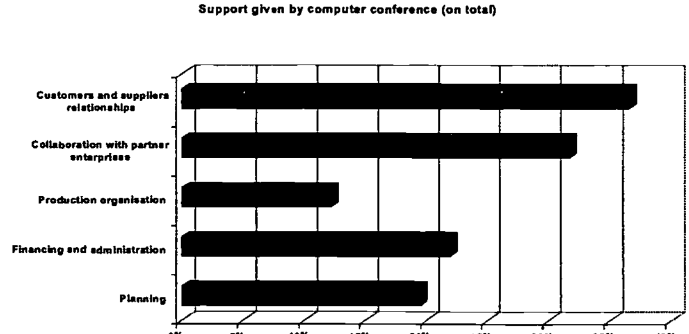


Figure 3 – Support given by computer conference

4 Conclusions

The survey shows that the spread of the network among Liguria's small and medium-sized enterprises has not been matched by a general grasp of network-related concepts. Consequently, training and orientation dedicated to network concepts and opportunities are called for, so that companies understand the kind of network services that might meet their needs.

Moreover, the survey reveals that these enterprises are aware of the potential of networking tools in expanding information sharing and communication possibilities. This awareness, however, is restricted to forms of use that do not modify work organisation and interpersonal relationships; one reason for this is that companies do not yet have the firm grasp of network concepts required to envisage applications in less immediate contexts. In fact, there is no perception at all of such applications because this would require awareness of the tools, an understanding of the actual possibility of achieving greater productivity, changes in organisational structure and internal relationships, and an investment in technology and know-how.

As these results reveal, there is a clear need to develop orientation and training projects addressed to SMEs. These should provide:

1. Network concepts and opportunities, so that companies understand the kind of network services that might meet their needs. In particular, enterprises should be helped to learn the following:
   1.1. Basic notions about network technology;
   1.2. Infrastructure and public services;
   1.3. Distance communication methods and techniques;
   1.4. Methods of sharing documents and applications.

2. General skills in teleconferencing tools as well as methodological and content-based knowledge of potential advantages in relation to specific needs. In particular, enterprises should receive training so that they are able to do the following:
   2.1. Explore typical working tasks and decide what type of teleconferencing tools, if any, can increase the quality of the job;
   2.2. Investigate if and how the use of teleconferencing tools can favour the introduction of organisation methods not adopted in the enterprises, but able to improve competitiveness;
   2.3. Critically analyse a communication technology to define how useful it can be in a specific work situation;
   2.4. Recognise specific tools as particular examples of communication models;
   2.5. Abstract the communication features of a software tool so as to be capable of comparing one tool with another of the same class without difficulties.

3. Awareness of the psychological and cognitive issues entailed in communication and collaboration through the computer. Specifically, enterprises should gain practical awareness that:
   3.1. Computer-mediated communication differs from direct communication, and calls for adjustment in the ways one interacts with others;
   3.2. All those involved in an activity requiring computer-mediated communication, especially those without a technological background, must be able to call on technical support. In this way they will be encouraged, psychologically as well as practically, to use the new tool;
   3.3. If an experiment in the use of distance interaction methods is to be successful, there first needs to be a well-established atmosphere of reciprocal trust between the participants;
   3.4. People must be aware of both the opportunities and technical limitations of the tools used;
   3.5. To encourage the use of these systems, the work needs to be organised in such a way that each person gets a turn at assuming responsibility for some task or other;
   3.6. The system must be made indispensable for getting access to information and joining in discussion.

It is no easy task to create training schemes, including experimental ones, that meet these conditions. There are a number of reasons for this. From the educational viewpoint, an approach to training is called for that combines conventional training with a situated approach to the learning of teleconferencing opportunities and problems. When it comes to choosing the topic on which the training initiative is to be based, it is necessary to ensure that it is one of common interest to all the companies involved. Then there is the matter of the required expertise, calling for the involvement of various actors: training experts, to select the best methodology for tailoring the programme to the context; company representatives, to spell out production and organisational requirements; experts in the subject area; and experts in the specific technology. In economic terms, a balance must be struck between the need to provide up-to-date technology and the necessity for companies to contain costs.

European projects like *Teleconferencing* that are designed to help enterprises cope with innovation provide strong impulse in this direction. They create the conditions under which pilot projects of the kind described above can be introduced, provide tools for evaluating their effectiveness, and form the cultural background needed to built advanced technology training systems that meet the needs of enterprises.

Acknowledgements

The Teleconferencing Project is carried out by an international consortium comprising IMA-CNR (Italy), Thati Gmbh (Germany), AMT (U.K.) and OPCAREG (France). It is jointly funded by the European Commission's Social Fund and by Italy's Ministry for Employment and Social Security. The Italian partnership involved in the project comprises: IMA-CNR, Genoa (Italian promoter), CONSULTEAM (Savona), the Employment Agency of Liguria, Enaip Liguria, ERG Petroli S.p.A. (Genoa), Gruppo Imation (Ferrania, Province of Savona), ISOMAR (Savona), Nuova Magrini Galileo (Bragno, Province of Savona), Ricerca e Progetto S.a.s. (Genoa) and STEM - ISI Impianti S.p.A (Genoa).

References

[1] Angelides M.C., "A Framework for Examing Desktop Video Conferencing in the Organisatonal Context", CIT Journal Vol. 6, No. 3, pp.285-296, (1998).
[2] Ahuja M.K. & Carley K.M., "Network Structure in Virtual Organisations", JCMC Vol. 3, No.4, http://jcmc.huji.ac.il/vol3/issue4/ahuja.html, (1998).
[3] Anderson T., & Kanula K., "On-line Forums: New Plarforms for Professional Development and Group Collaboration", JCMC Vol. 3, No.3, http://jcmc.huji.ac.il/vol3/issue4/anderson.html, (1997).
[4] Eklund J., & Brusilosky P., "Individualising Interaction in Web-based Instructional Systems in Higher Education", http://www.uow.edu/auc/Conf98/papers/eklund.html, (1998).
[5] De Bra, P., & Calvi L., "AHA: a Generic Adaptive Hypermedia System", Proceedings of the 2nd Workshop on Adaptive Hypertext and Hypermedia, http://wwwis.win.tue.nl/ah98/DeBra.html, (1998).
[6] European Commission, "The green paper on innovation", December (1995).
[7] Jacobs G., & Rodgers C., "ISDN-based distance learning: tangible costs, intangible benefits", Computers & Education Vol.31, pp.41-53, (1998).
[8] Jarvenpaa S.L. & Leidner D.E, "Communication and trust in global teams", JCMC Vol. 3, No.4, http://jcmc.huji.ac.il/vol3/issue4/jarvenpaa.html, (1998).
[9] Forcheri, M.T. Molfino, & A. Quarati, "Design of learner-centered tools for continuous training in SMEs", Education & Information Technology, Vol. 3, pp.261-276, (1998).
[10] Kaye A.R. (Ed.), "Collaborative Learning through Computer Conferencing", Springer-Verlag, (1993).
[11] Kraut R., Steinfield C., Chan A., Butler B. & Hoag A., "Coordination and virtualization: the role of electronic networks and personal relationships", JCMC Vol.3 No.4, http://jcmc.huji.ac.il/vol3/issue4/kraut.html, (1998).
[12] Romm C.T., & Pliskin N., "Toward a Virtual Politicking Model", Communication of ACM, Vol.40, No. 11, pp. 95-100, (1997).
[13] Rosen E., "Personal videoconferencing", Manning, Greenwich, (1996).
[14] Schreiber D. A., & Berge Z. L. (Eds), "Distance Training", Jossey-Bass Publishers, San Francisco, (1999).
[15] Wiesenfeld B.M., Raghuram S., & Garud R, "Communication Patterns as Determinants of Organisational Identification in a Virtual Organisation", JCMC Vol.*3*, No.4, http://huji.ac.il/vol3/issue4/wiesenfeld.html, (1998).

The "Half-Life" of Knowledge in the University of the 21st Century

Roger Mundell, Denise Stockley, Jeanette Muzio, Tanya Wilson, and Laureen Vickery
CEDAR, Royal Roads University, 2005 Sooke Road, Victoria, British Columbia, V9B 5Y2, Canada
roger.mundell@royalroads.ca; denise.stockley@royalroads.ca; jeanette.muzio@royalroads.ca; tanyawilson@royalroads.ca; laureen.vickery@royalroads.ca

In this paper, the role of the post-secondary institution in promoting half-life, and short half-life knowledge skills is examined. We provide an overview of the role that the university traditionally played in transmitting knowledge and lead into a discussion regarding the need for change in order to adapt to the knowledge society of the present and future. Four different models of online technologies in North American virtual universities is presented, followed by a comparison of the approaches that academia and private sector have taken towards educational technology. In conclusion, we argue that there are not competing ideologies for online learning. Rather, we are all addressing different parts of the same problem.

