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ABSTRACT

This document contains abstracts of 29 research projects in progress in Great Britain divided into six sections: (1) the current phase of Information Technology in Education Research (InTER) programs on groupwork with computers, tools for exploratory learning, conceptual change in science, and bubble dialogue as an ethnographic research tool; (2) projects supported by other agencies on computer-aided learning in music, computer testing of musical ability, effects of gender and interaction in computer-based learning, computer models of reading and spelling, computer-supported collaborative learning in physics, a computer-based program for mathematics teachers, the gap between arithmetical and algebraic thinking, computers in the secondary school curriculum, and information technology and training; (3) Economic and Social Research Council Linked Research Students projects on a knowledge-based approach to question answering in online systems and the design of knowledge-based advisers for learning; (4) Training Agency projects on supporting technology across the curriculum, whole school development in information technology, computer-based modelling, information technology-based open learning, authoring environments for simulation, and the DISTIL survey; (5) Developing European Learning through Technological Advance (DELTA) projects on a knowledge-based authoring facility, European cooperation in technology-based education, and student model acquisition in a natural laboratory; and (6) updates of InTER projects on the design of the Writer's Assistant and characteristics of human search procedures. (MES)

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Research in Progress – update April 1990

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Compiled by:
Maureen Boots
Administrative Assistant
ESRC – InTER Programme

InTER

Information Technology in Education Research Programme

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DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF LANCASTER, LA1 4YF

Research in Progress
– update April 1990

Preface

The InTER Programme has the diffusion of research results as one of its objectives. In addition to this, there is a policy of continuous exposure of work – in – progress with the aim of inviting supportive and critical contributions from other members of the research and practitioner community. It is hoped that such contributions will inform those actively engaged in the research as they benefit from the experience and expertise of others.

This annual review of Research in Progress has the abstracts grouped in six sections:

- interim reports from the current phase of InTER research programmes and its policy evaluation;
- reports on various research projects supported through other ESRC channels and by other agencies;
- reports from ESRC Linked Research Students;
- reports of a number of projects funded by the Department of Employment – Training Agency, some of which are in association with the InTER Programme;
- outlines of a few of the DELTA projects;
- finally, updates of references to certain projects reported in InTER/8/89.

This Paper does not claim to provide comprehensive or representative coverage of UK research in the field. Researchers whose work is not reported are asked to help the Programme in providing better coverage.

The Programme is grateful to those researchers who have responded to our request for project outlines and I wish to thank Maureen Boots for her work in compiling the contributions.

Professor R Lewis
Coordinator
ESRC – InTER Programme

An outline of the origins and scope of the InTER Programme is given inside the back cover of this paper; a list of current papers in this series appears on the back cover.

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SECTION 1 - InTER Project Reports

Groupwork with Computers*

Co-directors: Professor Michael Eraut, University of Sussex and Professor Celia Hoyles Institute of Education University of London.

Setting up the Project has been a complicated task. First, working relationships had to be established between two universities, six LEAs (Bedfordshire, East Sussex, Harrow, Havering, Surrey, West Sussex) and a dozen schools. An organisational structure had to be created, and the preparation of the schools had to be phased and implemented. This preparation had to cover:

- increasing the teachers' familiarity with a wide range of software;
- developing their awareness of groupwork and the factors which influence how children work in groups;
- training teacher researchers in each school;
- planning how computers would be used in project classrooms in 1989/90; and
- what would be the focus of the teacher researchers.

Without this preparation, there would not have been a sufficiently wide and varied range of activities on which to base the research. Follow-up supportive visits to classrooms of 'project teachers' were a frequent and important feature of this first stage. Each school has a teacher practitioner and a teacher researcher and all 12 practitioners and all 12 researchers have been involved as groups in planning this year's work. A member of the research team acts as the designated Liaison Person for each school.

Comparisons between schools are qualitative rather than quantitative during the project's second year in order to deepen our understanding of the factors affecting learning. Some tighter comparative research designs will then be pursued in the third year in the light of these second year results. To facilitate this comparison, a 'core and options project curriculum' has been agreed with the schools. All schools will be doing a large amount of work with Logo and with Databases, and core Logo tasks have been agreed together with one large Database project in each school. The options or mini-programmes cover:

- Control Technology (4 schools);
- Spreadsheets (5 schools);
- Tray (5 schools).

Two schools will also be using simulations. This will give us an excellent range of software and user contexts.

Each teacher researcher has a personal project in addition to collecting some data on behalf of the project as a whole. A number are making recordings of group processes and all are collecting print-out data in addition to making extensive fieldnotes. About half will be focusing on comparisons between the performance of different types of group under different conditions, while the other half focus on a more 'micro-analysis' of learning processes and outcomes. Project researchers' planned topics cover the development of mathematical thinking (geometric ideas,

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* ESRC Research Project funded from October 1988-September 1991 as part of the ESRC-InTER Programme.

spatial visualisation, the concept of variable), classroom organisation (how computer use is organised, how groups are organised), teacher intervention in groupwork, pupils' working styles in different groups and individually, and success criteria in groupwork and individual learning (teachers, pupils, researchers). Other university staff will be focusing on gender issues, the role of teacher researchers, task demands and group structure, control technology and expressive use of computers.

Reference

Eraut, M. & Hoyles, C. (1989) Groupwork with computers, in *Journal of Computer Assisted Learning, 5:1, pp 12–24,* Blackwell Scientific Publications Ltd, Oxford.

Tools for Exploratory Learning*

Co–directors: Dr Joan Bliss, King's College London and Professor Jon Ogborn, Institute of Education University of London

Modes of learning:
A number of ideas fundamental to our original research proposal have been clarified and developed during the past year. We proposed initially a distinction between exploratory and expressive tools, we now propose to distinguish between two modes of learning – rather than tools. Exploratory learning mode permits pupils to investigate views of a given domain, which are different from theirs. Expressive learning mode permits pupils to represent their own models of a domain and in this way reflect upon and explore their own models. In the former learners are developing models based on the assumptions of others and in the latter, they are modelling their own assumptions. These two modes of learning are conceived of as different but complementary. Tools can be used in both an exploratory and an expressive mode.

Reasoning:
The question of the nature of learning in either of the above modes is too big and so we have decided to focus our research on a more manageable but equally important aspect, that of reasoning or argumentation, with the major focus being to examine the nature of children's reasoning using these different types of models and in either of these two modes of learning. Our emphasis is now on tools which permit reasoning in terms of qualitative, semi–quantitative and quantitative models.

Choice of domains: Topics
It was felt that the dichotomy between the domains of technology and social situations sometimes forced the choice of tools, with quantitative ones being used in the exact sciences and qualitative ones in the humanities. We are now adopting *topics* which are essentially cross–curricular and within which all three types of reasoning can be exhibited. Three topic areas were identified on the grounds of both being familiar and relevant to children, that is, they will have some intuitive knowledge of them through their own experience. These are: diet, supermarkets and motorways.

* ESRC Research Project funded from October 1988–September 1991 as part of the ESRC–InTER Programme.

Tasks:
The design of tasks in an exploratory mode now requires the formulation of situations within a "What......if" framework. In other words, tasks would involve pupils thinking through a problem in terms of "what happens if you change this or that?" within alternatives, with the tool helping them to do this. Pupils are asked to judge each alternative and give reasons for their judgment. Data and its analysis will concern the content and nature of the reasoning with different types of tools (quantitative, semi-quantitative, and qualitative), and in different modes of learning (exploratory and expressive), and how these differ both at different ages and in the different topic areas.

Software - Specific Tools:
There will be one tool for use in each of the areas: quantitative, semi-quantitative, and qualitative, adapted for use in either the exploratory or expressive mode. Customised spreadsheets using the application *EXCEL* 1.5 are being used for the quantitative tasks and are made to appear as user-friendly as possible.

A new tool named *IQON* has been developed in Smalltalk for use in the semi-quantitative reasoning tasks. *IQON* allows the user to represent an integrated system in terms of its elementary parts and to show the relations between them.

Although *SUPERLINX*, an improved version of *LINX*, has been explored in pilot studies it is felt that this is not suitable for the programme. The possibility of an Expert System shell as a qualitative tool is now being investigated.

Realisation of Main Study:
The main study is being undertaken in successive parts, with the semi-quantitative exploratory part starting at the end of February. The data analysis of each part will be carried out immediately after data collection. The complete main study will take approximately 12 months.

Reference
Bliss, J. & Ogborn, J. (1989) Tools for exploratory learning, in *Journal of Computer Assisted Learning, 5:1, pp 37-50,* Blackwell Scientific Publications Ltd, Oxford.

Conceptual Change in Science*

Co-ordinators: Professor Ros Driver, University of Leeds and Eileen Scanlon, The Open University

Introduction
The aims of this research programme are to clarify and describe the process of change in learners' conceptual understandings of natural phenomena. The domain of reasoning in mechanics has been selected for study. Computer software which may be useful in exploring and developing children's reasoning and promoting conceptual change in this domain is being developed and evaluated. The group that is carrying out the research is based at the Universities of Leeds, Glasgow and the Open University.

* ESRC Research Project funded from October 1988-September 1991 as part of the ESRC-InTER Programme.

Understanding children's reasoning
School children, seeking to understand and explain physical phenomena they encounter in the real world, construct mental models of how that world behaves. These models are sets of beliefs which are used to provide explanations that seem coherent; they are not likely to be changed unless they fail under special challenge in contexts which are of particular interest or relevance to the pupils. These informal or naive models of physics use concepts such as energy, force, power which may be ambiguously expressed and which may take on properties to suit particular contexts.

A literature review has been conducted of studies of children's prior conceptions in that domain, and the demands of the secondary science curriculum in dynamics have been surveyed in order the design interventions at appropriate levels. This preparatory work has guided the selection of specific aspects of dynamics as targets for investigation. Interview studies with about 30 pupils aged 9–14, have been conducted in order to probe children's explanations of events in the context of horizontal and vertical motion of bodies. The results of this interview study are providing information about specific features in children's prior conceptions within these scenarios and their evolution with age. A number of commonly held prior conceptions have been identified and these are informing the design of appropriate software.

