DOCUMENT RESUME

ED 328 234 IR 014 833

AUTHOR Hawkridge, David
TITLE Who Needs Computers in Schools, and Why? CITE Report No. 73.
INSTITUTION Open Univ., Walton, Bletchley, Bucks (England). Inst. of Educational Technology.
PUB DATE 89
NOTE 13p.; Prepared by the Centre for Information Technology in Education.
PUB TYPE Viewpoints (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Literacy; Computer Managed Instruction; Developing Nations; Educational Change; *Educational Strategies; Elementary Secondary Education; Foreign Countries

ABSTRACT

This paper outlines and discusses four rationales for using computers in schools: (1) the social rationale, which states that it is necessary for children to become aware and unafraid of computers in order to prepare for life and work in an industrial society; (2) the vocational rationale, which states that children should learn computer programming and become generally computer literate; (3) the pedagogic rationale, which states that computer assisted instruction offers advantages over other teaching methods in subjects such as physics and art (among many others); and (4) the catalytic rationale, which states that computers help children become less dependent on the teacher as expert and will enable change in education to occur. Three additional rationales are also noted and discussed: the information technology industry rationale, the cost-effectiveness rationale, and the special needs rationale. It is concluded that priorities for using computers in schools are changing rapidly and should be further examined. (5 references) (DB)

WHO NEEDS COMPUTERS IN SCHOOLS, AND WHY?

David Hawkridge
Institute of Educational Technology
The Open University

Abstract

What are the popular rationales for using computers in schools? Are there others that are being neglected? How do they stand up to criticism? Are they the same in both developing and industrial countries? Is there any evidence that priorities are changing? This paper addresses these questions and draws particularly on recent research, funded by the Harold Macmillan Trust, in developing countries of Africa, Asia and the Arabic-speaking world.

Who needs computers in schools, and why?

Imagine for a moment that you are Minister of Education in some country, not this one. Do you like the idea? Perhaps the thought of all the perks crosses your mind, or even the notion of entertaining Sir Kenneth Baker, as he may well be before long. Or perhaps you instantly recoil from having as many problems on your hands as he has. At any rate, you may be sure that, as Minister, sooner or later, probably sooner, you will have to consider very seriously this question of who needs computers in schools, and why? You will receive plenty of advice, and not simply from your officials. And you will want a sound rationale.

Today I'd like to spell out four popular rationales for using computers in schools, and subject them to some criticism. Then I shall draw comparisons between such rationales in industrial countries and developing ones. What I have to say is based on recent work I've been doing, with two British colleagues, in Africa, Asia and the Arab-speaking world (Hawkridge, Jaworski and McMahon, in press). I am glad that The Harold Macmillan Trust funded our project, paying our co-workers in seven of those countries. Finally, I want to consider whether priorities are changing? Are governments shifting their ground as they try to justify putting computers into schools?

Uses of computers in schools

But first, let's just remind ourselves what children use computers for? In industrial countries, children use them in schools for four main purposes.

- o to become generally aware of the uses and limitations of computers;
- o to learn computer programming (usually in BASIC but sometimes other languages such as PASCAL or LOGO);
- o to learn to use programs, for word-processing, spreadsheet analysis, graphics, process control and information retrieval from databases;
- o to learn selected topics from school subjects right across the curriculum, with the computer and educational software either complementing or temporarily replacing the teacher.

Teachers also use computers for record-keeping: some teachers even keep track of the progress of individual children. Administrators use them to support managerial and administrative functions, such as scheduling and financial accounting. All this is well-known. Now let's consider the popular rationales behind these uses.

Four popular rationales

To justify using computers in schools, the strongest reason offered by policy-makers is that all children of secondary school age (and perhaps even those of primary school age) should be aware and unafraid of how computers work, because computers are pervading industrial societies and are

likely to be important in all countries. Since schools prepare children for life, they should prepare them to deal with computers, which ought to be de-mystified. Many politicians also feel that modernisation of schooling involves bringing computers into schools. If children need to become literate and numerate, today they need also to know something about computers. All children should have courses in 'computer awareness'. But let me return to this later. I shall call this the Social Rationale.