Keywords: **Knowledge Construction and Navigation, Methodologies, and Teaching and Learning Processes**

1 Introduction

As we move away from the industrial society to a knowledge-based society, how we view teaching and learning in the 21st century is changing as well. Duderstadt [3] argued that information technology contributed to this shift by "dramatically changing the way we collect, manipulate, and transmit knowledge". He suggested that four themes were converging in the last decade: (a) the role knowledge would play in determining security, prosperity, and quality of life for the individual, (b) movement towards globalization, (c) the ease and speed that information technology allows us to obtain information, (d) formal social structures were being replaced through informal networks and collaborations among individuals and institutions.

Currently our university system is geared toward an undergraduate student who attends the university after their high school completion. Many institutions also offer graduate courses and courses for the distance learner. Beyond that, most institutions do not have course offerings geared towards the mid-career learner. Denning [1] suggested that these professional programs would play a role in the business design of a successful university in the next century. This corresponds to a rising number of requests from industry requesting professional development for their employees to be provided by post secondary institutions [1]. This has resulted in a significant trend that the traditional divisions between post-secondary institutions, the workplace and government are becoming less visible [5].

2 Theory of the "half-life" of Knowledge

Knight [4] discussed the concept of the "half-life" of knowledge. He discussed two broad categories: (a) core knowledge or skills, and (b) economically relevant knowledge. These core skills have a longer half-life, and include things like critical thinking and reasoning skills, communication skills, and social skills. These types of skills are the on-going skills that are part of lifelong learning. The economically relevant knowledge has an even shorter half-life. These skills or knowledge relates to what makes you marketable (e.g., job skills, knowledge of an industry or profession or trade). The concept of the half-life suggests that over a period of time this knowledge is worth less economically, therefore, in orderto retain your economic value and marketability you have to learn more.

This half-life knowledge is making us feel more pressure as we attempt to keep up with the pace of learning new skills. Twenty-five years ago, you would be able to use the knowledge you learned for approximately twenty-five years. A person could learn a skill at age twenty and build their entire career around it. Ten years ago, the average half-life for economically relevant skills was only seven years. Three years ago, it was four years. Today it is eighteen months in the knowledge society. This half-life is even less in technology related fields. Individuals in the workforce will need to constantly upgrade their skills, as their current knowledge base needs to continually evolve to keep up with how rapidly technology is changing [6].

The "early adopters", the ones in high tech and engineering, re-invent themselves by jumping from job to job to stay on the newest wave of invention. This has created the "skills shortage crisis" found in larger organizations. These people constantly migrate to newer companies and even other countries in order to stay on the cutting edge and to market themselves while their skills are still relevant. That accounts for in Canada what is coined the "brain drain" that the government assures us does not exist.

3 Need for A Change

In a 1995 study, Dolence and Norris [2] suggested that this upgrade of skills might need to take place on average every five to seven years. They predict that by the year 2010, the full-time equivalent of one-seventh of the American workforce will be enrolled in higher education or retraining. This would mean that everybody in the workforce in Canada alone needs to do some new learning every three years that would put approximately five million new learners into the system every year. This would be over and above the entry level people that are currently in the workforce. You can imagine the size of the market in The United States, or India, or Asia. (see Dolence & Norris chart).

Country	Labour Force 2000	FTE Leaners	Campuses (30,000 students)	Cost to Build Campuses (Canadian $)
United States	141.1M	20.2M	672.00	$352.8B
Japan	64.3M	9.2M	306.00	$160.8B
Germany	37.2M	5.3M	177.00	$93.0B
United Kingdom	29.1M	4.2M	139.00	$72.7B
France	25.8M	3.7M	123.00	$64.5B
Italy	24.2M	3.5M	115.00	$60.4B
Spain	15.7M	2.2M	75.00	$39.3B
Canada	14.6M	2.1M	70.00	$36.5B
Australia	8.9M	1.3M	42.00	$22.2B
Sweden	4.6M	.7M	22.00	$11.5B
			TOTAL $	$913.7Billion
The World	2,752.5M	100.0M+	3,300.00	??????

To accommodate this demand would require a re-invention of our education and training systems to cope with these new demands. For now, competition is not the issue. We have not yet refined a product or an approach that promises to satisfy the enormous demand that is already emerging, and that will reach a crescendo over the next decade. To add to this increasing demand, the first wave of the so-called "echo-boomers" is set to hit our post-secondary system this year. This increase will pressure an already overburdened system, if we keep it the way it is today.

4 Application of Online Technology in Academia

The following are four different models of online technology usage in four North American virtual Universities.

Athabasca:

Pioneers in electronic distance education, they focused on the time and place needs of their students. They offer self- paced learning with mentors and instructors available online, instead of by snail mail. Their program is built on Lotus notes. They are now moving into some more collaborative models, particularly with their MBA program, this is cohort based. They are reporting phenomenal demand, but still report a high rate of in-completion.

Western Governors University:

This university can be viewed as more of an accreditation collective. They offer a widely diverse collection of program offerings using diverse delivery technologies from diverse university departments. It has been slow to get off the ground, but the cross-accreditation concept is good, but still needs to evolve.

Royal Roads University:

A hybrid model. Students attend the campus at the beginning, middle, and end of their degree program for a very intensive "boot-camp" like experience designed to bond them as a community. In between, they work online in-group oriented and collaborative exercises. They go through the program in "Cohorts" all at the same time, with the same start and finish dates, but with flexibility built into each course to allow for "learner-centred" approaches. In this way, the University can put 1800 students through a former military college with only 300 classroom seats. Most students are fully employed while taking the programs, and are able to apply immediately what they learn.

Tech-BC:

Here's an interesting model. Perhaps the one with the most implications for Universities as we know them. Imagine if you were to divide the learning objectives into the ones that must be learned on campus and the ones that can be accomplished online. Have the students attend University a couple of days per week and do the rest of the work online. Leverage the facility, and potentially offer partnered learning with industry while the student remains employed. We think this model offers a blueprint for how we can leverage overtaxed facilities. This model is dependent of course on having a market within commuting distance.

If we revisit the concept of long half-life learning, and short half-life learning, we envision a future where we use Universities to teach that "long half-life" stuff that is best learned on campus, or face to face with other students. In this model, academics drive the "long-half life" stuff, but we use the technology to cover the "short half-life" material that is constantly changing, and is driven by economics and industry. There will be some crossover of course, but it is interesting to note that there are already some noticeable leanings in the two camps of academia and industry.

Academia and the Private Sector

The following is a comparison in general trends between the Academic and Private sectors:

Academic online programs tend to favour:

- Asynchronous
- Community based
- One to many
- Semester based
- Everyone covers everything

These things lend themselves to those "long half-life" skills.

Private sector training has tended to favour:

- Synchronous
- Learner-Centred
- Many to one
- Just in time
- Just enough
- Performance support

These, you could argue, are better suited to the "short half-life" skills.

So should we be marrying all these techniques together? Or on the other hand, should each sector start to focus on the niche to which they are best suited? Of course for the last 40 years, the lines between academic training and job-skill training have become increasingly blurred. Employers tell us they value critical thinking, reasoning skills, pattern recognition, organizational skills, and communication abilities. Many tell us they find these skills are well developed in individuals who have studied for example, anthropology, music, and history. They like these people to have a University education; however, they don't want to spend a year or six months grooming them after University, because today' s graduates don't stay that long. They need to have the necessary job skills from day one.

These are those "short half-life" skills. Obviously, we cannot take two, three, or even four years to teach skills with a half-life of eighteen months. Would the answer be a model like the one at Tech-BC or at Royal Roads? On the other hand, will the new educational institution be a combination of new kinds of university offerings, perhaps with a robust new private industry creating big budget online units that can be used as adjuncts to University courses?

5 Concluding Thoughts

The point we are trying to lead to is that there are not really competing ideologies for online learning. We all are actually all addressing different parts of the same problem. We are like the six blind men in the parable of the elephant.

The Blind Men and the Elephant
by John Godfrey Saxe

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
Though all of them were blind,
That each by observation
Might satisfy his mind.