Software development
Two software systems are being developed to address children's prior conceptions. One programme, called DM3 (Direct Manipulation of Mechanics Microworlds), is an interactive simulation of motion under force, allowing pupils to observe and manipulate, both informally and in a structured experimental manner, the behaviour of objects in motion. It will thus support educational interventions on topics in mechanics. Smith's ARK program has been examined as a starting point. A new software program has been designed based in some aspects on ARK. The program will simulate force and motion almost as generally as ARK, but concentrate on how to present this to pupils and teachers via interfaces that are easier than ARK's, but not necessarily as uniformly in the radical Direct Manipulation style of ARK (where controls are subject to forces and motion too). It is much more concerned with efficiency, partly because of having a slower machine to run on and partly in order to get better visual realism of motion. It is intended to be easy to port different lessons and interface items between versions without having to copy whole SMALLTALK images, and to import graphics from other programs, systems and machines.

The program design takes account of our four classes of user (pupils, lesson conductors, lesson designers, and interface designers.)

The other system, VARILAB, allows children to reason (and engage in discussion with partners and teachers) by expressing their casual accounts of events as a qualitative model. Written in SMALLTALK, and using the object-based software and direct manipulation ideas in DM3, the student will be able to build (graphically) small physical systems made up of bodies and agents that act on them. Bodies can be 'connected' to each other, and agents provide changes to the properties of bodies (eg. speed or energy level). Thus, students build/connect the objects, state or select the effects of agents, and then the system runs dynamically showing changes (in speed, say, through time), which can be compared with the nt being explained. The students can experiment and change their causal systems (eg. increasing mass) or their hypothesized agent-effects. The system itself is designed to point out inconsistencies, and reasons if it is unable to 'run' and illustrate an event.

The design of VARILAB (which requires students to clarify their casual explanations, and examine their consistency) is well-suited, we believe, to process understanding and developing views of physics. The design is largely in place, the implementation is underway and a first prototype has been produced. Ways in which the system can be used in classroom interventions, and how its effects may be evaluated are under consideration.

Interface design
Microworlds have also been developed, programmed in Hypercard on the Mac IIx microcomputer. A range of intervention strategies have been devised to promote conceptual change, focussing on the identification and development of computer software which could be useful in exploring and challenging children's reasoning. Prototype mechanics microworlds have been developed and trialled. This work is informing the design of the software and intervention strategies to be used in the classroom testing.

The microworld we have developed for exploring vertical motion under gravity proved remarkably successful. It was accessible and usable by 15-year-old pupils. Our subjects enjoyed interacting with the system; they appeared to be engaging directly with it and many were impressed with its realism. We have shown that iterative testing of such microworlds is essential during the design phase, and the lessons learned from this exercise have already influenced some of the design features of DM3.

Classroom trials
In the final year of the project, classroom trials will be undertaken using the software embedded in an overall teaching sequence. Test instruments to evaluate change in students' conceptions, currently under development, will be used together with detailed analyses of protocols to document the change in students' conceptual understanding in mechanics.

Outcomes
As a result of the programme of work, it is intended not only to have developed and trialled software but to have considered in a principles way pedagogical strategies appropriate to promoting the conceptual change process.

Reference
Driver, R. & Scanlon, E. (1989) Conceptual change in science, in *Journal of Computer Assisted Learning, 5:1, pp 25-36,* Blackwell Scientific Publications Ltd, Oxford.

Bubble Dialogue as an Ethnographic Research Tool*

Harry McMahon and Bill O'Neill, Faculty of Education, University of Ulster at Coleraine

The Bubble Dialogue in Ethnographic Research Project is being undertaken by the University of Ulster's Language Development and Hypermedia Research Group. The group, which consists of five members of the academic staff of the Faculty of Education, has for the last two years been exploring the use of hypermedia in language development (McMahon and O'Neill, 1989). In addition to offering HyperCard as an open-ended software environment for pupils to exploit, the group has generated a number of prototypes of so-called "dialogue tools", which provide specific microworlds for pupils to engage in dialogue and writing.

One type of tool, the "bubble tool", utilises the comic-strip metaphor. It allows the user, either working individually or with partners (who can be peers or a teacher/researcher), to play the roles of characters on the screen by entering projected speech and thought into the characters' think and say bubbles. On the one hand, the think/say metaphor used in the bubble tool allows subjects to build conversations which gently reveal the public/private and individual/social dimensions of their experience and, on the other, allows the researcher access to such complexity in the resultant scripts.

In a bubble dialogue setting the characters are set against a backdrop and the scene is introduced in a prelude. Transactions between different sets of characters played against different backdrops with a variety of preludes allows for a rich variety of scenes. Thus, the bubble tool allows the researcher to explore, in what for subjects appears to be a captivating medium, the what of conversations, the nature of the perceived relationships between participants and the common knowledge of the players. In one version, the text of subjects' recorded conversations can be played out by characters on the screen and as the conversation develops subjects are able to enter their reflections on the intentionality of the participants by filling in the think bubbles.

In the context of this project we will be looking at how the bubble tool might be used as an ethnographic research tool for gaining insight into children's reflections on their experience with computers. We will explore how it can be used to take a "sideways" look at the discourse of children and teachers who are the subjects of study in two other InTER projects, the Tools for Exploratory Learning Project and the Groupwork with Computers Project.

References

McMahon H and O'Neill W, (1989), Language Development, Hypermedia and Dialogue Tools. Faculty of Education, University of Ulster.

McMahon, H. (1990), The InTER Programme: Capturing dialogue in learning. InTER/18/90, May 1990

* Research Project funded by the ESRC from January 1990 to December 1990 as part of the ESRC-InTER Programme.

The InTER Policy Evaluation*

Professor Barry MacDonald and Ian Stronach, Centre for Education Research, University of East Anglia

The Inter Policy Evaluation has produced an initial report entitled "Making a Start: The Origins of a Research Programme"+. The Report addresses the origins of the InTER Programme, the nature of the preceding ITE Programme, and the policy context of the ESRC. It focuses particularly on the processes of selection, and the ways in which the InTER programme was formed. The Report invites comments from readers concerning InTER itself, and research issues more generally. These comments can be registered on a computer conference at Lancaster. It is hoped that in this way iterative dialogue can develop about key issues. The evaluators intend to use these comments to deepen the understanding of the issues addressed in the report, and to provide a later, summative account.

The current focus of the evaluation (1989–90) is on case studies of the individual projects themselves, ie. Groupwork with Computers, Conceptual Change in Science, and Tools for Exploratory Learning. This detailed case study phase will also involve the treatment of general themes as they emerge, such as the recruitment, promotion and retention of research workers.

The Evaluation Team anticipates that the case studies will be followed by a more comparative study of research developments elsewhere. These comparisons will have both national and international dimensions.

Reference

MacDonald, B. & Stronach, I. (1989) The independent policy evaluation, in *Journal of Computer Assisted Learning, 5:1, pp 51–64,* Blackwell Scientific Publications Ltd, Oxford.

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* The Programme Evaluation funded by the ESRC from October 1988–September 1992 as part of the ESRC–InTER Programme.

+ This initial report is available from CARE, University of East Anglia, Norwich, NR4 7TJ

SECTION 2 – Research Project Reports

Systems development in computer aided learning in music*

Andrew P Fenton, Department of Music, University of Lancaster

This is one of two research projects currently being undertaken by the Centre for Research into the Applications of Computers to Music (CRACM) at Lancaster University. The aim of the project is to build music software to teach ear-training, harmony, and counterpoint at first-year degree level, with the prime objective of building that software in a structured, modular fashion. This structured approach should reduce the coding and maintenance effort required to build and run the system and should promote the production of a system which can be manipulated by students and teachers easily.

The first question addressed by the research was *what* must a computer teaching system be capable of to enable it to teach efficiently and effectively? The first and most important characteristic is that it must be able to respond in an 'intelligent' human manner. This means that it must be capable of understanding and using the notation and terms that musicians habitually employ. Second, it must be capable of marking a student's work in a manner similar to that adopted by most teachers, not only correcting errors the student has made, but also giving credit for tasks successfully completed. Finally, the music teaching system should allow students some control over how the system behaves, for instance allowing the teacher full control over parameters such as the order in which material is taught.

The second question addressed by the research was *how* such a system might be designed using only the standard equipment at present available in universities. The following three design tools were employed to help tackle this problem. The *software lifecycle* encapsulates a formal framework in which software can be developed and consists of a number of sequential phases, viz. the Requirements, Design, Implementation, Testing, and Maintenance phases. The Requirements phase defines what the system should be capable of and is laid out in a requirements Document (see Fenton 1989a). The above paragraph is a brief summary of the requirements of the teaching system which constitutes the first phase of the software lifecycle. The second design tool has its roots in *Intelligent Tutoring Systems* (ITS) research and is, again, a model which is employed to simplify the design task. (This being the second phase in the software cycle.) The model breaks the teaching system down into four parts: the Communication Strategy, the User Interface, the Domain Knowledge, and the User Model. All of these parts are essential to the successful functioning of an ITS and hence were adopted as a first step in it's design. The third and final tool, *object-oriented design*, is a methodology which enables us to break the ITS system into small independent units. This should encourage the production of a configurable, changeable ITS, consistent with the aims expounded in the Requirements document alluded to above. (See Fenton 1989b for a more detailed description of the design of the ITS.)

At present, the research is entering the implementation phase of the software lifecycle. The low-level functions of a pilot teaching system which will teach only Figured Harmony, are currently being implemented. Later, a more complex system will be built on top of this pilot system, adding the 'intelligence' so vital to successful teaching.

* ESRC Research Grant C00232437 from October 1988 to September 1990.