A second reason offered is that many children should learn to operate computers. Teaching children programming gives them some confidence in their ability to control computers, and may be a foundation for a career in computer science. Teaching children how to use applications programs does not require them to learn programming, but it does give them skills that may be useful to them as children and possibly when they move into jobs. Specific vocational training will come later, from employers or post-secondary institutions. At school, runs the reasoning, many children, boys and girls, should take courses in 'computer literacy' or even 'computer science'. This is the Vocational Rationale.

A third reason advanced is that children should be able to use computers in learning physics, art or any other subject, where computer-assisted learning (CAL) offers advantages over other methods. Schools in industrial countries like the United States and the United Kingdom now have access, given the funds, to a considerable stock of CAL software. This is the Pedagogic Rationale, based on a strong belief that computers can teach.

A fourth reason is that schools can be changed for the better by the introduction of computers. Teaching, administrative and managerial efficiency may be improved. Some educators assert that when computers arrive in a school, its staff, parents and children are more open to change than they usually are. Computers help children to become less dependent on the teacher as expert. Computers require children to do less memorizing of facts and more information-handling and problem-solving. Computers encourage children to learn by collaborating rather than competing with other children. Computers help administrators to bring about change. Computers are seen as catalysts, enabling desired change in education to occur. This is the Catalytic Rationale.

Scrutinising these rationales

Each of these four rationales probably sounds to you reasonable enough, and quite familiar, but each is rather too simplistic. Each deserves to be scrutinised, lest its proponents be guilty of merely jumping on a bandwagon.

What does the Social Rationale lead to? Ministries of Education think they must provide 'computer awareness', in classes or clubs that teach an awareness of the principles on which computers work, including some elementary BASIC programming. Most children commonly get only a little hands-on experience and usually there is no examination or test of their achievement. In industrial countries, quite large numbers of children are now receiving such computer education.

Where are the roots of the Social Rationale? Are they in liberal thinking which urges free and equal access for all children to computers, the wonder machines of our age? And which wants the citizenry to be more fully developed as individuals? If so, what are governments doing to provide free and equal access? Is there strength in the idea that children can realise their individual potential because of computers in schools?

Or is this Social Rationale based on the socialist utilitarian desire to bring the greatest benefit to the greatest number, in the service of all? That would mean at least avoiding the emergence of elites, or domination of the machines by one racial group or gender. This is not what is happening in socialist countries, let alone capitalist ones. It is not even the declared policy in any of them.

Or is the Social Rationale fear-driven, in the sense that we fear lest our children should be unable to cope with these new monsters, which must be demystified? Yet it is well-known that our children cope with them better than we do!

Or is this Rationale being subtly put about by politicians in league with international capitalist financiers and manufacturers who see great profits to be made out of widespread acceptance of

computers? It claims the high ground morally, this Rationale, being for the people. But is it true that schools have been stampeded, stampeded into teaching computer awareness? They have certainly been assailed by technological hype, generated by multi-national companies selling information technology and information itself.

Or is the Social Rationale merely a piece of 'after-the-fact' justification for the rather low level of what has happened in many schools? Some people argue that using computers in this way, to generate computer 'awareness', is a waste of resources, because computers are potentially very powerful educational tools.

Well, I've raised a lot of questions about the Social Rationale. But let me turn now to the Vocational Rationale. Adoption of this rationale leads to 'computer studies' courses, quite often aimed at preparing secondary school children for a public examination. Such courses include substantial knowledge of how computers are designed and used, plus plenty hands-on experience of applications such as word-processing and spreadsheet analysis, and some training in programming, usually in BASIC but sometimes in PASCAL.

The Vocational Rationale has a Thatcherite, market-orientated ring to it: computers help children to prepare for jobs in the market-place. Computers will take them to successful money-making, wealth-creating careers. But other major British political parties have also declared that computers are vital to our economy and students should learn how to use them. Remember James Callaghan. Political arguments arise instead over whether school is the right place for vocational training. Because the Vocational Rationale calls for far more time to be spent on computer education than does the Social Rationale, the question of curriculum priorities comes up. What should computers displace? Because computer-related technology and jobs are changing fast, governments adopting this rationale may be very uncertain about the course content. Obsolescence is a huge problem. Worse, the lack of well-trained teachers often means that programming is poorly taught, and children must later unlearn what they learned at school, once they are in jobs or post-secondary education. Wouldn't they be better off doing physics? So the Vocational Rationale is not without its difficulties.