In the next six verses, each of the blind scholars grasps a different part of the elephant. One thinks that the elephant is like a snake, and another thinks they are like a tree, another like a fan, and in the last verse, it says,

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong.
Though each was partly in the right,
They all were in the wrong!

We think this describes quite well our present confusion about technology and where it will fit into our need to learn. We are all working on different bits of the elephant. The question we need to address as a community at this and other academic conferences, are where do we go from here?

References

[1] Denning, P.J. (1996). Business designs for the new university. Educom Review, 31(6), 20-30.
[2] Dolence, M.G., & Norris, D.M. (1995). Transforming higher education: A vision for learning in the 21st Century. Ann Arbor, MI: Society for College and University Planning.
[3] Duderstadt, J.J. (1997). The future of the university in an age of knowledge. Journal for Asynchronous Learning Networks, 1(2). Available: http:www/aln.org/alnweb/journal/issue2/duderstadt.htm
[4] Knight, P.T. (1997). The half-life of knowledge reform of the education sector for the global knowledge-based economy. Paper prepared for the Forum on Education in the Information Age, Cartagena, Colombia, 9-11 July 1997.

[5] Lewis, B., Smith, R., & Massey, C. (1999). Mirroring the networked society: Government policy, higher education, and telelearning technology in Canada. Canadian Journal of Communication, 24, 319-336.
[6] Muzio, J. (1999). The development of a prototype learner-centred electronic distributed learning course for Royal Roads University. Doctoral Dissertation Nova Southeastern University.

The Rhetoric of the web—A semiotic approach to the design and analysis of web-documents

Jens F. Jensen
InterMedia Aalborg, Aalborg University
Niels Jernersvej, NOVI4-215, DK-9220 Aalborg East, DENMARK
Phone: +45 98 15 62 79 Fax: +45 98 14 24 44
E-mail: jensf@hum.auc.dk

This paper seeks to discuss possible approaches through which semiotics and rhetoric can be applied to the World Wide Web seen as a multimedia; or, in other words, possible approaches through which Web-sites and Web-pages can be studied and designed from a semiotic point of view-The aim of the paper is thus to outline a coherent theoretical, methodological and analytical framework for the study and design of Web-documents based on semiotics and rhetoric. This paper has analytical, theoretical, methodological, as well as practical implications. It is of interest in relation to the analytical and theoretical understanding of the new and rapidly growing web medium, and in relation to methods of examining this phenomenon. The study shows the concepts and categories from the field of semiotics and rhetoric are highly relevant to the area of the web and it indicates that the concepts presented here can form the building blocks for a more general ' Semiotics of Cyberspace'. The observations from this study may also have an effect on conventional theory formation and understanding within semiotics, rhetoric, and communication research and media studies. However, it also has implications for the construction and design aspects since the design of Web-documents and Web-sites must be based on actual knowledge of the conditions and possibilities for communication and the construction of signs, codes and meaning in the new medium.

*The paper was not available by the date of printing.

Towards a model of using Information Technology in education for pre-service teacher education

Kai-ming LI, Yiu-sing LAM, Pak-hung LI and Kwok-leung WU
Department of Curriculum and Instruction,
Hong Kong Institute of Education, 10, Lo Ping Road, Tai Po, N.T. Hong Kong
kmli@ied.edu.hk, yslam@ied.edu.hk, phli@ied.edu.hk, klwu@ied.edu.hk

This paper reports the present scenario of using computer and traditional instructional media for primary class teaching in HKSAR. 323 primary teachers who have attended staff development seminars and refresher training workshops in the use of IT in education were invited to provide information for the study. The teaching time in a week and the teaching modes with 16 instructional media including computer technologies were examined. Results showed that textbook, blackboard and printed text materials remain the dominant instructional media in current practice of teaching in primary schools. The use of computer technology is rare despite the expectation that computer and computer-related technologies will make learning more effective and efficient and even to replace the traditional "educational technologies". The findings also indicated that technologies were used mostly as information delivery tools. Teaching strategies were limited to mass teaching and teacher-centered presentation. This phenomenon may have relationship with the ineffective training in the use of IT as indicated in many researches though courses in this area have been included in most teacher education programmes around the world. The last section of this paper will discuss on the contents of IT courses and to suggest a teaching model of using IT in education for pre-service teachers education programmes.

Keywords: **Methodologies, Teaching and Learning Process, Instructional Design**

1 Introduction

The Hong Kong Special Administration Region (HKSAR) government has already launched a five-year strategic plan of promoting the use of Information Technology (IT) in education aiming at enabling our students to be competitive and technological competent in the international arena since 1998 [1]. A total of about three billion dollars in capital cost and five hundred million dollars in annual recurrent cost will be used.

Computer and computer related technologies were expected to make teaching and learning more effective and efficient when it entered the classroom in 1980s [2]. Many teacher education programmes around the world have already started incorporating computer courses as basic requirement for teacher certification. In HKSAR, the previous colleges of education [1] have also started to include computers in education and computer applications courses in the Educational Technology subject which is compulsory to all the pre-service teachers in late 1980s. However, despite the provision of this training in many teacher education programmes, many researches report that the actual usage of new technologies in teaching was very limited. Teachers are not prepared to use new technology effectively in the classroom [3] [4]. Abdal-Haqq (1995) [5] even stated that "...few teachers routinely use computer-based technologies for instructional purposes" (p.1). In U.K., the HMI also commented that "new teachers make little use of Information Technology in the lessons"[6].

The purpose of this study is to find out the present scenario of the use of instructional technologies in primary

1 The previous colleges of education were amalgamated into the Hong Kong Institute of Education in 1994.

school teaching. The teaching time and the modes of using computer and traditional technologies are examined and compared. Such information will act as the base line for future investigation on the changes in teaching modes, strategies, and the use of new technologies in the 21st century classrooms. The last part of this paper will discuss on the contents and a teaching model that may be useful for preparing pre-service teachers to use computer more effectively in their future class teaching.

2 Method

2.1 Participants

The participants in this study were 323 primary teachers who attended staff development seminars and refresher training workshops in the use of IT in education offered by the Department of Curriculum and Instruction of the Hong Kong Institute of Education in 1999. 76% of them were female primary teacher. 95% of them possessed personal computers at home. 56% of them have received computer training in pre-service teacher education programme. This sample was further divided into three groups according to their teaching experiences: 27%, under 5 years; 25%, 6-10 years; 48% over 10 years.

2.2 Data Collection

The participants were asked to complete a survey at the beginning of the seminar and workshops. The first part of the survey was the demographic data of the participants while the second and third part required the participants to respond to the time spent in a week and the different modes of using 16 instructional media selected for this study respectively (see Table 1 and 2).

3 Results

3.1 The time of using instructional media in a week

Table 1 shows that board writing remains the most frequently used medium in the classroom. About 75% of the participants spend more than half of their teaching time with it. The second frequently used medium is board drawing (about 38%) while the third one is printed medium (about 30%). The table also reveals that 10 items have their using time less than half of the total teaching time in a week (item 6-11 and 13-16). It is also obvious to see that computer technologies were seldom used in class teaching at this stage. This phenomenon may be well explained by the un-readiness of computer facilities in most of the primary schools in the period of this study.

However, the figures revealed in the mean percentage of the use of traditional media in Table 1 show that about a quarter of the participants did not use any traditional instructional media and about 57% of them taught with these media less then half of the teaching time in a week. Only 17% of them used them for more than half of the teaching time in a week. This result shows that "text-book" teaching remains the dominant strategy in most primary school teaching despite those traditional instructional media have already placed in the schools as standard equipment.