References
Fenton, A.P. (1989a) *Requirements for an intelligent tutoring system in music,* Version 2.0, Centre for Research into the Applications of Computers to Music, University of Lancaster.
Fenton, A.P. (1989b) *The design of an intelligent tutoring system for music, Musicus (1/ii),* CTI Centre for Music, University of Lancaster.
Sommerville, I. (1989) Design of an intelligent tutoring system in harmony. *Proceedings of the International Computer Music Conference,* IBM - Los Angeles Scientific Center.
Wenger, E. (1987) *Artificial Intelligence and Tutoring Systems,* Los Altos, CA: Morgan Kaufmann Publishers Inc.

Computer testing of musical ability

Gerard Doyle, S. Martin's College, Lancaster

The assessment of 'musical ability' in the primary school child is important both to the music teacher and the administrator; successful organisation of performing groups and cost-effective deployment of visiting instrumental teachers warrant attempts at indication or prediction of 'musical ability' in young children.

Bentley (1966a) has centred measurement of 'musical ability' around a series of essential skills and concepts; his 'Measures of Musical Abilities' (1966) are founded upon perception and recognition of pitch, melodic, harmonic and rhythmic procedures, and are widely used in the education service. The test examples are provided on audio disc and pupils write closed responses on a pro-forma in 'examination' conditions.

This instrument is defined by its author as suitable for use with children of eight years and above. Many teachers and schools, however, wish to carry out informal preliminary assessment with children below this age, in order that pupils may be helped to make choices and to develop existing skills. Mills (1984) has drawn attention to discrepancies which arise in Bentley's measurements when tests are administered by audio disc; there can be little doubt, too, that when children of less than eight years attempt Bentley's measures, variables such as low levels of skill in responding to verbal instructions and lack of dexterity in writing responses are potential hindrances.

A pilot study with seven-year-old children has sought to ameliorate these problems; tests were administered by computer and children responded verbally to the tester. Results were sufficiently encouraging to justify the organisation of a larger study, with six and seven-year-old children; the study will explore practical gains and constraints in administering aural tests of this nature by computer, and will investigate the acceptability of such data to teachers.

References
Bentley, A. (1966) *Measures of Musical Ability.* (disc) Harrap: London.
Bentley, A. (1966a) *Musical Ability in Children and its Measurement.* Harrap: London.
Mills, J.I. (1984) The "Pitch" subtest of Bentley's Measures of Musical Ability: a test from the 1960s reconsidered in the 1980s, in *Psychology of Music, Vol 12, no. 2.*

Gender, interaction and learning using computers

Paul Light, Stephen Little, Silvia Barbieri and Neil Mercer, School of Education, The Open University

An earlier study (Blaye et al, 1989) showed substantial facilitation of both performance and learning when children worked in pairs vs alone on a computer-based problem solving task set in an 'adventure game' format and implemented in Hypercard. The present study involved modifications to the software to improve recording of the children's information searching activity. The subjects were 66 eleven year old children. On this occasion all children worked in pairs on the first session, and all worked individually on a second session with a modified form of the same task. For the first session there were 11 boy-boy pairs, 11 girl-girl pairs and 11 girl-boy pairs. Results indicate a massive gender difference in performance on the task in both the first and second sessions, with boys outperforming girls. Initial analysis shows little effect of within vs between gender pairings. Videotapes are being transcribed and analysed to identify interactional correlates of effective performance and learning.

References

Blaye, A., Light, P.H., Joiner, R. & Sheldon, S. (1989) Collaboration as a facilitator of planning and problem solving on a computer-based task. *Centre for Information Technology and Education Report No. 90*, Institute of Educational Technology, The Open University.

Gender effects in young children learning with LOGO*

Martin Hughes, Pam Greenhough and Katrina Laing, School of Education, University of Exeter

The research which we are currently carrying out is concerned with three main issues. The first issue is that of *early LOGO learning*: what are children learning when they start to use the LOGO Turtle, how does this learning take place, and how can it be facilitated? The second issue is that of *peer-interaction* and its effects on learning: this is a long-standing issue within developmental psychology, but the recent emphasis on groupwork in educational computing has given it a fresh impetus in this area. The third issue is that of *gender*: there is much concern that girls will be at a disadvantage compared with boys as computers and IT are used more widely across the curriculum, but little systematic research has been done in this area. For example, it is generally believed that girls will learn best in single-sex groups, away from the supposedly inhibiting effects of boys, but so far few studies have been done to see if this belief is correct.

The first study we carried out looked at 60 children aged 6/7 years learning to use the LOGO Turtle in either single-sex or mixed-sex pairs. Thus there were 10 boy-boy (BB) pairs, 10 boy-girl (BG) pairs, and 10 girl-girl (GG) pairs. All the children had three sessions with the Turtle. During the first session the children worked in their pairs, learning the simple command set used to control the Turtle. In the second session they again worked as pairs, and were asked to take the Turtle around an obstacle track: they had 15 minutes in which to complete the

* Two studies funded with grants from the Nuffield Foundation, the second study being carried out by Katrina Laing an ESRC-supported research student.

task. During the third session they again attempted the track task, but this time as individuals, and with unlimited time (see Hughes et al, 1989, for more details).

The findings were both clear-cut and unexpected. Only 2 GG pairs completed the task on the second session compared with 9 BG pairs and 10 BB pairs. A similar pattern emerged in the third session, when girls who had worked in GG pairs took significantly more moves to complete the task than the girls who had worked in mixed-pairs or than boys. More detailed analysis of the data suggested that the crucial difference between the groups was that the GG pairs reacted particularly badly when the Turtle crashed into an obstacle, and persisted much longer with inappropriate post-crash strategies. Analysis of the social interaction occurring at this critical point indicated that the GG pairs were more likely to react emotionally to this situation by blaming themselves or their partners, rather than engaging in careful analysis.

A second study has recently been carried out which aimed (amongst other things) to replicate these findings with a different design. This second study involved 80 children aged 6/7 years, with 60 children assigned to single-sex or mixed-sex pairs as in the first study, while 20 children (10 boys, 10 girls) worked as individuals throughout. Analysis of this study is still underway, but it seems that while there were several gender effects in the data, the particular difference between GG and other pairs found in the first study has not been replicated. One major difference between the studies is that in the second study all the children were introduced to the Turtle as individuals rather that as pairs, and this may account for the different findings.

Reference

Hughes, M., Brackenridge, A. & Greenhough, P. (1989) Girls, boys and Turtles: gender effects in young children learning with LOGO. In C. Hoyles (ed) *Girls and Computers*, University of London Institute of Education, Bedford Way Papers 34.

Collaboration and feedback in children's computer-based learning

*David Messer, Psychology Division Hatfield Polytechnic and Paul Light, School of Education, The Open University**

The twin foci of this research will be the effectiveness of collaborative modes of working and the effectiveness of software-based feedback in supporting learning and problem-solving by 10-13 year old children. The research will adopt a largely experimental approach, but the experiments will be school-based and supplemented by interviews and/or more naturalistic/observational methods. Several tasks used in previous research will be further developed as substrates for this research, all being implemented in Hypercard on the MacIntosh.

References

Light, P.H. & Blaye, A. (1990) Peer interaction and learning in relation to educational microcomputer use. In H. Foot, M. Morgan and R. Shute (eds.) *Children Helping Children*, John Wiley.

* Research funded by a grant from The Leverhulme Trust from September 1990 to August 1993.

Computer models of reading and spelling

Gordon D. A. Brown, Department of Psychology, University College of North Wales, Bangor*

We are currently developing computer models of the development of reading and spelling processes in both normal and dyslexic children. The modelling is being carried out within a connectionist/neural network framework. In parallel with this computational modelling, we are conducting experiments to test the predictions of the models. The aim of the research is to gain a greater understanding of the process of reading and writing development, with particular reference to the characteristics of individual words that make those words easy or hard to read and spell. This increased theoretical understanding can then be applied to the production of optimally graded sets of materials for teaching dyslexic and other readers about the spelling and sound structure of language. We have now developed some simple computational models of reading and spelling, and completed a series of experiments to test some assumptions of the models.

Reading

Early work funded by the ESRC resulted in a computational model that partially explained the relative difficulty experienced by adults in naming words with irregular or unusual spelling–to–sound correspondences (Brown, 1987a, 1987b). It was believed that words with unpredictable pronunciations, such as HAVE (cf. RAVE, GAVE, SAVE, CAVE etc.) were named more slowly that regular words such as HILL (cf. KILL, HILL, FILL, BILL etc) because of the irregularity of their spelling–to–sound units. But our computational model suggested that it was in fact the unusualness, rather that the irregularity, of the words' pronunciation that tended to cause difficulty (Brown, 1987c). As part of an ongoing project funded by the Leverhulme Trust, we have now completed a lengthy series of experiments on both normal and dyslexia children of various ages, as well as on normal and dyslexic adults, and these experiments suggest that both regularity and frequency of spelling–to–sound correspondence can lead to difficulty. The insights provided by the computational modelling process, having been tested empirically, should now be able to inform the design of course materials for adult illiteracy programs and the remedial teaching of dyslexics. We are currently undertaking computational analysis of a number of existing sets of graded course materials to examine the extent to which these materials, which have typically been developed by experienced teachers with well developed intuitions as to the kinds of words that are likely to cause difficulty to their pupils, can be characterised in terms of the psychological dimensions we have isolated. Preliminary analysis suggests that such *graded* word lists in fact confound a number of correlated but psychologically distinct dimensions, such as purely orthographic regularity as well as the separate factors of spelling–to–sound regularity and spelling–to–sound frequency or unusualness. We are continuing to develop the computational model of reading and to integrate it with models of other language processes.

Spelling

More recently, we have been applying similar computational modelling techniques to the analysis of spelling problems. Here, computational modelling within a connectionist/learning framework can potentially provide an underpinning for developmental stage models of learning to write, for the causal mechanisms

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underlying transition between stages in such models are typically underspecified in current accounts. The development of an explicit computational model of spelling acquisition can also permit the derivation of empirical predictions in a similar manner to our research with the reading model outlined above, and indeed preliminary results suggest that words that are particularly difficult to spell by children of various ages are those with unusual sound-to-spelling correspondences as well as those with irregular or exceptional sound-to-spelling correspondences. These results appear to parallel those obtained from the study of word reading (note that words that are regular in terms of spelling-to-sound correspondence may be irregular in terms of sound-to-spelling correspondence, and vice versa).