Next, the Pedagogic Rationale. This focusses on improving teaching and learning, and may well be the one that commands greatest support, perhaps overwhelmingly so, here at CAL89! It has an idealistic tone. Let me quote: We want 'to enrich the existing curriculum and improve the way in which it is delivered, by using computers as sophisticated educational tools which can extend traditional ways of presenting information to children and offer new opportunities through techniques (such as simulation), possible only with computers' (Commonwealth Secretariat, 1986). 'Enrich', 'improve', 'extend', 'offer' are all good positive verbs to use.

The rationale isn't faulty, even if enthusiasts exaggerate a little. But the technical and financial means of following it through may be lacking, as we struggle to develop satisfactory educational software. Many papers being read here reflect research going on to realise the potential of computers in helping children to learn. We already see examples of what computers can teach that teachers alone cannot. Some of our best hopes may lie in using computers for monitoring and sensing within science, for data logging, robotics and computer-aided design, and for information retrieval in the humanities. Clearly, we don't want children using computers to learn in schools that which teachers can teach better. The Pedagogic Rationale is essentially hopeful, if only the resources can be found.

Of these four Rationales, I think the Catalytic one has the most hidden power, but it also promises a Utopian future that will never arrive. First, it speaks of schools as they might become, if only computers could be present in large enough numbers, with the right kind of software to enable children and teachers to change. Supporters of this Rationale say that computers will help children to move away from rigid curricula, rote-learning and teacher-centred lessons, by giving more control to children of their own learning. 'Let the child program the computer, not the computer program the child', shout the likes of Seymour Papert, and it is indeed a powerful idea. Somehow, we are told, teachers will adopt 'more relevant' curricula by using computers and bring educational opportunities to a larger number of people.

I think these people are pinning their hopes on computers because their ideals for schools have not

been achieved by other means. I have some sympathy with them. Optimists among us hope that LOGO, microworlds, word-processing, computer conferencing and the like will soon impact farvourably on the curriculum and schools. It is certainly the British Government's desire, expressed through the National Curriculum Council, to see computers embedded in the new centralised curricula of the 1990s.

Second, the Catalytic Rationale speaks of organisational change. Pessimists -- and I'm sure there are none here -- insist that NO desirable organsiational change will ever come about through introducing computers. Such people are very gloomy about present attempts to computerise management information systems in schools. But administrators are already changing the way they manage schools, and are turning to computers to help them.

Despite these qualifications, I would say that only a blind optimist or a Conservative politician would use the Catalytic Rationale to justify future expenditure on the basis of what has changed so far. Schools, whether they opt out or not, now have to raise funds and control expenditure. Computers help, even if one disagrees, as I do, with the underlying ideology. But computers follow the law, rather than the law following computers. They are seldom catalytic in the broad sense, although they change working practice.

Other rationales

I think that these four, Social, Vocational, Pedgagogic and Catalytic, are the most popular rationales being used to justify putting computers into schools, but I want to mention three others, which I shall call the Information Technology Industry Rationale, the Cost-effectiveness Rationale and the Special Needs Rationale.

The Information Technology Industry Rationale runs like this: in our country (it could be the United Kingdom or Zimbabwe) we want to build up a strong information technology industry. On the hardware side, we want to manufacture, or at least assemble, computers and their components. On the software side, we want to build up a highly skilled workforce of programmers, capable of undertaking contract programming for customers from this and other countries.

Proponents of this rationale tend to be from within the industry, and they favour placing large numbers of locally-made or assembled computers in the schools, at government expense, adding the comment that this will bring down the average cost of hardware and may indeed be the only way in which the national enterprise can be viable, to the benefit of industry and commerce. The manufacturers and/or importers bring pressure to bear on Ministries of Education to prescribe the models they sell. Once the machines are in the schools, they expect the Vocational Rationale to prevail and have little interest in the others. They have 'made their market' once, and may be able to make it again if the country does indeed build up a workforce of programmers. This rationale is market-driven, without doubt, under the guise of serving national interest. It often hides behind one of the four rationales I have already discussed.