Types of Media		Never Use (%)	Less than 1/4 time (%)	Between 1/4 to 1/2 time (%)	Between 1/2 to 3/4 time (%)	More than 3/4 time (%)
Traditional Media						
1.	Blackboard/Whiteboard Writing	1.5	2.9	20.4	33.8	41.4
2.	Blackboard/Whiteboard Drawing	2.9	28	31.5	22.6	15
3.	Realia/Model	1.9	51.3	33.2	10.6	3
4.	Graphics	3.3	53.1	32	9.6	2
5.	Printed Material	3.6	32.4	34	18.4	11.6
6.	Photo	13.1	69.3	12.8	4.5	0.3
7.	Slide	71.8	23.1	4.2	0.6	0.3
8.	Overhead Transparency	40.8	38.7	17	1.9	1.6
9.	Audio Tape	30.8	44.8	17.4	3.5	3.5
10.	Video Tape	35.5	42.8	15.8	4.9	1

11.	Tape-Slide Programme	88.5	8.9	1.6	1	0
12.	Learning Package	13.1	49.4	25.6	9	2.9
Computer						
13.	Computer Generated Texts and Graphics	53.8	32	11.3	1.9	1
14.	Computer Presentation Programme	82.8	12.7	3.2	1.3	0
15.	Computer Assisted Learning Programme	86.4	9.1	3.9	0.6	0
16.	Internet	94.8	2.9	1.3	0.7	0.3
	Mean Percentage :	79.45	14.18	4.93	1.13	0.33

Table 1: The Percentage of Responses to Teaching Time Used with Instructional Technologies in A Week by Primary Teachers of the Study (N=323)

3.2 The modes of using instructional media

Participants who have used the instructional media were asked to respond to the types of instructional modes of how these media were used. Table 2 shows that for the first three frequently used media as identified in last paragraph, they were used mostly for teacher's presentation (82%, item1; 79.2%, item2 and 66.7%, item4). The average percentages for group learning and individual learning activities for traditional media are 16.6% and 8.2% while those for computer are 8.6% and 4.5% respectively. These figures show that teacher's presentation is still the major mode of teaching among primary teachers at the present moment.

	Types of Media	Teacher's Presentation (%)	Group Learning Activity (%)	Individual Learning Activity (%)
Traditional Media				
1.	Blackboard/Whiteboard Writing	82	-	-
2.	Blackboard/Whiteboard Drawing	79.2	-	-
3.	Realia/Model	66.4	30.6	9.5
4.	Graphics	66.7	23.5	7.6
5.	Printed Material	31.5	47.4	36.7
6.	Photo	48	24.5	9.8
7.	Slide	20.5	4.3	3.7
8.	Overhead Transparency	41.3	15	6.4
9.	Audio Tape	36.4	10.4	6.1
10.	Video Tape	35.5	8	4
11.	Tape-Slide Programme	11	3.1	1.5
12.	Learning Package	40.7	32.4	13.5
	Mean Percentage :	46.6	16.6	8.23
Computer				
13.	Computer Generated Texts and Graphics	26.3	17.1	9.5
14.	Computer Presentation Programme	9.2	7.3	3.7
15.	Computer Assisted Learning Programme	7.3	5.5	3.1
16.	Internet	4	4.6	1.5
	Mean Percentage :	11.7	8.63	4.45

Table 2: The Percentage of Responses to Teaching Modes Used with Instructional Technologies by Primary Teachers of the Study (Respondents can select more than one mode)

3.3 Effects of difference in gender and teaching experience on the use of instructional media

Since the sampling was not randomized, normal distribution of the sample could not be assured. A non-parametric analysis using the Mann Whitney U test was then used to compare the difference of the distribution of the responses between female and male primary teachers and the three groups of teachers with different teaching experiences.

Types of Media		Gender	Never Use (%)	Less than 1/4 time (%)	Between 1/4 to 1/2 time (%)	Between 1/2 to 3/4 time (%)	More than 3/4 time (%)
3.	Realia/Model*	Female	1.3	46.4	37	11.9	3.4
		Male	4.1	67.5	21.6	5.4	1.4
4.	Graphics*	Female	3	48.1	35.1	11.7	2.2
		Male	4.2	70.4	21.1	2.8	1.4
5.	Printed Material*	Female	3	31.8	30.5	20.3	14.4
		Male	5.6	34.7	44.4	12.5	2.8
6.	Photo*	Female	11.8	66.8	15.1	5.9	0.4
		Male	17.8	76.7	5.5	0	0
7.	Slide*	Female	74.8	19.7	4.3	0.9	0.4
		Male	61.6	34.2	4.1	0	0
11.	Tape-Slide Programme*	Female	90.9	6.9	1.7	0.4	0
		Male	80.8	15.1	1.4	2.7	0
13.	Computer Generated Texts and Graphics*	Female	58.7	30.6	8.1	1.3	1.3
		Male	37	37	21.9	4.1	0
14.	Computer Presentation Programme*	Female	89.8	7.7	2.1	0.4	0
		Male	60.3	28.8	6.8	4.1	0
15.	Computer Assisted Learning Programme*	Female	91.5	6.4	1.7	0.4	0
		Male	69.4	18.1	11.1	1.4	0

** Statistically Significant Difference at $\alpha = 0.05$, Mann-Whitney U Test*

Table 3: The Percentage of Responses to Teaching Time Used with Instructional Technologies in A Week by Female and Male Primary Teachers of the Study

Significant differences were found in the distributions of 9 items between female and male teachers. In Table 3, referring to the "never use" column, it is interesting to see that female teachers used simple and traditional media (item 3,4,5 and 6) more than male teachers while male teachers used more complicated traditional media (item 7 and 11) and computer technologies (item 13,14 and 15) in this study. Similar analysis was conducted among the teachers with different teaching experiences. Only one item was found to be statistically different between the less experienced and more experienced teachers. Table 4 shows that experienced teachers used slide more than the less experienced teachers.

Types of Media		Teaching Experience	Never Use (%)	Less than 1/4 time (%)	Between 1/4 to 1/2 time (%)	Between 1/2 to 3/4 time (%)	More than 3/4 time (%)
7.	Slide*	Group A	82.4	14.1	3.5	0	0
		Group B	66	29.1	4.3	0.7	0

** Statistically Significant Difference at $\alpha = 0.05$, Mann-Whitney U Test*

Group A: Teaching experience less than 5 years; Group B: Teaching Experience greater than 10 yearS

Table 4: The Percentage of Responses to Teaching Time Used with Instructional Technologies in A Week Between Two Groups of Primary Teachers with Different Teaching Experience of the Study

Analysis on the teaching modes of using these instructional media, however, showed that no significant differences were found between the female and male teachers and also among the three groups of teachers with different teaching experiences.

4 Discussion

From the above findings, it is obvious that the use of instructional media including computer technologies was limited. The teaching strategies employed by most primary teachers were still very teacher-centered although they have already completed instructional technology and related courses in the teacher education programme. Computer uses were rare even though more than 50 % of the participants have attended computer courses while receiving their pre-service teacher training and 95% of them possess home computers. It is evident that future teaching is influenced by the learning experiences that pre-service teachers gained in their tertiary education [7]. Researches also show that the provision of instructional models for classroom implementations of technology is far more important than the training of the "know-how" skills [8]. The instructional strategy should act as the model and should be student-centred rather than terminology and hardware centred [9]. Task-based or problem based activities are more effective than skill drilling of certain hardware or computer software by direct demonstration. A course with well–designed contents and effective teaching model for the use of IT in education is believed to have positive influence on the actual implementation in school teaching.

4.1 The Contents

We suggest that for an IT in education course to be successful, the following areas should be included. We believe that such contents allow our pre-service teachers to have more comprehensive mastery of knowledge and skills of using IT in education and enable them to put theories and practical skills into real practice in primary school teaching.

1. Understanding the development, trends, advantages and limitations of using IT in education.
2. Understanding the roles and contributions of IT and teachers in the communication and learning process.
3. Designing and producing instructional materials with IT.
4. Operating computer hardware and application software while producing and using computerized instructional materials
5. Selecting and deriving learning activities with computerized instructional materials and resources
6. Evaluating the effectiveness of computerized instructional materials and programmes that involves the use of IT.

4.2 The Teaching model

Figure 1 is a proposed teaching model of using IT in education for teacher preparation programme. This model is informed by constructivist views of learning in which the learner is the center and the actor of learning. There are six major components in the model:

1. The teacher – is the one who build this model, creates a constructivist learning environment, acts as the resource, guide and the facilitator of the learning process and models the actual implementations and strategies of using IT in an authentic context.
2. The learner – is the master of this model, comes with different background and learning style, interacts with other components of this model and to construct the knowledge and skills actively.
3. Resources and support – assist the learner to complete his/her task throughout the learning process.
4. Integration – is the experience that the learner gains when applying IT in teaching and learning in an authentic situation.
5. Reflection – is the introspective thinking allowing the learner to have deeper understanding of the IT applications and be able to examine related issues critically.
6. Monitoring strategies – provide clear instructions and directions allowing the learner to have a complete picture of the objectives and significances of the learning, the tasks to be completed and the access to relevant resources and support.