The computational spelling model makes use of recurrent connectionist architectures to capture the essential temporal dimension involved in the production of a sequence of letters. We have also used recurrent neural networks to provide a dynamic account of speech-based human short-term memory (Brown, 1989, 1990a, 1990b). This is a preliminary model, but we are extending it and plan to integrate it with a model of word recognition. In this way we hope to provide a computationally explicit account of the relation between the word reading and the short-term memory problems that are associated in developmental dyslexia.

Other Research

We have applied for funding to pursue much of the above research. In a broader context, some of our other research within the general area of information technology and education concerns the relation between psychology and cognitive science as disciplines. We are also assessing the ability of connectionist models to provide an account of the development of symbolic behaviour in children (Brown & Oaksford, 1990). This work has a number of potential educational implications.

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A Study of Computer-Supported Collaborative Learning in Physics

Tim O'Shea, Eileen Scanlon*, Paul Clark*, Claire O'Malley+*
Research Fellow: Josie Taylor

This project has two phases. Phase 1 involves empirical studies of small groups of 14-16 year old school-children solving physics problems co-operatively (with and without the computer), and comparative studies of individual versus co-operative problem-solving. Phase 2 involves the design, development and evaluation of an interactive simulation environment to support co-operative activity. The research is still at a very preliminary stage and we are moving forward on several fronts.

In the first phase of the investigation, we have selected a tractable kinematics problem for the first phase of the investigation involving collisions in Newtonian mechanics - the Pucks Problem. Students will be asked to predict the motion of two ice-pucks of differing or identical weights when a moving one collides with a stationary one. This problem is well-defined and has a single correct solution for each condition. Although it seems a fairly simple problem, we know that people have an surprisingly low rate of success at answering correctly for every condition, sometimes even when they have had a physics education (Stainton-Ellis, O'Shea, & Scanlon, 1988). Correctly predicting the behaviour of the pucks is dependent upon an understanding of the conservation of momentum and energy, two concepts which we hypothesise students find difficult. We are building a prototype interactive simulation environment so that students can manipulate the behaviour of the pucks to accord with what they believe will happen.

In order to test the hypothesis that small degrees of disagreement make for the most productive collaborative activity, we are also constructing a pre-test instrument for identifying what students predict will happen next in each condition, allowing us to match students into pairs on the basis of their varying degrees of disagreement. As a complementary activity we are also developing a methodology to analyse our data based upon the work of Richard Joiner (1989).

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ESRC Research Grant C000231660 from January 1990 to December 1991.
* The Open University, Milton Keynes, MK7 6AA.
\+ Department of Psychology, University of Nottingham, Nottingham, NG7 2RD

A computer-based INSET programme for secondary mathematics teachers*

Celia Hoyles, Richard Noss and Rosamund Sutherland, Institute of Education, University of London

Aims

The aims of the research were to develop, implement and evaluate a programme of in-service teacher education concerned with the use of generic computer applications within the secondary school mathematics curriculum. The objectives of the programme were to encourage teachers to: develop confidence in the use of the computer as a problem-solving tool; develop ways of structuring the computer environment within their mathematics classrooms and evaluate its role in terms of pupils' learning; design and implement a computer-based microworld for a specific area of the mathematics curriculum; reflect on their own learning processes and relate these to the learning of the pupils within their classrooms; confront the issues relating to the computer's influence on the role of the teacher, and to increase awareness of pupil learning styles; develop dissemination procedures within the school mathematics department.

A 30-day INSET course on using the computer in the Mathematics classroom took place during 1986/87 (Course 1) and 1987/88 (Course 2). The courses were evaluated in two ways: from the point of view of the course itself, and from the perspective of the teachers.

For the former, we focussed on:

- the courses' effectiveness in developing the competencies of the participants in the use of the computer applications;
- the effectiveness of the implementation of the computer applications into their mathematics classrooms;
- the extent to which the teacher participants were able to apply their computer competencies in the development of computer-based mathematical microworlds;
- the extent of dissemination.

From the teachers' perspective, our concerns were twofold:

- to map the views and attitudes which the participants held initially about mathematics, mathematics teaching and computers;
- to describe and analyse the reciprocal interactions between participants' views and attitudes, their activities on the course and what they said about their practice.

Data was collected from the following sources: interviews at the beginning, mid-term and end of the courses; examination of project work and pupil case-studies by the teachers; data collected from observation notes of participants activities on the course; classroom observations and follow-up data; post-course questionnaires distributed to the teachers.

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In year 3 a computer–based microworld (the 'Ratio and Proportion Microworld') was developed in collaboration with four of the teacher–participants and evaluated in their classrooms. The microworld was evaluated:

- *formatively* using process data on microworld implementation consisting of observational notes on the selected group of pupils, marked homework assignments and pupils' computer–recorded files;
- *summatively* by pre–, post– and delayed–post written tests and audio–recorded interviews of a selected group of pupils.

Summary of Research Results

From the evidence of the end–of–course interviews and post–course questionnaires, the participants gave an overall positive evaluation of the course. More objectively, we note that fifteen out of the twenty course participants continued to use the computer in ways which were qualitatively and quantitatively different from their computer use before they started the course.

From the point of view of transition to the classroom, we found that an important prerequisite for using the computer in the classroom was the development of a personal confidence and competence in the use of the software i.e. without specific regard to pedagogic issues. All five of tbe twenty participants who have not continued to use the computer in their classrooms, were computer–novices at the beginning of the course. The tendency was for those who started the course with an initial confidence in using computer applications to be more successful at integrating the computer into their practice. Thus we are led to the conclusion that there are essentially two phases to the successful integration of computers into the mathematics classroom, both phases maintaining an educational rather than a technical focus. Within a single short course it is difficult for both phases to be successfully negotiated by a single teacher.

Baseline criteria for successful courses were identified as follows: the course must be substantial in terms of contact time; course organisers must have expertise with the software from both a personal and professional point of view; activities must be developed so as to resonate with the setting generated by distinct software environments. The course must provide tried and tested computer–based materials for getting started in the classroom; there is a need to integrate school–based and University work; and to maintain a balance between clearly–defined structure and teacher–control over their own learning. Finally, we claim tbat the success of the dissemination of such a course is highly dependent on support from course participants' schools and Local Education Authorities.

We looked more closely at the reciprocal interactions between teachers' views and attitudes about mathematics and its teaching, their course activities and their practice. The following points emerged:

- There was an almost universal tendency for participants to project their own preferences and attitudes onto their pupils;
- We have been able to classify the participants' motivations for approaching computer–based mathematical learning along a *proactive/reactive* dimension. Proactive participants were seeking mechanisms by which to instantiate their predetermined ideas about mathematical teaching. Reactive teachers who were being directed towards change by external pressures and constraints;

- For those teachers whose position towards mathematics was essentially 'ethnomathematical' the computer activities became an extension of other investigational activities in their classrooms. For these teachers the course allowed them to discriminate more clearly about their own intervention strategies, whereas those with a more curriculum-focused view of mathematics, tended to see the computer in the role of a vehicle with which to introduce specific curicula content.

Course participants developed their own computer-based microworlds as part of the course activity. We found that the process of microworld design and evaluation in the classroom was crucial in encouraging teachers to reflect on pupils' conceptions, address the issue of teacher/pupil control and reflect on the potential of integrating the computer into the curriculum. The product of the teachers' microworlds was less satisfactory and the participants were themselves highly critical of their own microworlds and have almost universally ceased to use them in their classrooms. As a result, the researchers themselves developed a 'ratio and proportion microworld' which consisted of a set of activities, Logo-based and paper-and-pencil, aimed at providing activity structures in which the children could use, investigate and construct computational objects built according to ratio and proportion rules.

Summative evaluation of the microworld indicated significant improvement in pupil responses subsequent to the microworld experience to written questions concerning ratio and proportion. The microworld clearly engendered a move away from random pattern-spotting towards a greater sensitivity to the underlying mathematical structures. These moves were highly dependent on context and the presence of fractions in the framing of the questions. We also observed a significant perturbation of pupil strategies in the form of a move away from addition towards consistent attempts, not always successful or explicit, to apply multiplicative operations.

Our formative evaluation highlighted the importance of playful and carefully constructed computer-based activities to reveal and build intuitions and develop a language for representing these intuitions. It also indicated the crucial significance of off-computer activities, either in groups or in teacher organised classwork to make explicit different pupil strategies on the computer, to discuss any misconceptions which have not been confronted and to validate those that are correct from a mathematical perspective. Critical aspects of the microworld from the perspective of pupil-learning were isolated: we note here the importance of class-discussions and activities which aimed at provoking conflict related to the use of an additive strategy in ratio and proportion problems.

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The gap between arithmetical and algebraic thinking*

Rosamund Sutherland, Institute of Education University of London

One of the difficulties with traditional algebra in a "paper and pencil" context is that it is not easy to find beginning problems which need algebra as a problem solving tool. This is not the case for the programming language Logo or for the spreadsheet package Excel. Like algebra these environments are formal systems with precise syntax and rules and pupils must perceive them as such before they can use them in any meaningful way. Over the last few years there has been a move towards developing computer programming environments which can be used to develop pupils' algebraic conceptions (Sutherland, 1989; Thomas & Tall, 1986). These studies indicate that certain computer experiences can enhance pupils' understanding of variable and that within a programming environment pupils can use formal syntax to represent a general method.