The Cost-effectiveness Rationale commands little support, even in the World Bank, but its proponents (such as Carnoy, Daley and Loop, 1987), argue that computer hardware and software can substantially replace teachers, and be more cost-effective. Perhaps hey draw their evidence from industrial and commercial training, where computers have in fact proved to be cost-effective in certain settings (Hawkridge, Newton and Hall, 1988). As yet, you would have to go a very long way to find a private primary or secondary school based mainly on teaching through computers, and it would be operating at a loss. The rationale is faulty because it does not take into account the socialising and other humanistic roles of schools, which parents will not sacrifice, rightly, I feel.

The Special Needs Rationale asserts that children with special needs, including those with moderate or severe learning difficulties, and those who are sensorily or physically disabled, benefit greatly from using computers, which can motivate slow learners and compensate for disabilities (Hawkridge, Vincent and Hales, 1985). Here the rationale is sound, but there is no general panacea: instead, extremely patient assessment of each child's needs is essential before computer-based solutions are offered. The cost of assessment and of the technology is high.

Rationales in developing and industrial countries

So which rationale or rationales does each country choose? And do developing countries choose different ones from industrial countries? It seems clear that national strategy on putting computers into schools depends to a large extent on the dominant rationale. The Social Rationale does not lead to the same strategy as the Vocational one. For example, if a government wants to teach computer awareness in secondary schools, it may try to introduce rather low-cost microcomputers into a large number of schools. It will expect every school to have several teachers who, between them, can teach all children for 2-3 hours a week in, say, the second year. But if a government strongly influenced by the Vocational rationale wants to introduce computer studies, possibly as an examination subject near the end of secondary schooling, medium-priced microcomputers will be needed, teachers will have to be much better trained, and probably only selected classes of children will be able to take the course. In fact, the government will probably decide to limit hardware and software provision to a minority of secondary schools in the country, on the grounds of shortage of resources and only a small national requirement for school graduates with computer studies.

Governments influenced by the Pedagogic and Catalytic Rationales must face a far larger bill for hardware and software. Consider the CAL software side for a moment. The cost of developing and marketing suitable CAL software is very high, as we know to our cost in the UK. Indeed, it is so high that very few countries have tried on a large scale. The rest are importing software or doing without it. Those importing it are usually unhappy with what they get, for pedagogical as well as cultural reasons. Those doing without it are escaping from these two rationales: they are giving up hope and may indeed be very sceptical of trials elsewhere. Doubtless they have not sent representatives to CAL89.

I will not dwell here on the question of whether developing countries need computers in their schools. That is for them to decide, and many are saying Yes, they do, and are stating their rationales. Though these countries advance similar rationales to those given by industrial ones, most of them place greatest emphasis on the Vocational Rationale, and much less on the Social, Pedagogic and Catalytic ones. For example, China, which committed about £50 million in 1984 to support its policy on computers in schools, definitely selects children to study computers, and expects them to proceed to computer science or to be useful to their employers, because it perceives computers as an essential part of its drive towards modernisation. India at first signalled its determination to give selected children a chance to enter this field of computer technology, but educationists there called for a less elitist project, based on the Social Rationale and to some extent on the Pedagogic Rationale. There were even some who sought to bring the Catalytic Rationale to bear, to change Indian schools. Lately, however, the Vocational Rationale appears dominant, with the Ministry of Electronics playing a major role.

Pakistan, working on a much smaller scale than India, has a pilot project aided by an international bank. The rationale adopted so far is clearly Vocational. Six South-East Asian countries have planned for a computer literacy course for all secondary children, with elective computer studies courses for senior classes, but hardly any CAL to serve the Pedagogic Rationale and no mention at all of the Catalytic one. Of the six, some have resources to implement the plan in full, others not. Singapore decided some years ago that software development, in particular, would be an important part of its economic future. The Ministry of Education requires every secondary school student to take a 20-hour computer familiarisation course, and subsidises computer clubs in many of the schools. Mauritius and Sri Lanka are taking a similar Social and Vocational line, with undertones of the Information Technology Industry Rationale. Could these islands, with their well-educated peoples, become data-entry and software sweatshops for Asia and Africa?