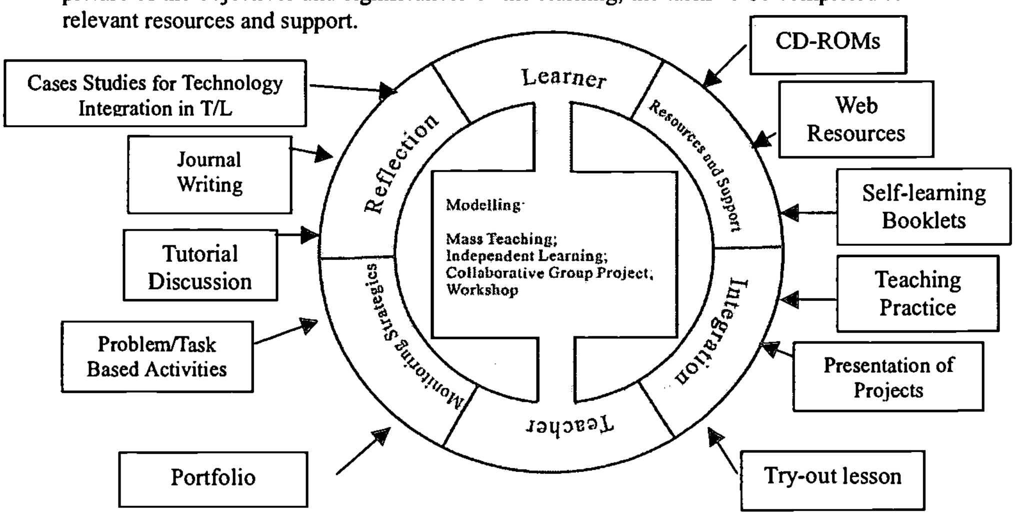


Figure 1: A teaching model of using IT in education for teacher education

5 Conclusion

The components of the teaching model guide the development of various strategies, learning activities and resources that can be found in Figure 1. Evaluation of the effectiveness of this model has been started and the results will be reported in due course. The findings of the survey in the first part of this study signal the ineffective use of instructional media both in terms of teaching time and strategies in primary school teaching. Change is expected if our students are to be really benefited by the five-year strategy of using IT in education. Teacher education, therefore, places an important role in this aspect.

References

[1] Education Manpower Bureau (1998). Information Technology for learning in a new era: 5-year strategy 1998/99 to 2002/03, November 1998, HKSAR.

[2] Goodlad, J.I. (1984). *A place called School.* New York: McGraw Hill.

[3] Bosch, K.A. and Cardinale, L. (1993). Preservice teachers' perceptions of computer use during a field experience. *Journal of computing in Teacher Education*, 10(1), 23-27.

[4] Office of Technology Assessment (OTA)(1995) Teachers and Technology: Making the Connection. US: OTA 1995 Report.

[5] Abdal-Haqq, I., "Infusing technology into pre-service teacher education", ERIC digest. (ERIC Document Reproduction Service #ED 389699). (1995)

[6] Her Majesty's Inspectors (1993). *The new teacher.* London: HMSO.

[7] Adams, P.E. and Krockover, G.H. (1997), Beginning science teacher cognition and its origins in the pre service secondary science teacher program. *Journal of Research in Science Teaching*, 34, 633-653.

[8] Novak, D. and Knowles, J. (1991). Beginning elementary teachers' use of computers in classroom instruction. *Action in Teacher Education*. 8(2), 43-51.

[9] Bigum, C. (1990). Situated computing in pre-service computer education. In A. McDougall and C. Dowling (Eds.). *Computers in Education.* North Holland: Elsevier Science.

Traversing the Case Graphs A Computer Model for Developing Case-based Learning Systems

Isaac P.W. Fung & R. H. Kemp
Institute of Information Sciences and Technology
Massey University
Palmerston North, New Zealand
Fax: +64-6-3502259
P.W.Fung@massey.ac.nz; R.Kemp@massey.ac.nz

This paper presents an extended theory for representing cases in a case-based physics learning environment. There are two issues with which developers of case-based tutoring systems often contend: one is assessing and retrieving similar cases from the case library; the second one is delivering the case contents to the students. Whilst an earlier paper has addressed the former issue, this paper focuses on the latter by defining a computational mechanism that is used for delivering the case content. The mechanism is developed by defining a procedural semantics on the case graph which incorporates the dynamic modelling capability of petri nets. A case is initially opaque to the student. During case interaction, however, it will be made transparent gradually by engaging the students with problem-solving activities. The activities are modelled using the notions of marking places and firing transitions, where places and transitions represent case variables and operations, respectively. The idea is illustrated with an example of providing guidance to students solving problems in the domain of Newtonian mechanics.

Keywords: **Artificial Intelligence, Conceptual Graphs, Intelligent Tutoring Systems, Case-based Reasoning**

1 Introduction

This paper presents an extended theory of representing problem-solving cases proposed in [5] for the purpose of modelling instructional activities between the cases and the learners within the context of case-based tutoring systems (CBTS) [11]. In response to the classic criticisms [12] leveled at the first-generation of computer-assisted learning software that frequently have to go back to inflexible, pre-compiled problem solutions, CBTS is very attractive for several reasons. Two of them are particularly appealing to us. From an instructional perspective, students are highly influenced by past examples (i.e. real cases) to guide their problem-solving activities [1] or completing cognitive tasks [8]. Our project sponsor demands that the final system should faithfully reflect what students actually do when completing their homework. It is, therefore, our aim to ground our system design at the outset on sound psychological findings about pupils' learning behaviours. Secondly, from a technical viewpoint, case-based adaptation techniques are powerful in adapting interface components to the user's need [14].

Individual learner's needs, style and progress do differ substantially. Case-based reasoning technology [7] endows the system with the capability of inferring what is considered 'best' for the students by referring to their past learning histories. [5] proposed the use of conceptual graphs (CG) [13] for representing tutorial cases. While this method elegantly tackles the issue of assessing case similarity, how the case graphs are built remains a 'black-box'. The case users have no way to inspect the internal processes for constructing the graph. To ensure the cases are useful in tutorial contexts, the knowledge components of the cases need to be 'available' to the students. What we mean by 'available' is making the case solution transparent, i.e. the system is capable of justifying each problem-solving step being shown to the students in terms of the underlying physical principles.

The procedural semantics defined on case graphs which forms the core contents of this paper, provides a way of making the solution procedures explicit to the students. The idea is to synthesize a CG and the actor graph defined in [13] into one single global graph instead of treating them separately. The resulting structure is a tripartite graph that has three types of nodes: concept nodes, symbolic relation nodes and mathematical relation nodes. The mathematical relation nodes are for handling mathematical calculations in the domain of Newtonian mechanics, the targeted subject domain of our project These calculations are important in many science and engineering applications. In making the synthesis, two important ontological commitments were made. Firstly, human cognitive functions in studying a concrete case are viewed as a process of constructing graphs. Relevant concept nodes are created and linked to each other via some appropriate relation nodes (whether symbolic or mathematical). A case represented by the graph consists of sets of concept nodes and relation nodes, but to what extent the students understand the case contents remains unknown until some observable actions are seen. Secondly, the process of building the graph is based on the notion of concept node marking. Initially, the sets of nodes in a case are all opaque to the users because they are not yet marked. The set of nodes representing the initially given physical quantities are marked first. Each problem-solving step is viewed as generation of new graph nodes, but they are implemented as the nodes states change from unmarked to marked. To mark a set of nodes, the mathematical relation nodes (or operators) which link the marked and the unmarked nodes have to be fired. The procedures of solving the problem are defined as the firing sequence for marking the target concept nodes. The subgraph associated with a particular fired node represents the semantics of the knowledge behind its firing.

2 Formal Definition of the Case Constituents

We represent a typical case abstractly by a directed graph which is composed of

* Three disjoint sets of vertices C, R and R_m (i.e. $C \cap R = \varnothing$; $C \cap R_m = \varnothing$; $R \cap R_m = \varnothing$ and $C \cap R \cap R_m = \varnothing$) where C represents the set of concept nodes; R represents the set of symbolic relation nodes; and R_m represents the set of mathematical relation nodes.
* A set of directed arcs E such that $E \subseteq (C \times R) \cup (R \times C)$. Each arc $e \in E$ connects a concept $c \in C$ to a symbolic relation $r \in R$ or vice versa.
* A set of directed arcs E_m such that $E_m \subseteq (C \times R_m) \cup (R_m \times C)$. Each arc $e_m \in E_m$ connects a concept $c \in C$ to a mathematical relation $r_m \in R_m$ or vice versa.