The aim of this research project is firstly to develop understanding of what is meant by both "arithmetical" and "algebraic" thinking with specific reference to the effect of computer–based experiences. The underlying assumption of the project is that certain computer–based experiences can help pupils bridge the gap between arithmetical and algebraic thinking. These computer–based experiences will consist of the programming language Logo and the spreadsheet package Excel. It is intended to study pupils over a range of ages from about 10 to 16 years of age. With this background in mind this proposal sets out to develop a theoretical framework related to the following issues:

- The nature of the gap between arithmetic and algebraic thought and how this might relate to a particular representation of an object. Is one type of representation (either computer or paper and pencil based) likely to provoke one type of thinking within pupils? Is there in fact a clear identifiable gap between arithmetical and algebraic thinking?
- The ways in which computer–based activities can help pupils develop from arithmetical to algebraic thinking. Computer–based Logo and spreadsheet tasks will be refined and trialed with the aim of provoking pupils to develop from arithmetic to algebraic thinking.
- The means by which pupils are able to negotiate and formalise a generalisation.

This will be investigated with respect to the Logo, the spreadsheet and a paper and pencil environment. The following type of question will be asked:

- Is the means by which pupils come to a decision about a generalisation related to difficulty of problem, type of problem or type of computer environment?

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Computers in the Curriculum of Secondary Schools*

Arnold Morrison, Stirling

With computers now widely available in secondary schools, teachers are looking to colleagues and to research for guidance on ways of using them effectively and for information on the availability and evaluation of software. Reports of two studies funded by the Scottish Education Department are now available.

The first reviews research into the effectiveness of computers as means of assisting teaching and learning in secondary schools and deals with general findings and research in various areas of the curriculum.

The second study focuses on the experiences of a number of secondary teachers (mainly in Science and Social Subjects) as they developed ways of organising their appropriate software. Teachers' views on uses of computers in different subjects, computers in resources-based classrooms, and criteria for software evaluation are among the matters explored.

Research Report on IT and Training*

Sara Delamont, SOCAS, University of Wales College of Cardiff

Supply of, and Demand for, Low level IT Skills in South East Wales+, Teresa L Rees, SRU, UWCC (Funded by the Training Agency.).

There is a growing demand in South East Wales for workers who have low level IT skills, while the pool of school leavers will get smaller in the next few years. This research was a survey of employers in South East Wales (in public and private sectors) and of those who provide training in IT skills.

Employers saw no difficulties in recruitment in 1988/89, but expected a shortage of workers in the future. Employers believed that only people under 24 could use new technology, so had no plans to re-train older people. Employers wanted training for middle and senior management in IT skills and the potential of IT. There is a shortage of experts in IT who are also teachers of the skills.

The report argues for more training to be designed for women returners and older people generally, because the school leaver population will *not* be large enough to meet demands.

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* The two studies are now published as 'Computers in the Curriculum of Secondary Schools', Practitioner MiniPaper, Scottish Council for Research in Education, Edinburgh, 1989 ISBN 0 947833 33 1.

* Report on work being undertaken at the University of Wales College of Cardiff (UWCC), Social Research Unit (SRU) and School of Social and Administrative Studies (SOCAS).

+ Report available from SRU, SOCAS, UWCC, 62 Park Place, Cardiff, CF1 3AS; £10.00 – cheques payable to UWCC.

SECTION 3 – Research Students Reports

Question answering and explanation giving in on-line systems: A knowledge-based approach*

Colin Tattersall, Computer Based Learning Unit, Leeds University

Accomplishing tasks with application software is not straightforward without considerable experience (Moran, 1983). The unexpected prompts, accidentally deleted files and incomprehensible feedback which every computer user experiences indicate the need for help when using software.

Traditional help facilities spool large volumes of pre-stored texts onto screens in an attempt to address all problems for all users with a single response. Inevitably, such help merely assists in some problems for some users.

This ESRC linked studentship (supervised by J.R. Hartley and A.J. Cole) examines the generation of responses to users' questions concerning Information Processing Systems (IPSs). These responses are geared towards addressing both users' immediate needs (of task accomplishment) and the general goal of understanding applications. Beyond stating how to achieve tasks with the software, the process attempts to generate texts indicating how this functionality is supported. This is done using a flexible scheme allowing comparison with what is known to the questioner, expansion on unfamiliar topics and provision of a variety of different question types reflecting the different stages of user interaction (Norman, 1984).

To provide such advice, the system must draw upon a wide variety information, and it is in this sense that the process can be said to be knowledge-based. Linked to ESPRIT project p280 EUROHELP, the work makes use of models of the software, the user, and the system state. In this way, responses sensitive to the context of both user and system can be generated.

Early experimentation with users of IPSs resulted in a taxonomy of questions and expert responses. Analysis of this data (Pilkington, 1987) indicated the ways in which human experts construct responses and the types of information included in these texts. This was followed by a rapid prototyping phase (using LOOPS) which tested the feasibility of using *answer frames of rhetorical predicates* (McKeown, 1985) to respond to users' questions. Such frames have their definition in terms of the underlying representation, which, being generic across IPSs, yields a general help text generation mechanism. The prototype system, PORSCHE (Producer Of Rhetorically StruCtured HElp), is therefore only limited in the content of its responses by the underlying representation. The design of the Application Model formalism (Smith et al, 1989) was influenced by this desire for representational richness, but was counterbalanced by consideration for the AM builders. If no clear methodology and supporting tools exist then such rich knowledge bases cannot be constructed. Once a balance between these two opposing forces had been found, a detailed (though not formal) specification of the question answering scheme was written. This formed the basis of response formulation in the EUROHELP Intelligent Help System demonstrator.

* ESRC Linked-Studentship supervised by J R Hartley and A J Cole, Computer Based Learning Unit, University of Leeds

Questions which may be asked of the system are divided into *initial* and *follow-on* queries. This frees the user from one-shot help (Aaronson & Carroll, 1987) by allowing further, related questions to be posed. The initial questions are shown below:

Question Type	requesting ...
Enablement	*How do I....?*
Elaboration	*What is ......?*
Evaluation	*What happened ?*

Each type of question has an associated answer frame detailing a total ordering of rhetorical predicates. These predicates retrieve information either directly from the AM or via other components such as the planner. Once an initial response has been constructed, user model variables are examined and the text adapted accordingly. Those concepts unknown to the user become the topic of a *subframe expansion*, providing further details with the initial content. A comparison algorithm based on the work of McCoy (McCoy, 1988} associates similarity with shared answer content such that a related but well known entity may be involved in the answer. Furthermore, a variety of follow-on questions linked to the *what happened?* question are provided to mitigate interpreting the question literally. Thus *what should I have done?*, *how do I undo that?*, and *how do I continue?* provide opportunities to address what the user wanted to achieve. Allowing the questioner to signal his or her ongoing task removes the many difficulties of plan recognition.

The research gives rise to a scheme which marries work in Intelligent Help System design to a range of techniques from the field of Text Generation. Such a process is not without cost, since representations of IPSs must be constructed, but this cost is less than that associated with producing large pre-stored texts, and results in help better suited to the needs of users.

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The design of knowledge–based advisers for learning*

F.N. Arshad. Department of Psychology, University of Leeds

Introduction

The aim of this research was to design a computer based educational Advisory system. The Adviser (implemented in SMALLTALK–80) addresses the problems that arise when students are required to manage their own learning, an important decision making process in tertiary education. In designing the system the research also examined the value of providing advice in Computer Assisted Instruction (CAI).

In tertiary education it is generally expected that students should make the majority of the learning decisions themselves. This decision making may involve deciding *WHAT* to study, *HOW* to study it from a wide range of methods available, and finally, *WHEN* to study each topic. This can cause problems if students are not experienced in making such decisions. In schools study is closely directed and monitored; students have limited choice concerning what they should study and how. At tertiary level, there are many more choices. Problems are caused by a lack of well developed study skills (Arshad and Kelleher 1989).

The Advisory system developed, is capable of alleviating this lack of preparation by aiding the student in study management. Operating in the domain of Applied Statistics the system has been designed to help students in making decisions about what topics to study, while taking account of their background knowledge, and method of learning (or study habit). Finally, the Advisory system directs the student as to when each topic should be studied, based on demonstration of certain performance (or mastery) levels.

The Advisory System

The design methodology is heavily influenced by experimental studies. These were conducted to ascertain how human tutors organise their course information (eg, into networks) and what sort of advice they gave to different categories of student, eg. mathematically able as opposed to non mathematical students.

The study advice provided to the student is a plan of action comprising a list of activities the student can engage in. Within this plan, a sequenced set of topics inform the student what items can be learnt, whilst the order of sequence suggest when they should learn them to attain complete understanding. The plan of study also tells the student how each of the topics suggested for study can be learnt, eg. through the use of particular learning materials. Some learning materials are on–line, whilst some require learning activity away from the terminal, eg. attendance at a lecture or seminar.

Components of the System

Providing advice about WHAT, HOW & WHEN to study is dependent upon the system having access to subject matter knowledge, the available resources for teaching the subject matter and, to be able to adapt the advice, information about the student is also required.

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* ESRC Linked–Studentship supervised by J R Hartley, Computer Based Learning Unit, University of Leeds

Domain Representation
The subject matter of Applied Statistics has been represented as a series of inter-connected networks, consisting of nodes and labelled arcs. The nodes in the network(s) represents Statistical topics which can be learnt by the student, whilst the labelled arcs denote relationships between the topics. Three types of nodes (Root, Organising and Leaf) have been identified which capture varying levels of detail. Each type of node can be identified in the network(s) by virtue of its relation to various arcs.

Each node in the network(s) contain information of several types, relating to its knowledge requirements. Typically, this information includes a topic node label and a description or synopsis of the topic, which forms it's Conceptual knowledge. Associated mathematical calculations are included (if appropriate) which represent Procedural knowledge for the topic, whilst knowledge for understanding and applying a given topic in context is incorporated as Operational knowledge. However, it is not necessary that every topic node should contain all three types of knowledge.

Different types of labelled arcs representing relationships between each node have been identified. Some of the labelled arcs (part-of, type-of and specialisation) distinguish between different node types, eg root-organising and leaf nodes, and others distinguish between topic nodes which are necessary Prerequisites (contains and applies) and as such, will affect the sequencing of those items (for more detail see Arshad 1990).