Two other island nations, Fiji and Trinidad, found that their desire to follow the Pedagogic Rationale was frustrated because British origins of their curricula clashed with US origins of the software, bought to run on US machines. In Kenya, not run by the Ministry, there has been a well-founded, but not entirely successful, attempt to follow the Pedagogic and Catalytic rationales as well as the Social and Vocational. There, the market for computer-related skills is still small and can be met by children from only a few secondary schools.

Is there evidence of changing priorities?

There is no time to speak of Bahrain and Botswana, Jamaica and Jordan, Egypt, Lesotho, Nigeria or Tunisia. And I do not know what is happening in the Latin American countries. But is there evidence of changing priorities in any countries, industrial or developing? Are governments shifting their ground as they try to justify putting computers into schools?

Our recent study certainly indicates that Ministries of Education without a policy on computers in schools are waking up to the fact that they need one, based on a clear rationale. The trouble is, the computers arrive anyway, whether through donations or by purchase out of non-government funds. There is indeed great pressure from manufacturers and their agents. This sort of pressure can be very damaging in developing countries. Without a policy computers, some of them obsolete, arrive in uncoordinated fashion. Teachers are not trained. Software is scarce. Hardware is incompatible. Spares, repairs and maintenance hardly exist. Expensive private schools probably survive best, with a network of foreign contacts, quickly widening the gap between their children and the rest. Ministries without a policy will probably formulate one soon, but does that mean priorities are changing? Not necessarily, because for them computers may have to remain a low priority, due to lack of resources.

Ministries of Education with a policy, backed by a rationale or rationales, may still lack the money to do all they want to, of course, and they may be unable to give computers high priority. But at least they are able to take important decisions, within the policy. For example, should they allow their schools to accept donations of hardware, particularly of obsolete hardware? Should they require schools to have at least one properly trained teacher before obtaining a computer? Should they set up a centre for support services and possibly to develop educational software? What degree of dependence on other countries can they tolerate? Ministries with a policy can also determine, at the right time, whether computers should receive higher priority.

Ministries of Education with a policy that has been tested for some years are changing their priorities. Even in the United States, where legislatures in states such as California have been persuaded to put very large sums into computers for schools, there is pause for reflection. Here in the United Kingdom, we have a three-year study of the impact of computers on schools, accompanied yet again by short-term programmes for hardware, software and support. At the same time, subject working parties for the National Curriculum Council are being pushed to embed computer-assisted learning in all the core subjects. Nobody knows what the final outcome will be for British schools. Probably the dark realities of costs will slowly be recognised, and with the dawning recognition priorities may shift again.

The Social and Vocational Rationales are gathering strength in developing countries, and the Pedagogic Rationale in richer industrial ones. The Catalytic Rationale, noble as it is, is there in the background to give us hope. The rationale finally chosen and implemented by each country will be the affordable one.

Summary

Let me summarise. I have advanced what I consider to be the four popular rationales for using computers in schools, and I have touched on three others that are possibly being neglected. I have offered you some criticisms of each. I have shown that these rationales are not influencing developing and industrial countries in the same way. Indeed, there are interesting differences and some evidence that priorities are changing as the true costs are calculated. Whatever our own personal rationales may be for using computers in schools, I believe we can look forward to an absorbing and intellectually exciting period as countries shake out the wrinkles and decide exactly what they want to do, why and whether they can afford it.

Acknowledgements

My thanks to Harry McMahon for very helpful comments on a draft of this paper.

References

Carnoy, Martin, Daley, Hugh and Loop, Liza (1987). Education and computers: vision and reality. Paris: Division of Educational Sciences, Contents and Methods of Education, Unesco.

Commonwealth Secretariat (1986). Microcomputers in schools. Report and papers of a meeting of Commonwealth specialists, Edmonton, Alberta, 15-17 May.

Hawkridge, David, Jaworski, John and McMahon, Harry (in press). *Computers in Third World Schools*. London: Macmillans.

Hawkridge, David, Newton, Wendy and Hall, Carole (1988). *Computers in company training*. London and New York: Croom Helm and Methuen.

Hawkridge, David, Vincent, Tom and Hales, Gerald (1985). *New information technology in the education of disabled children and adults*. London and San Diego: Croom Helm and College Hill Press.