Shown in Figure 1 is an example case graph where

$C \ = \ \{c_1, c_2, c_3, c_4, c_5, c_6\};$

$R \ = \ \{r_1, r_2, r_3, r_4\};$

$R_m \ = \ \{r_{m1}, r_{m2}, r_{m3}, r_{m4}\};$

$E \ = \ \{(c_1, r_1), (r_1, c_2), (c_3, r_2), (c_4, r_2), (r_2, c_2), (c_5, r_4), (r_4, c_2), (c_6, r_3), (r_3, c_1)\}$; and

$E_m \ = \ \{(c_1, r_{m1}), (r_{m1}, c_2), (c_2, r_{m2}), (c_2, r_{m3}), (c_5, r_{m3}), (r_{m2}, c_3), (r_{m3}, c_4), (c_3, r_{m4}), (c_4, r_{m4}), (r_{m4}, c_6)\}.$

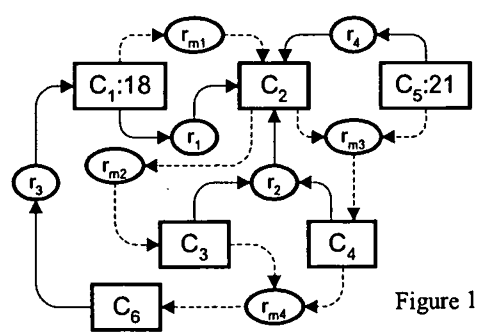


Figure 1

* For every $r_m \in R_m$, there exist an input set $I_r(r_m)$ and an output set $O_r(r_m)$ such that

$I_r(r_m) = \{ c \in C \mid (c, r_m) \in E_m\}$; (c , r_m) is called the input arc of r_m, and c is called the input concept of r_m; and $O_r(r_m) = \{ c \in C \mid (r_m , c) \in E_m\}$; (r_m, c) is called the output arc of r_m, and c is called the output concept of r_m.

For example, the input/output set of the node r_{m3} in Figure 1 are $I_r(r_{m3}) = \{c_2, c_5\}$ and $O_r(r_{m3}) = \{c_4\}$ respectively.

* For every $c \in C$, it is defined as *marked* if it is being instantiated to a specific individual. In Figure 1, c_1 and c_5 are marked whereas the others are non-marked.
* The marking μ of a graph G can be represented by a *n-vector*: $\mu = (\mu_1, \mu_2, \dots, \mu_n)$, where each $\mu_i \in (T, F)$. For example, the graph in Figure 1 has the marking $\mu = (T, F, F, F, T, F)$.
* A mathematical relation node $r_m \in R_m$ is *enabled* whenever each concept $c \in I_r(r_m)$ is marked. In Figure 1, only r_{m1} is enabled at that marking.

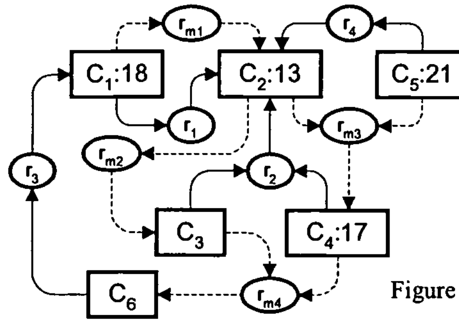


Figure 2

* When a mathematical relation node is enabled, it can be fired at any time and every time a mathematical relation is fired, every $c \in O_r(r_m)$ will be marked[1].
* For every $c \in O_r(r'_m)$, where r'_m is the fired mathematical relation, the content of c is evaluated according to the formulas inscripted in the respective $r'_m \in I_c(c)$.
* Supposing the formulas inscripted in r_{m1} is $c_1 = c_2 + 5$ and r_{m3} is $(c_2 + c_5) / 2$, the firing of r_{m1} will mark c_2 which enables r_{m3} because c_5 has already been marked. If r_{m3} is fired later, a new marking (shown in Figure 2) will be formed and become $\mu = (T, T, F, T, T, F)$.

3 Representing Mechanics Problem-solving Cases

In our application domain, Newtonian mechanics, two categories of physical entities are identified with respect to the cases we use for tutoring: *physical objects* and *physics concepts*. Both are represented, however, as rectangular-shaped concept nodes. In each case, a number of physical objects are involved, such as a block, a car, a plane, a spring, etc., but they are normally described abstractly just as a physical object. Various meaningful relations obtain between the objects, which essentially represent the physical configuration between them. For instance, it makes sense to represent the 'rest_on' relation that holds between a block and a plane whenever the block is on the plane. Other meaningful relationships are: 'above', 'contact_with', 'moves_on', and so forth. There are attributes, intrinsic and motion-related, of the physical objects which refer to one object only. For example, 'acceleration'(a motion-related attribute) and 'mass' (an intrinsic attribute) applies to a single physical object on its own. In representing a physical situation, there are some other domain-related ideas such as external force or friction, which characterize the case being described. All these concepts are categorized as physics concepts as they are used to describe the state of the world depicted by the case. Figure 3 shows a typical case adopted from a standard physics textbook.

Two blocks A & B are resting on a frictionless horizontal plane as shown. If an external force of 10N is acting on A, what is the acceleration of the blocks and the force of contact between them? (The masses of A and B are 3kg and 7kg respectively).

[1] The notion of marking and firing is borrowed from the petri nets formalism [9]

Solution: Apply Newton's 2nd Law on A&B

$$\begin{aligned}
\text{Net Force}_{A\&B} &= \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B} \\
\text{External Force}_{A\&B} &= \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B} \\
10 &= (3+7)\ \text{Acceleration}_{A\&B} \\
\text{Acceleration}_{A\&B} &= 1\ \text{m/s}^2
\end{aligned}$$

Apply Newton's 2nd Law on A

$$\begin{aligned}
\text{Net Force}_{A} &= \text{Mass}_{A} \times \text{Acceleration}_{A} \\
\text{External Force}_{A} + \text{Contact Force}_{A} &= \text{Mass}_{A} \times \text{Acceleration}_{A} \\
10 + \text{Contact Force}_{A} &= 3 \times 1 \\
\text{Contact Force}_{A} &= -7\text{N}
\end{aligned}$$

Apply Newton's 2nd Law on B

$$\begin{aligned}
\text{Net Force}_{B} &= \text{Mass}_{B} \times \text{Acceleration}_{B} \\
\text{Contact Force}_{B} &= \text{Mass}_{B} \times \text{Acceleration}_{B} \\
\text{Contact Force}_{B} &= 7 \times 1 \\
\text{Contact Force}_{B} &= 7\ \text{N}
\end{aligned}$$

Figure 3: A typical Newtonian mechanics case and its solution

As the complete graph representing the case occupies too much space, the whole graph is divided into several subgraphs. To illustrate the idea, three representative subgraphs are shown in Figure 4, 5 and 6. The subgraph in Figure 4 represents the physical objects involved in the case and their relationships. The (component) nodes encodes the part-whole relationship between the whole system A&B and its constituents A and B. The tuple [Blocks: A&B] → (component) → [Block: B] depicts the block labelled as 'B' as part of the whole system labelled as 'A&B'. The other relation nodes essentially represent the spatial relationships between the objects.

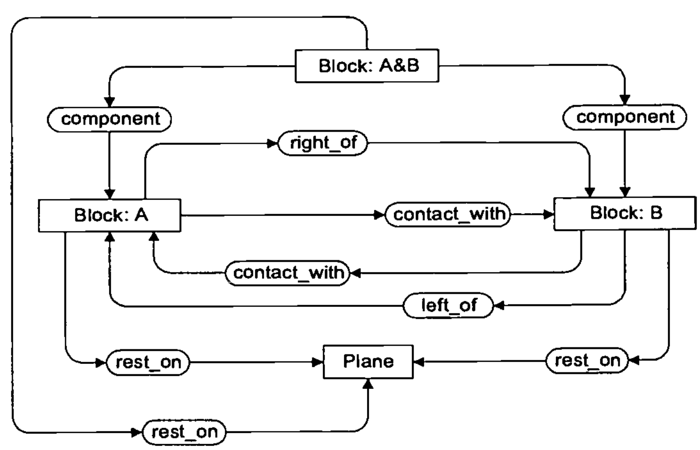


Figure 4: The subgraph showing the physical objects involved in the case and their relationship

The subgraph shown in Figure 5 concerns the attributes, both intrinsic and motion-relationed, of block A, and other relevant physical concepts centred around it. The absurd type [T] as the agent of the Net_Force_A and External_Force_A indicates it is something that is of no relevance to us. In Figure 6, those concept types that participate in some sort of mathematical relations are shown. Note that most of the arcs in Figure 6 are dotted indicating they are different from the usual symbolic relations.