From this node-arc network topics are selected and sequenced for a given student. The labelled arcs are used in two ways: some are used to assist the student in navigating around the network(s), eg. pre-requisite links, whereas others (part-of, type-of and specialisation) are used to provide the student with 'shallow' knowledge about the domain, linking different ideas. Hence, some links are used as tools to converse with the student about their learning, whilst others are used to sequence information. The topics in the domain representation have pointers to a source of information (teaching materials) which will enable the selected topics to be implemented.

Database of associated teaching material
This contains information about the resources available for teaching each topic in the domain. Several types of teaching materials are identified for each topic ranging from on-line to traditional, off-line materials. Each of the materials differ in their functional style, thus providing different types of learning interaction. For example, to enable a student to develop conceptual knowledge about a topic, the system may attempt to promote it through Expository methods by means of textual materials (ie extract from books with illustrations). Equally, test-teach pre-stored computer based modules may serve as well for the acquisition of conceptual knowledge about the selected topics. Other functional styles of some of the materials used are Consolidatory, Remedial, Test/Diagnose etc. The functional style of only one of the materials will be suitable for the current learning task.

Student model
The student model provides the third source of information for the advisory process. This model typically consists of two types of information about the student. The first part, 'student profile' is set up on initial interaction with the student. Essentially it consists of a set of variables describing a student in terms of their background knowledge, relevance of course to degree and time available for ...ning.

Some attempts have been made to account for and accommodate the learners study habits or predisposition for particular types of learning strategy in terms of whether they are a Serialist or a Holist (Pask 1976). This is identified by requesting the student to indicate levels of confidence, degree of support required (eg. directed, exploratory) and whether they ant passive/active learning methods. Low confidence and a strong preference for directed support is taken to be an indicator of a Serialist learner, whilst high confidence, less directed support is an indicator that the learner is a Holist and would prefer access to several topics and active, exploratory materials.

Some of the profile information is utilised in constructing the second part of the model ('student image'), which describes what the student "knows" about the topics in the domain. Topic nodes are marked as known, partly–known, unknown or in error. The student's knowledge of the topics is represented as a subset of the domain. Perturbation techniques are also used to account for errors in their knowledge of the subject.

Once, the system has ascertained what the student knows and what preferences have been specified, the advisory process can begin. This involves the selection and sequencing of appropriate topics for the student, followed by identification of suitable learning interaction, through the use of particular learning materials.

Advisory rules

These rules are the system's knowledge about how to provide study advice. The advisory process proceeds with the system locating the domain of interest within the subject matter. This involves identifying a network consisting of a root node and it's sub–ordinate topics (organising and leaf nodes). The Adviser constructs a study sequence from these topic nodes using rules which dictate the constraints under which topic nodes can be selected. As such, sequencing of topics is based on what the student knows and on the types of links which relate unknown topics to those that are known.

Several types of rules allow different approaches to be adopted for searching out reasonable topic nodes eg., Top–down analysis or Bottom–up synthesis, and Depth–first specialisation or Breadth–first differentiation. These determine whether the study scheme should be based on node information or focused/unfocused sub–trees, using arc relationships as the deciding force. So, within the chosen type of plan, the system can use controlling rules which use arc–knowledge of, say pre–requisites (eg. 'a' contains 'b') to determine sequence, and the AND/OR junctions (ie part–of, type–cf) arcs to set sub goal conditions. The Adviser also uses knowledge strength measures to follow either 'strong' or 'weak' routes, whilst knowledge types rules are used to organise goal development, eg conceptual/procedural knowledge is a requirement for operational knowledge (Arshad 1989).

The candidate plans constructed (based on the organising methods described above) accommodate different students, in terms of the learning style indicated, eg Serialist/Holist, and the student's background knowledge. These plans are then acted upon by further rules. This second set of advisory rules embody educational policies which represent teaching actions judged appropriate for each of the topic nodes in the candidate plan. These enable the control of different types of action with the student, eg. introduce information, consolidate with procedural knowledge, repair misconceptions, or summarise and extend learning to other unknown inter-linked topics. Appropriate teaching materials are recommended to the student for achieving the study plan goals. Finally, to help study, tactical comments (based on the arc relations) are integrated into the study plan. These clarify the goal and its relation to the developing concept of the overall domain or subject matter.

Conclusion

The research has provided a design methodology, which has considerable flexibility (in terms of applicability to other subject areas) that allows tutors to construct a topic domain to allow the advisory software to be used with their students. In addition it has identified new ways in which the system adapts the advice to suit different learners. This is primarily achieved through the nature of the search adopted for available topics (eg Top-Down, Bottom-up etc). Few systems have been specifically designed to explore the value of providing study advice in CAI. In this respect, the Advisory system developed is unique!

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SECTION 4 – Training Agency Project Reports

Supporting Technology Across the Curriculum*

Research Team: Professor Bob Lewis and Dr Jim Ridgway (Co-directors) Department of Psychology, Lancaster University, Don Passey Cumbria LEA and Marilyn Shone Lancashire LEA.

The focus of the project is to accelerate innovation by classroom teachers in their use of Information Technology (IT) by helping to maximise the effectiveness of Advisory Teachers and other agents of change.

The research began by defining the challenge more clearly, via a detailed (and ongoing) analysis of the minimum requirements for IT in schools, as set out in the National Curriculum, and an analysis of the roles played by a variety of change agents including Advisers, Advisory Teachers, and IT co-ordinators and senior staff in schools. 'Toolkits' (which include courses and documents) are being developed to support each of these agents in different ways.

Prepared so far are:

- a course on Effective Self Evaluation for Advisory Teachers, which sets out to elicit common beliefs from a team about stages of teacher progression in their uses of IT. These beliefs are then used as a basis for discussions on how change might be brought about, and as a source of advice on how simple documentation can satisfy the requirements for personal planning as well as record keeping for more public acceptability. This course has had preliminary trials, and will be developed further with new Advisory Teachers in September.
- a course for IT co-ordinators and senior staff in schools, which sets out the demands of the National Curriculum and raises issues about the appropriate deployment of IT across the curriculum, and offers pointers to sources of advice. This course has been given successfully within several LEAs, linked with local expertise from Advisory Teachers, and will be made widely available, in the near future;
- a document on INSET provision which provides a number of case histories, and offers checklists on how to proceed, and a range of methods of evaluation, with appropriate guidance on their usage. This document is undergoing revision.

Ongoing work includes:

- an analysis of the perceived effectiveness of Advisory Teachers by themselves and the teachers with whom they have worked;
- an analysis of the roles currently performed by IT co-ordinators in schools;
- an analysis of the problems of disseminating IT, which considers barriers at different levels within the system, and ways in which they may be overcome;
- an analysis of the roles and deployment of Advisory Teachers within different LEAs, and of the ways that LEAs are responding to a common set of problems which includes: reduced funding for IT, changing roles of Advisers, integration of support services, and the Local Management of Schools.

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* A collaborative project between the University of Lancaster and Cumbria and Lancashire LEAs, funded from October 1988 to March 1992 by the DoE Training Agency TVEI Support Unit. Address for correspondence: STAC Project, Department of Psychology, Lancaster University, Lancaster, LA1 4YF.

Whole School Development in Information Technology*

Research Team: Professor Michael Eraut (Director), John Pearce, Alan Slaney, Stephen Steadman, Institute of Continuing and Professional Education, University of Sussex

During the 1980s most secondary schools acquired one or more microcomputers and used them in a variety of ways; eg. teaching Computer Studies, in TVEI, and within individual curriculum subjects. More recently ESG funding has supported development within LEAs through the appointment of IT teacher/advisers and in development of IT across a wide range of different subjects. This is consistent with the recognition of IT as a cross curicula theme in the National Curriculum.

The next step in the evaluation of IT in schools places importance on developing the whole school policies for IT. A school policy for IT would cover the curriculum, school administration, resource management, finance and staff development. A policy would not only state aims but also provide plans and targets for action.

The main aim of this project is to develop and disseminate INSET strategies and materials of proven effectiveness in the following areas:

- whole-school policies for Information Technology;
- school management of Information Technology;
- school-focussed staff development in Information Technology.

The Project Team is working in five LEAs and 16 schools in a variety of ways:

- exploring ways of constructing and implementing a policy,;
- offering ideas and approaches drawn form the team's previous experience;
- contributing expertise in curriculum development, whole school review and methods of self evaluation.

Shared accounts of how a school policy evolves will contribute to a map of policy options which will guide other schools' decisions.

Production of five short papers intended for IT co-ordinators and senior managers in secondary school should be completed by September 1990; the series will consist of:

1. What's in a Policy? Creating a Policy for IT Secondary Schools
2. Getting Started: Conducting Audits
3. Policy into Practice: Supporting Change
4. What Makes IT INSET Effective?
5. IT in the National Curriculum

A videotape is being produced to stimulate discussion around some of the issues involved in the development of a whole school IT policy.

* A University of Sussex/Brighton Polytechnic Project in collaboration with Croydon, East Sussex, Kent, Surrey and West Sussex LEAs, funded October 1988–September 1991 by the DoE Training Agency TVEI Support Unit. Address for correspondence: Arts E Building, Sussex University, Brighton, BN1 9QN.

The Computer Based Modelling Across the Curriculum*

David Hassell, AUME, Hatfield

The specific objectives of the project are to:

- promote the use of the computer to enhance aspects of the current curriculum which involve the modelling of physical and human systems;
- construct and use models with the same generic software within the context of different subjects and through cross curicula activities;
- develop independent and group learning;
- develop and evaluate classroom materials;
- design and evaluate materials for teacher development;
- disseminate materials within and beyond the Chiltern Region.

The project is to investigate the opportunities for the incorporation of computer-based modelling into the curriculum. Four subject areas, Mathematics, Geography, Science and Business Education provide the focus for the project. In addition the cross curicula nature of the modelling process is to be emphasised. At the end of the three years the findings will be disseminated through a support package. It is envisaged that these materials will be published throughout the country and will be used to support teachers developing the use of computers in a range of cross curicula activities involving modelling. It is expected that they will be used for a range of in-service activities.