Biography

David Hawkridge is Professor of Applied Educational Sciences and was Director of the Institute of Educational Technology at the Open University 1970-88. Within the Institute he is a member of the Centre for Information Technology in Education, which carries out much research and development in CAL and AI. His own research 1980-87 focussed on evaluation of the use of computers in the US and UK a) in schools, b) by disabled children and adults, and c) for company training. For his 1988 study, reported on here, his co-authors are John Jaworski of the BBC and Harry McMahon of the University of Ulster. John Radcliffe of the BBC, formerly in charge of the British Computer Literacy Project, participated in early stages of the work.

CENTRE FOR INFORMATION TECHNLOGY IN EDUCATION

List of CITE Reports

These reports may be obtained from:

Hansa Solanki, Institute of Educational Technology, The Open University, Walton Hall, MILTON KEYNES, MK7 6AA, England.

Report No.	Title and Author
1	A.T. Vincent, (1985) Computing and the Blind.
2	A. Jones, G. Kirkup, J. Morrison (1985) A Trial of Home Based Computer Terminals.
3	Gill Kirkup, (1985) The Present and Potential Use of Ceefax in the Open University.
4	Mark Elsom-Cook, (1986) Artificial Intelligence and Computer Assisted Instruction.
5	Mark Elsom-Cook, (1986) A Pascal program checker.
6	Simon Holland, (1986) How computers are used in the teaching of music and speculations about how Artificial Intelligence could be applied to radically improve the learning of composition skills.
7	Simon Holland, (1986) Design consideration for a human-computer interface using 12-tone three-dimensional harmony space to aid novices to learn aspects of harmony and composition.
8	Alison Petrie-Brown, (1987) The Influence of Context and Coherence as a Foundation for Dialogue Research.
9	Eileen Scanlon, Randall B. Smith (1987) A Rational Reconstruction of a Bubble Chamber Simulation Using The Alternate Reality Kit.
10	Mark Elsom-Cook, (1987) Intelligent Computer-Aided Instruction research at the Open University.
11	Mark Elsom-Cook, (1987) Towards a framework for human-computer discourse.
12	Mark Elsom-Cook, (1987) MATILDA AND IMPART: Lisp tools.
13	Mark Elsom-Cook, (1987) Guided discovery tutoring and bounded user modelling in Intelligent Computer Aided Instruction ed. J. Self, Chapman-Hall 1987.
14	A.M. Petrie-Brown and M.T. Elsom-Cook, (1987) An Examination of an AI model of indirect speech acts.
15	A. Edwards, (1987) Integrating Synthetic Speech With Other Auditory Cues In Graphical Computer Programs For Blind Users.
16	S. Holland, (June 1987) A knowledge-based tutor for music composition.
17	S. Holland, (June 1987) New Cognitive Theories of Harmony Applied To Direct Manipulation Tools for Novices.

18 M. Baker. (July 1987) Intelligent Computer-Aided Instruction and Musical Performance Skills.

19 M. Baker, (August 1987) Proposed Research Directions for Intelligent Computer-aided Instruction in Musical Performance Skills.

20 A D N Edwards, (August 1987), Adapting interfaces for visually disabled users.

21 M Elsom-Cook, (September 1987), Acquisition of computing skills.

22 M. Baker, (September 1987), Computational Analysis of musical grouping structures.

23 M Baker, (June 1987), Automated Analysis of Musical Grouping Structures as a Basis for a Guided Discovery Environment for Interpretation of Music.

24 D Laurillard, (October 1987), The different forms of learning in psychology and education.

25 A.D.N. Edwards, (November 1987) Modelling blind users" interactions with auditory computer interface.

26 P. Fung, (November 1987) Novice Prolog Programmers.

27 P. Fung, B. DuBoulay & M. Elsom-Cook, (November 1987), An initial taxonomy of novices' misconceptions of the Prolog interpreter.

28 G. Kirkup, (November 1987), Considering the effect on women students of an increased use of microcomputers in distance education.

29 Sara Hennessy, Rick Evertsz, Dave Ellis, Phil Black, Tim O'Shea, Ann Floyd, Design Specification for 'Shopping on Mars' a computer-based Educational Activity.

30 A D N Edwards, The Use of home computers by disabled students at the Open University. Part 1: Previous use of computers in courses

31 Michael E. Fox (March 1988) A Report on Studies of Motivation, Teaching and Small Group Interaction with special reference to Computers and to the Teaching and Learning of Arithmetic.