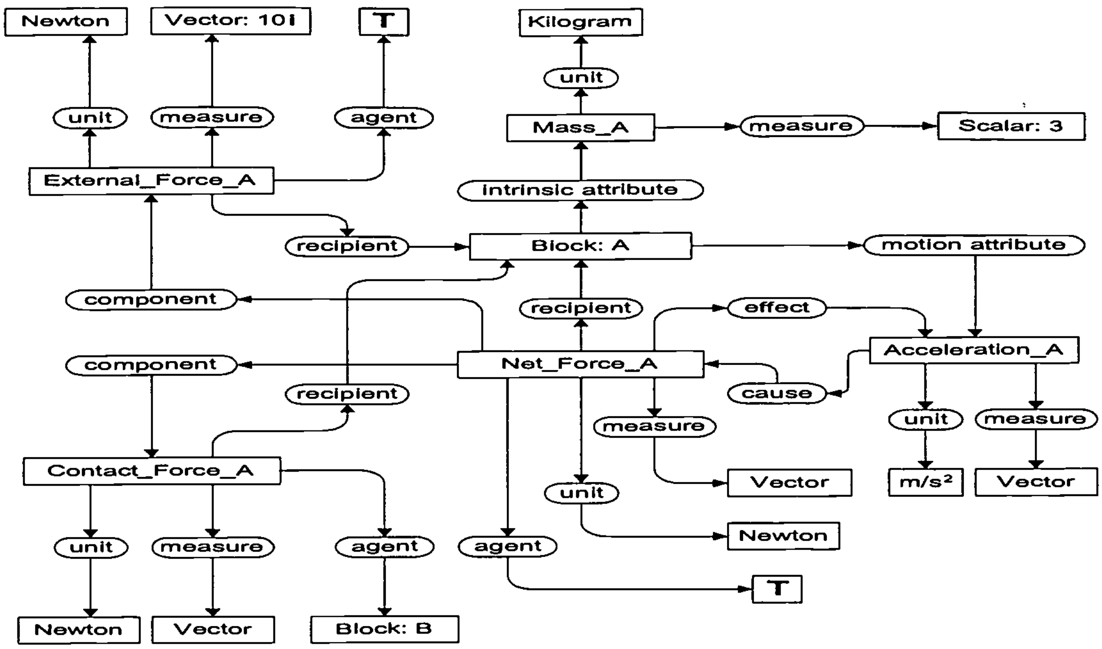


Figure 5: Subgraph showing the attributes of block A and other relevant physical concepts.

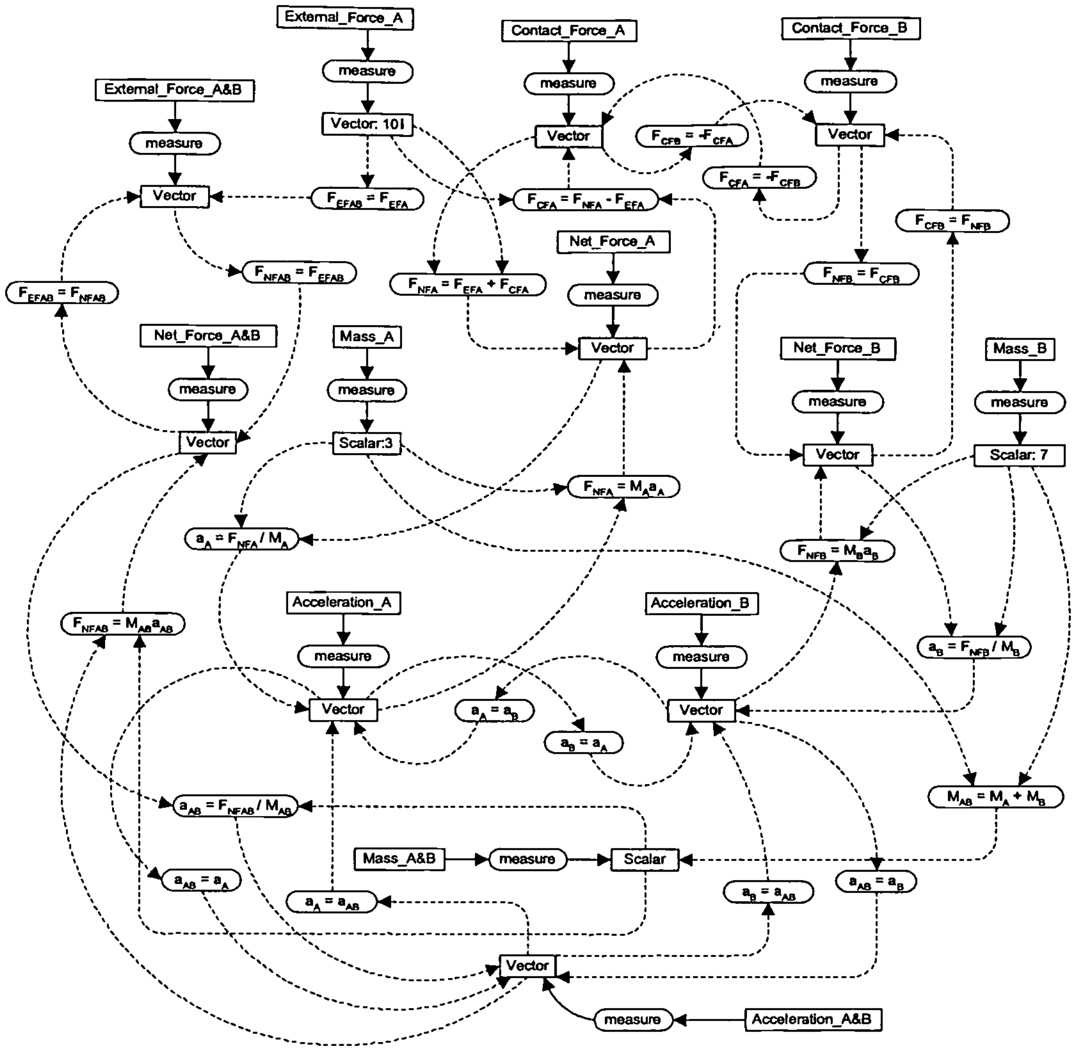


Figure 6: Subgraph showing the mathematical relationships between the relevant concept types

4 Modelling Variables Instantiation as Node Marking

Once a case has been encoded with the formalism, problem-solving activities can be modelled. When given a problem to tackle, the students will generally be asked for a new value from a set of given data. This is modelled as marking the concept nodes such as C_1 and C_5 in Figure 1. The goal is to get the concept node C_6 marked. At the initial marking, only r_{m1} is enabled and therefore any attempt to trigger other mathematical operations is not allowed and, thereby, invites tutorial intervention. The whole process of creating successive markings can be illustrated with a search tree (see Figure 7). The tree

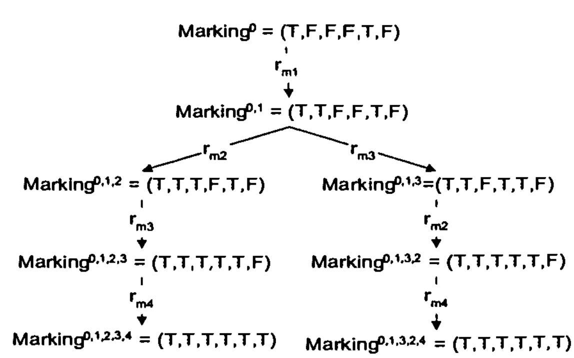


Figure 7

indicates the student can gain access to a large solution space for him/her to explore but in the mean time the tutor can keep track of what can/cannot be done.

5 CLASP: A Case-based Learning Assistant System in Physics

A system called CLASP, has been developed to implement the idea. At the current stage of development, two types of activities associated with examples have been identified: providing solutions for studying, and exercises with answers; hence the modes of interaction in the CLASP prototype are also designed around these two themes. When the users issue a request (in terms of the problem description of their own problems) the system will search through its whole case library and provide them cases which match their request. The style of presenting the case will follow the user's wishes, but only two modes of interaction (solution studying and guided-problem-solving) are available. This is to reflect the common way of using examples in physics textbooks. In the study mode, the system presents the whole case (i.e. both the problem and solution statements) for the user to study. This looks like an electronic reference book and the student may browse through the relevant cases. In the guided-problem-solving mode, the system only presents the problem situation to the users, but appropriate system guidance will be provided in solving the problems. The schematic architecture of CLASP is shown in Figure 8. The students interact with the system with the support of the back-end knowledge base.