The project has four phases:

Phase 1 – April 1989 – September 1989 – Preliminary
During this phase the teachers were selected and release time was negotiated for them. The teachers involved were given some initial support and training and a pilot school was identified.

Phase 2 – September 1989 – July 1990 – Development
The development of modelling ideas, classroom and support materials will take place in each of the schools, initially in the teachers individual subjects and later with a cross curicula emphasis. Each school has a staff enhancement to support their work.

Phase 3 – August 1990 – July 1991 – Replication
In this phase the subject spread in each school will be increased. Dissemination of the ideas and materials already developed will begin at a variety of levels.

Phase 4 – August 1991 – March 1992 – Dissemination
The final evaluations, reports and materials to be used for wider dissemination will be prepared for publication. This will be completed by the project officers with the help of some of the staff from the schools.

* A Project jointly managed by the Institute of Education, University of London, the Advisory Unit for Microtechnology in Education and five LEAs in the Chiltern region – Hertfordshire, Oxfordshire, Harrow, Enfield and Barnet; funded by the DoE Training Agency TVEI Support Unit. Address for correspondence: AUME, Hatfield, Herts, AL10 8AU.

Information Technology–based Open Learning*

Research team: Dr Viv Hodgson, Dr David Hutchison, Professor Bob Lewis, Dr David McConnell, Dr Chris Paice, Ian Stuart (all of the University of Lancaster).

The feasibility study into Information Technology–based Open Learning (ITOL) was completed in April 1989. (A summary of the Report is available as InTER/12/89). The aim of the study was to model a system by means of which the learning resources available within universities or similar institutions may be made more easily accessible to persons outside those institutions.

Phase Two: Demonstrator Project

The ITOL model now needs to be tested in a real professional development setting. The principles behind the model need to be demonstrated as effective. This will be achieved by demonstrating the applicability of the model in three distinctly different professional spheres viz. accountancy and finance, mechatronics; management learning.

The Demonstrator Project is concerned with the implementation of the model. The questions posed in relation to providing professional updating and development via ITOL are:

- Where do we want to be by 1995?
- Where are we now?
- What stages in implementation do we need to pass through?
- What research questions might be addressed?
- Who might be expected to finance the Demonstrator Project?

The refinement of the model requires a closer examination of specific areas, such as the form and nature of information resources which can be accessed through ITOL, and their management; storage and rapid access of resources; minimum costs for running ITOL; easy accessibility to learners.

In addition, we need to consider the needs of professional learners, and the acceptability of electronic tutoring to teachers in higher education, and the support systems needed to run ITOL. It is envisaged that several large public and private sector organisations will be involved as industrial learning partners in the Demonstrator Project. They will contribute to the design of the ITOL learning environment, and play an important role in the evaluation of the implementation. This close co–operation will help to keep the range of possible requirements reasonably predictable.

The Demonstrator Project will last for two years and will be closely evaluated throughout in order to monitor the use and effectiveness of the system and provide a mechanism for review and revision at all times.

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* The Phase One feasibility study was funded by the Learning Systems and Access branch, Training Agency from October 1988 – March 1989. Address for correspondence Dr D McConnell, CSML, University of Lancaster.

Authoring Environments for simulation-based CBT*

Collaborators: Professor R. Lewis (Lancaster - Director), Terry Mace (Information Learning Systems Ltd - Project Manager), Dr Terry Hinton (Surrey), Dr Trevor Hopkins, Steve Wallis and Stephanie Wilson (Manchester), John Lougher (British Steel plc), Richard Millwood (King's, London), Jeff Oliver (Castle Learning Systems). Ian Graham and Khawar Iqbal (Mentor Interactive Training Ltd), Jon Stock (Crosfield Electronics).

This project is now at the stage of preparing its Final Report and it is hoped that this will become available as an InTER paper in the next few months. The aims were outlined in InTER/8/89 and an interim report appeared as InTER/13/89.

The prototype authoring tools were developed and tested as planned with two complex simulations incorporated into courseware for specific training requirements at British Steel and Crosfield Electronics. The authoring tools include modular modelling tools, graphics editor and courseware editor. The library of "gadgets" continues to grow as additional functionality is required. A full implementation phase is planned and as a step towards this a seminar on model representation is being held under the auspices of the InTER Programme to define further modules for this complex aspect of the toolkit.

DISTIL Survey+

Collaborators: Michael Twidale and Professor R. Lewis (Lancaster), Terry Mace (Information Learning Systems), Dr. Peter Ross (Edinburgh), Chris Clifton (Logica) and David Shorter (Scion)

The DISTIL consortium collected information on research and development projects and products from the UK and overseas in which AI techniques have been used in learning and training materials (see InTER/8/89). The first version of the database was distributed to those who had contributed data in the middle of 1989.

The second phase (over the early months of 1990) had two aims:

- to validate the existing data by analysis followed by requests to contributors to clarify the data supplied or rejection of items found to be outside the scope of the project, and also to extend the coverage - over 200 items currently exist;
- to analyse the data in a way which would inform the Training Agency of the state-of-the-art and hence to provide guidelines on future directions R&D in the area might be usefully continued.

A report to the Training Agency is currently being prepared and it is hoped that this may also appear as an InTER Occasional Paper. It is planned to distribute a second version of the database to contributors later in 1990. Diskettes containing the data are available from the InTER Programme on receipt of two blank (five and a quarter inch) diskettes or a cheque (to the University of Lancaster) for £5.

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* A project funded from January 1989 to March 1990 by the Learning Technology Unit of the DoE Training Agency.

\+ A two phase project funded intermittently during 1989 and 1990 by the Learning Technology Unit of the DoE Training Agency.

SECTION 5 - DELTA Projects

TOSKA - Tools and Methods for a Sophisticated Knowledge-based Authoring Facility*

Robin Johnson and Peter Goodyear, Department of Educational Research, Lancaster University

TOSKA is a concept exploration of authoring tools for open and distance learning courses, utilising CAL and established ITS techniques. The tools should provide knowledge-based support for authors, with little or no AI experience, producing intelligent or semi-intelligent courseware. The rationale for the work lies in the significant advantages that can be achieved with intelligent courseware and the large investment of time and expertise currently necessary to realise these advantages

The project involves 6 other partners:

Dornier GmbH	W. Germany
University of Leeds (CBL Unit)	UK
CTC Ltd	Greece
DIDA*EL S.R.L.	Italy
IMS	Ireland
Catalunya University	Spain

The project started in March 1989. The first year of work was divided into four components; the architecture/integration of the tools and an analysis of the three traditional ITS knowledge sources (domain, instructional strategies, learner characteristics). The second year will develop and validate prototypes of tools, based on aircraft maintenance training (Aer Lingus) and training sales-people to use a sales support program in the truck industry (Daimlar-Benz). The project intends these domains to provide context for the authoring activity not to constrain the breadth of the tools' applicability.

The authoring activity can proceed on the three knowledge bases in parallel or in any desired sequence. Decisions made within a particular strand (knowledge base) may constrain subsequent decisions in other strands eg learners requiring high levels of control will restrict the types of instructional strategy that need to be considered. By encouraging the author to take a top-down approach to authoring it is hoped that the early conceptions arising in each strand will support the authors thinking in the other strands, for instance, by making concrete and explicit decisions about the classes of learners who might use the courseware, the task of designing appropriate instructional strategies will become more focussed.

Each of the knowledge bases to be authored must provide some structure for the author to work within. The investigation of appropriate structures has been the central concern of the three knowledge-based strands in the first year. The domain will be represented using a declarative representation to show the structure and relationships between the topics and sub-topics of the domain. The specifications for the required teaching modules will be attached to the domain representation and described using Merrill's Component Display Theory (1983). The instructional strategies module will be structured around the Generic Tutoring Environment (GTE) (Van Marcke 1990) which provides a method for authors to

*Project funded by the EEC DGXIII DELTA Programme from March 1989 to March 1991.

specify the decomposition of teaching tasks into sub-tasks and methods. At run-time the system traverses the tree, guided by knowledge of the learner, and chooses appropriate methods to satisfy the teaching tasks, given the learners requirements.

Lastly, work on the learner model will be structured around static learner attributes. This is a departure from traditional learner models which have focussed on overlays and bugs (Wenger 1987). The reason for this emphasis is a belief that more significant and useful adaptations to the learner can be achieved by high level considerations about the learners requirements than by considering the low level detail of overlays and bugs (Goodyear and Johnson 1990). The learner attributes will be considered in terms of learner classes to avoid the complexity of interactions that arise when considering several attributes. The system will also model overlays and bugs and it is hoped that their performance can be improved by partitioning them according to the learner classes.

The output from the authoring process will be in the form of specifications for the required knowledge bases. These will need to be checked for consistency and completeness and then compiled into a run-time system. TOSKA is not considering these latter activities.

The final output of this two year project will be a detailed specification for a restricted set of tools to support the authoring of intelligent and semi-intelligent courseware. Applications for funding to continue the work, building a complete and robust set of tools, are currently being investigated.

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Van Marcke, K. (1990) A Generic Tutoring Environment. *submitted to ECAI-90*

Wenger, E. (1987) *Artificial Intelligence and Tutoring Systems: Computational and Cognitive Approaches to the Communication of Knowledge*. Morgan Kaufmann, Los Altos, California.

START-UP*

UK Research Team: Lucinda Beier and Bob Lewis, University of Lancaster

START-UP is a project in Action Line 1 of the DELTA programme. Co-ordinated by the prime contractor in Paris, START-UP partners in Belgium, Denmark, France, Germany, Norway, Portugal, Sweden, Switzerland and the UK collaborate in research concerning technology-based learning materials in Europe.