32 Michael E. Fox (March 1988) Theory and Design for a Visual Calculator for Arithmetic.

33 M. Baker (February 1988) A Cognitive Model for Perception of Musical Grouping Structures

34 M. Baker (February 1988) An Artifical Intelligence Approach to Musical Grouping Analysis

35 P. Fung (December 1987) Novices' predictions of Prolog's control flow: A report on an empirical study

36 M. Elsom-Cook and F. Spensley (April 1988) Knowledge representation in a tutoring system for procedural skills.

37 F. Spensley & M. Elsom-Cook (April 1988) Dominie: Teaching and Assessment Strategies.

38 M. Baker (May 1988) Tutoring with Incomplete and Uncertain Knowledge

39 R. Moyse (May 1988) Multiple Viewpoints for Intelligent Tutoring Systems.

40 P. Whalley (May 1988) Hyper Technic - a graphic object-oriented control environment.

41 P. Whalley (June 1988) Cued recall as a Measure of argument integration.

42 L. Alpay (June 1988) A Survey and Examination of Intelligent Tutoring Systems in Medicine

43 M. Elsom-Cook (July 1988) Introduction to the ECAL system.

44 F. Spensley (July 1988) Dominie: Trainer Interface.

45 M. Baker (July 1988) An Architecture of an Inteiligent Tutoring System for Musical Structure and Interpretation.

46 E.Scanlon and R.Sibbitt (April 1988) Proceedings of CAL Conference 88.

47 L. Alpay (September 1988) Medical Problem-Solving and Intelligent Tutoring Systems: Proposed Research Directions.

48 S.A Cerri, M.T. Elsom-Cook, M. Leoncini (September 1988) TRILL: The Rather Intelligent Little Lisper.

49 R. Evertsz, S. Hennessy & R. Devi (September 1988) GADL: a Graphical Interface for Mental Arithmetic Algorithms.

50 P. Fung, (October 1988) A formalisation of novices' errors in Prolog programs.

51 M. Baker, (October 1988) Arguing with the tutor: a model for tutorial dialogue in uncertain knowledge domains.

52 (October 1988) Information Technology in Education: Conceptual change in Science.

53 T. O'Shea, C. O'Malley & E. Scanlon (October 1988) Magnets, Martians and Microworlds: Learning with and Learning by OOPS.

54 (November 1988) Directory of Research 1988.

55 P. Fung (November 1988) Automated Diagnosis of Prolog control flow errors: a first evaluation.

56 R. Mason (December 1988) The use of Computer-Mediated Communication for Distance Education at the Open University, 1988.

57 A.D.N. Edwards & P. Grove (December 1988) A User's Guide to the Voice Screen Reader.

58 R. Sibbitt (December 1988) How Children Spell Nonsense Words.

59 Directory of Research 1988-1989.

60 R. Joiner (February 1989) Mechanisms of Cognitive Change in Peer Interaction: A Critical Review.

61 R. Devi (February 1989) Machine Learning and Tutoring System.

62 M. Elsom-Cook (February 1989) Dialogue and teaching styles.

63 R. Moyse (March 1989) Knowledge Negotiation Implies Multiple Viewpoints.

64 D. Laurillard (March 1989) University of Hong Kong Medical Education Symposium. December 1-3 1988. Understanding Medical Students' Problem-Solving.

65 A. Kirkwood and G. Kirkup (March 1989). Computing on DT200, M205 & M371 - Report of the Initial Survey of Spring 1988.

66 R. Evertsz (April 1989) Two papers on the Abstract Interpretation of Production Systems.

67 M. Elsom-Cook and C. O'Malley (April 1989) ECAL: Bridging the gap between CAL and ITS[1].

68 D. Laurillard (May 1989) CAL and Numeracy.

69 G. Kirkup and E. Dale (May 1989) Home Computing Evaluation Report. M205 End of Year Report 1988.

70 A. Jones (May 1989) Home Computing Evaluation Project. M371 End of Year Report 1988.

71 A. Blandford (May 1989) Engineering Design Education and Intelligent Tutoring Systems.

72 D Hawkridge (May 1989) Towards 2000: Informatics in Education.

73 D. Hawkridge (May 1989) Who Needs Computers in Schools, and Why?