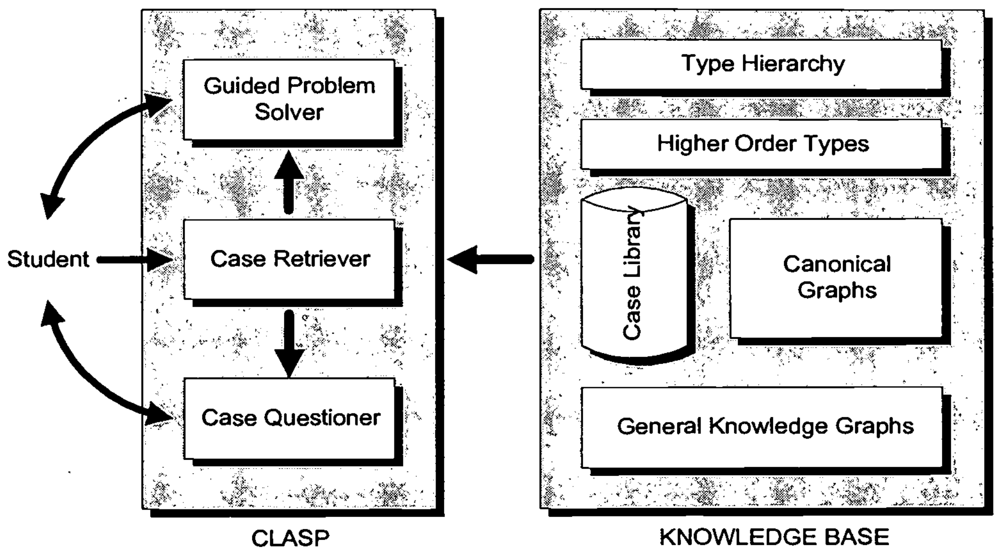


Figure 8: Schematic description of the CLASP architecture

Problem-solving in CLASP is modelled as a graph search. When a problem situation, such as the one shown in Figure 3, is encountered, the initial data are represented as concept nodes being instantiated to specific values and they are displayed to students on the working pad (Figure 9). Now the problem-solver can start tackling the problem by searching through the graph and seeing what additional information can be inferred from the initial given data. For the system to perform the tasks, the expertise has already been encoded in the case graphs, therefore the next step to be taken is searching the graph to find out which operators can be fired. The inferred steps may be unfolded or kept hidden for a while as a hint to advise the student. The intelligence of the system's problem-solving ability comes from its inference engine, being implemented by different graph search methods.

Problem Space	System's Comments:
External_Force_A: 10N Mass_A: 3 kg Mass_B: 7 kg	Initial Conditions: M_A = 3kg; M_B = 7kg; and External Force $_A$ = 10N.

Figure 9: The working pad and the corresponding system responds

The explanatory capability of the system comes from the matching of the input-operator-output nodes with the consequences of the general knowledge graphs. Whenever an operator is fired, the associated nodes will be matched against the consequences of the general knowledge graphs. If one is found, and it should be, then that particular graph will be tagged. If the student requests a justification of the step taken, the system can explain the graph in general terms. For example, the firing of an algebraic summation operator on the values of masses of two physical objects will match the consequence of the general knowledge graph in Figure 8 so the whole graph can be retrieved for explanation (Figure 10). The working pad, showing the problem space, and the explanation combinations supply the integration of what and why the step happened and the whole process becomes transparent to the student.

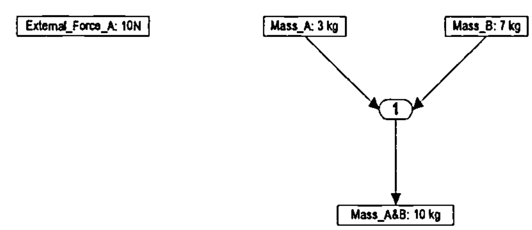
Problem Space	System's Comments:
	Step 1: For a system comprising two components, the mass of the whole system is evaluated by the algebraic sum of the masses of their individual components. $M_{A\&B} = M_A + M_B$

Figure 10: The working pad and the corresponding system responds

6 Conclusions

Case-based reasoning (CBR) is a versatile AI technology and can been found in many industrial applications [2] but its potential in training and education is still not fully explored. The work reported here may serves to strengthen the position of CBR in developing instructional systems.

The contribution of the paper to the endeavour of computer-assisted learning is twofold. Firstly, technically, a formal framework for representing cases for learning purposes has been developed. Its formal basis provides a solid foundation for developing robust computer-based instructional systems. With this methodology, the developers only have to concentrate their effort on collecting and encoding the cases. The rest (generating relevant instructional activities from the cases) will be taken care of by the system. This approach offers another advantage for rendering the cases amenable to further analysis. This may be used for providing tool to verify the case-base for internal consistency. Secondly, educationally, our approach paves the way for systematic educational software engineering because it is built on the needs of users, not the technical skills of the developers. Often, educational software developers have adopted a technically-driven design philosophy. Such systems run the risk of losing sight of what is actually happening in the real learning setting.

Our approach avoids the temptation of jumping onto the hi-tech bandwagon but, instead, concentrates firstly on what the students really need. The reason we developed a case-based learning system was not due to the existence of the technology and trying to find what role the technology can play in learning. Rather, we choose to develop a case-based approach to learning because students do learn from referring to past cases. This principle we consider crucial in determining if the final system proves itself useful to our students. Other features of the system have not been described due to space limitation. They include generating different categories of questions from a case graph [6] to promote self-explanation from the students. The model proposed in this paper can also perform qualitative reasoning [4], and causal order between system variables can be represented succinctly.

References

[1] Anderson, J.R. et al., "Learning to Program in LISP", Cognitive Science, Vol. 8, pp.87-129, (1984).

[2] Bergmann, R. et al., "Developing Industrial Case-based Reasoning Applications", Springer-Verlag, (1999).

[3] Fung, P.W., "Designing an Intelligent Case-based Learning Environment with Conceptual Graphs", PhD Thesis, Dept. of Computation, UMIST, England, (1996).

[4] Fung, P.W., "Generating Qualitative Predictive Problems in a Case-based Physics Tutor" In B. du Boulary & R. Mizoguchi (Eds.) Artificial Intelligence in Education: Frontiers in Artificial Intelligence and Applications Vol. 39, Ohmsha: IOS Press, (1997).

[5] Fung, P.W. & Adam, A., "Conceptual Graphs for Similarity Measurement in a Case-based Physics Problem Solver" In Proceedings of AI-ED 95 – World Conference on Artificial Intelligence in Education. Washington D.C, (1995).

[6] Fung, P.W. & Adam, A., "Questioning Students on the Contents of Example Solutions" In Proceedings of European Conference on Artificial Intelligence in Education, Lisbon, (1996).

[7] Kolodner, J. "Case-Based Reasoning" San Mateo, CA: Morgan Kaufmann Publishers, (1993).

[8] LeFevre, J.A. & Dixon, P., "Do Written Instruction need Examples?" Cognition and Instruction, Vol.3, pp.1-30, (1986).

[9] Peterson, J.L., "Petri Net Theory and the Modeling of Systems." Englewood Cliffs. NJ: Prentice-Hall Inc. (1981).

[10] Sanders, K.E., Kettler, B.P. & Hendler, J.A. "The Case for Graph-Structured Representations" In D.B. Leake & E. Plaza (Eds.) Case-based Reasoning Research and Development. Lecture Notes in Artificial Intelligence, Vol. 1266, pp. 245-54, Springer-Verlag, (1997).

[11] Schank, R.C., "Case-based Teaching: Four experiences in Educational Software Design." Report No.7, The Institute of Learning Sciences, Northwestern University, (1991).

[12] Self, J., "Student Models in Computer-aided Instruction." International Journal of Man-Machine Studies, Vol. 6, pp. 261-76, (1974)

[13] Sowa, J., "Conceptual Structures: Information Processing in Mind and Machine" Reading, MA: Addison-Wesley, (1984).

[14] Specht, M. & Weber, G., "Episodic Adaptation in Learning Environments" In Proceedings of the European Conference on Artificial Intelligence in Education, Lisbon, pp.171-176, (1996).

NOTICE

REPRODUCTION BASIS

☒ This document is covered by a signed "Reproduction Release (Blanket) form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").

EFF-089 (9/97)