START-UP aims to create a dynamic environment for European communication and cooperation in the field of technology-based education and training. it will address the needs of producers, trainers and teachers by:

* Project funded by the EEC DGXIII DELTA Programme from March 1989 to March 1991.

- examining the 'state of the art' in the production of technology-based learning materials and reporting on information collected;
- establishing an on-going network which will put European producers in touch with each other;
- recommending production methods which will increase efficiency and quality.

START-UP, in effect, serves as an information resource and contact point for all producers of technology-based learning materials.

Postal surveys have been conducted in order to determine
- the extent to which technology-based learning materials are produced in each geographical area;
- the types of organisations which produce these materials;
- the markets for which the materials are produced;
- levels of interest in participating in the START-UP Producers' Database and Network.

Case studies have been conducted within selected organizations which represent the major categories of producers identified by the project group. In the course of interviews with people involved in all aspects of the production process, START-UP representatives explore variations in:
- the organization and structure of that process;
- the learning approaches and technical methodologies used to produce technology-based learning materials;
- perspectives regarding both the constraints affecting the courseware development process and the particular strengths of the organizations represented.

Exchange of information between START-UP *partners* indicates that the environment for the production of technology-based learning materials varies enormously from one country to another. Variations concern, among other things:
- size and character of the market for technology-based learning materials;
- sources of funding for technology-based courseware production;
- composition (regarding category) of the population of courseware producers in each geographical area;
- hardware standards in both training and education sectors;
- standard authoring facilities for the production of technology-based learning materials, and
- national versus international perspectives on courseware production and dissemination.

The conclusion is inescapable that initiatives such as START-UP are required to support and facilitate communication among courseware producers. This is particularly important as producers need a strong voice in order to state coherent needs to the European Commission so that the needs of producers of technology-based learning materials will be addressed in the future. An important beginning in creating a 'producers community' was made in April 1990 at a START-UP conference for European producers in Interlaken.

NATLAB: Student model acquisition in a natural laboratory*

UK Research Team: John Self, Michael Twidale, Department of Computing University of Lancaster ; Roger Hartley, David Hintze, University of Leeds
Together with: Therry Chanier, Pierre Dillenbourg, David Nichols, Michael Pengelly

The major objective of the NATLAB project is to develop methodologies for building student models to be used within the learning systems envisaged by the DELTA programme. NATLAB involves research, development and application of advanced software tools based on techniques from artificial intelligence and cognitive science, and the evaluation of 'natural laboratory' systems in real settings. Two groups and the Universities of Lancaster and Leeds are collaborating on part of NATLAB.

A prototype interface, called BELLOC, for collecting and characterising information about learners' performances has been developed. The learning process is considered to consist of building "applicable rules", which are rules that it is reasonable for a student to have at a particular stage of learning. The teacher may also use applicable rules as heuristics to approximate the desired language competence. This approach de-emphasises the idea of absolute correctness. The concept of applicable rules potentially includes several layers of explanation. This has necessitated the development of a supportive graphical environment for the creation of applicable rules. Rule creation can involve induction from examples and counter-examples and generalisation and specialisation from existing applicable rules. The use of BELLOC by users of varying levels of linguistic expertise is being investigated

* Project funded by the EEC DGXIII DELTA Programme from March 1989 to March 1991.

SECTION 6 – Updates to InTER/8/89

The design of a Writer's Assistant*

Mike Sharples, School of Cognitive & Computing Sciences, University of Sussex

Unlike other writing support tools, the Writer's Assistant is founded on an explicit model of the writing process. Since the system provides support for the strategies and techniques identified by recent writing research, the individual author will find within it support for his/her own writing style(s). In this way, the Writer's Assistant will build upon its users' existing writing skills – they will find their existing strategies embodied in the system.

Publications

An early design proposal for the Writer's Assistant was published as:

Sharples, M. & O'Malley, C. A framework for the design of a Writer's Assistant. In J. Self (ed) *Artificial Intelligence and Human Learning*. Chapman and Hall.

The following reports, in the University's Cognitive Sciences Research Papers series, are available from:

Mrs Sheila Lee,
School of Cognitive and Computing Sciences,
University of Sussex,
Falmer, Brighton BN1 9QN.

CSRP 101: Pemberton, L. & Sharples, M. (1988) Textual Structures in a Computer-based Writer's Assistant System.

CSRP 119: Sharples, M. & Pemberton, L. (1988) Representing Writing: an Account of the Writing Process with regard to the Writer's External Representations.

CSRP 121: Pemberton, L. (1988) Using HyperCard to test the design of the Writer's Assistant.

CSRP 122: Sharples, M., Goodlet, J., Pemberton, L. (1988) Developing a Writer's Assistant. (Published in Williams, N. & Holt, P. (eds) *Computers or Writing*. Intellect/Blackwell 1989.)

CSRP 123: Sharples, M. (1988) A Development Methodology for Cognitive Support Systems.

CSRP 154: Sharples, M. & Pemberton, L (1990) Starting from the Writer: Guidelines for the Design of User-centred Document Processors.

[Each report costs £1; please make cheques payable to The University of Sussex.]

* A project funded by British Telecom (October 1987-September 1990). See *Research in Progress, March 1989* (InTER/8/89).

Characteristics of human search procedures*

Dianne C. Berry and Donald E. Broadbent, Department of Experimental Psychology, University of Oxford

This project has looked at the way in which people search through an uncertain environment in order to decide between alternative interpretations of it. The type of situation considered is that in which a person needs to identify some 'object', by querying a database with a combination of 'features'. In the majority of experiments the task has involved determining which of a set of factories is responsible for polluting a river, by ordering a series of tests for the presence or absence of the various pollutants. Successful performance involves both selecting the right tests to distinguish between the factories and, given the answer to any pollutant test, making the necessary inferences about the factories that remain.

Four papers have arisen out of this ESRC project.

Revised references (March 1990)

Berry, D.C. and Broadbent, D.E. (1987) Explanation and Verbalisation in a Computer-assisted Search Task. *Quarterly Journal of Experimental Psychology, 39A*, 585–609.

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Berry, D.C. and Broadbent, D.E. (In press) The role of instruction and verbalisation in improving performance on complex search task, *Behaviour and Information Technology.*

* Recipient of ESRC Award C0820005 (December 1985–June 1988) part of the ESRC–IT and Cognitive Sciences Initiative. See *Research in Progress, March 1989* (InTER/8/89).

Origins of the ESRC INFORMATION TECHNOLOGY AND EDUCATION PROGRAMME

The Education and Human Development Committee was established with the reorganisation of the then Social Science Research Council in May 1982. In 1984 the Council changed its name to the Economic and Social Research Council. Early in 1983 the Committee identified and circulated for discussion an initial listing of important topics which warranted expanded support or accelerated development. The broad area of Information Technology in Education occupied a prominent place in that list. The Committee emphasised its intention that research would be centred not only on the effect on education of machines to help teach the existing curriculum, but on the development and adaptation of the curriculum to equip people, including those of school age, to deal with intelligent machines and to prepare them for a life changed by their arrival. For example, there are questions concerning both cognitive and organisational factors which facilitate or inhibit the adoption of Information Technology in Education, and allied to these, questions around the nature, characteristics and development of information technology literacy. These initial topics remain central to the Committee's projected agenda.

Two reports were commissioned and detailed discussion and workshops were held in 1983. In its further considerations, the Committee was conscious of the fact that the research community is widely scattered and has relatively few large groups of researchers. Furthermore, it recognised the importance of involving practitioners and policy makers in the development of its programme of substantive research and research related activities and the necessity of ensuring close collaboration with commercial organisations such as publishers, software houses and hardware manufacturers. It was this thinking that led the Committee away from the establishment of a single new centre to the appointment of a coordinator as the focal poi- or the development of the initiative throughout the country.

The brief for the Coordinator included:

- the review, evaluation and dissemination of the recent and current activity in the field of Information Technology and Education;
- the identification of the needs of education in relation to Information Technology;
- the stimulation of relevant research and the formulation of research guidelines;
- the establishment and maintenance of a database of relevant work and undertaking arrangements for coordinating and networking of those active in the field including cognitive scientists, educational researchers, practitioners and policymakers.

In January 1988 the Council of ESRC approved a new initiative which would have resources to support a substantive research programme. This programme, the Information Technology in Education Research Programme, started in the autumn of 1988. The new series of InTER Programme Occasional Papers has a similar format to the previous ITE Programme series and covers aspects of the Programme's work. These are listed on the back cover of this paper.

Recent Occasional Papers in the InTER Series:

InTER/8/89	Research in Progress – update March 1989	March 1989
InTER/9a/89	A Guide to the Electronic Services	May 1989
InTER/9b/89	The CAUCUS Computer Conference System	November 1989
InTER/10/89	Information Technology and Language Development – a seminar report	July 1989
InTER/11/89	Barriers to Innovation – a seminar report	July 1989
InTER/12/89	Information Technology-based Open Learning – a study report	July 1989
InTER/13/89	Authoring Tools for simulation-based CBT – an interim project report	July 1989
InTER/14/90	Research in Progress – update April 1990	April 1990
InTER/15/90	Current practice and policies for using computers in primary schools: implications for training – a research report	April 1990
InTER/16/90	Exploration and Reasoning – a seminar report	April 1990
InTER/17/90	Supporting technology across the curriculum – an interim project report	May 1990
InTER/18/90	The InTER Programme: Capturing dialogue in learning	May 1990

Occasional Papers:
A full list of earlier papers is available from the Programme. Please note that some may be available in photocopy form only.

The above papers are available free of charge from:

ESRC-InTER Programme, Department of Psychology,
University of Lancaster, Lancaster LA1 4YF

Telephone:	0524-65201 Ext 3601 (24hr. answering)
Fax:	0524-841710
DIALCOM:	10001:yma027
JANET:	inter@uk.ac.lancs.cent1
EARN:	inter%uk.ac.lancs.cent1@ac.uk
DARPA:	inter%cent1.lancs.ac.uk.@cunyvm.cuny.edu
EuroKom:	robert_lewis@eurokom.ie