DOCUMENT RESUME

ED 321 744 IR 014 511

AUTHOR Rhodes, Valerie
TITLE Barriers to Innovation--A Seminar Report. Occasional Paper InTER/11/89.
INSTITUTION Economic and Social Research Council, Lancaster (England).; Lancaster Univ. (England). Dept. of Psychology.
PUB DATE Jul 89
NOTE 28p.; A product of the Information Technology in Education Research Programme.
AVAILABLE FROM ESRC InTER Programme, Department of Psychology, University of Lancaster, Lancaster LA1 4YF, United Kingdom (free).
PUB TYPE Reports - Descriptive (141) -- Reports - Research/Technical (143) -- Collected Works - Conference Proceedings (021)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Adoption (Ideas); *Computer Assisted Instruction; Curriculum Development; *Educational Innovation; Elementary Education; Foreign Countries; *Information Technology; Inservice Teacher Education; Models; Research Needs; Seminars
IDENTIFIERS *Barriers to Innovation; Great Britain

ABSTRACT

This report is based on discussions and papers circulated at a seminar on barriers to innovation in primary schools. Issues that relate to computers and the teacher are discussed in the first section, including ownership of the technology and models and strategies for inservice teacher education. Focusing on issues pertaining to computers and the school, the second section discusses organizational barriers to the implementation of information technology, the relationship between the curriculum and technology, and the school as a social system. The relationship between computers and society is covered in the third section. Research needs described in the fourth section include: (1) the role of computers in education; (2) social aspects of computer use; (3) teacher development; and (4) developments in software authoring environments. The concluding section looks at the future development of computer use. Appended materials include the text of a paper, "On Defining a Computer Environment for Innovation--A Case Study in Open Plan Computing" (Charles Crook); a project report, "The PALM Action Research Project" (Bridget Somekh); a list of published papers distributed before the seminar; and a list of participants. (24 references) (MES)

arriers to Innovation
a seminar report

Occasional Paper: InTER/11/89
July 1989

Edited by:
VALERIE RHODES
CENTRE FOR EDUCATIONAL STUDIES
KING'S COLLEGE LONDON

INFORMATION TECHNOLOGY IN EDUCATION RESEARCH PROGRAMME
DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF LANCASTER, LA1 4YF

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 point for 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.

Barriers to Innovation

– a seminar report

PREFACE

"The Uptake and Usage of Microcomputers in Primary Schools" is a project based at King's College London. At a meeting of the project's Consultative Committee early in 1989, it was suggested that a seminar should be held which brought together researchers and practitioners with a particular interest in innovation in primary education.

This Occasional Paper is based on the papers circulated prior to that seminar and on the discussion during the seminar itself. Whilst the focus of the debate was barriers to innovation in primary schools, only a small number of the many issues could be discussed fully. This paper should not therefore be regarded as an exhaustive summary; rather, it reflects some of the views of educationalists who were drawn from one of two traditions, educational technology and sociology of education.

Since the seminar, an HMI paper, Information Technology from 5 to 16, has been published (DES, 1989). This Occasional Paper may serve to reinforce many of the key issues contained in that publication. HMI touch upon the needs for those who can implement change to 'own' the innovation. They also stress the mutually supportive requirements of teacher education and school policy and management. It is hoped that some of the perspectives presented here, supported by research findings, will inform the strategic decisions which support the innovations.

The InTER Programme is grateful to those who attended the seminar and also to those (Margaret Cox, Valerie Rhodes, Charles Crook, Les Watson, Bridget Somekh, Harry Kahn, Joan Solomon) who submitted discussion papers or commented on earlier drafts of this paper. In particular I would like to thank Valerie Rhodes for composing this account of, often, conflicting yet stimulating discussion.

Professor R Lewis
ESRC – InTER Programme
University of Lancaster
June 1989

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1. INTRODUCTION

The introduction of microcomputers into British primary schools is one of the latest examples of an educational innovation. Some previous innovations have been adopted successfully, others have failed to be maintained over time. The barriers to, and problems of, implementing educational innovation in general have been well reported in the literature. Many of these, such as lack of time, the need for training and for an adequate supply of materials also relate to the introduction of information technology (IT) into schools. However it was argued by some of the participants at the seminar, that some of the barriers to the uptake and use of computers are different to the general barriers, because computers are a 'unique' innovation. The challenge is to understand better the nature of this uniqueness.

It was acknowledged that in asking teachers to use computers in their teaching they were being asked to undertake a considerable amount of new learning, not only in respect of accepting a new technology, but also with regard to changing current practice. If the potential which computers offer to education is to be exploited fully, new teaching styles have to be adopted to support new modes of learning. Consequently, the traditional role of teachers in the classroom, is being questioned. In view of the enormity of the task, some teachers may choose not to address these issues directly. Research into the use of microcomputers in primary schools (Bleach, 1986; Jackson, et al., 1986 and 1988) has shown that some teachers favour drill and practice software which supports rather than changes classroom teaching. However, this practice with early software is changing and, in primary schools in particular, software which can be used to support groupwork is becoming more common. A number of computer based materials development teams have built upon methodologies which were seen as 'accepted', for example, science simulations based upon the methodologies of discovery learning used by Nuffield Science.

The seminar discussions centred on three main themes. Firstly, issues which relate to computers and the teacher. Secondly, those which pertain to the school as a social system. Finally, the relationship between computers and society in general. As a result of these discussions a number of topics considered worthy of further research were highlighted.

2. COMPUTERS AND THE TEACHER

Teachers are likely to be less resistant to changes to which they have a favourable attitude and in which they have received adequate training. A thought-provoking comment was made during the seminar in which educational innovation was compared with the commercial marketting of a new product. How rapidly can we expect an educational innovation to be adopted when the marketting is so poor or non-existant? The question of developing teachers' sense of 'ownership' of the technology and ways of developing successful INSET strategies to facilitate computer use, emerged as the two major themes in relation to computers and teachers.

2.1 "Ownership" of the Technology

It was suggested that in the 1970's in the United Kingdom, when the development of educational computing was in its early stages, teachers were actively involved in developments and were therefore able to evolve a sense of 'ownership' of the technology. However, as a result of Government initiatives, computers were then

diffused rapidly through the education system. One result of the way computers have been introduced into our schools, is that many teachers feel that the technology has been imposed upon them from outside. Consequently the majority of teachers have not had the opportunity to identify with technology, or to develop any personal sense of meaning in relation to computers. However as Fullan has pointed out, if an innovation is to result in change it is imperative that individuals work out their own sense of meaning as "effective implementation is a process of clarification" (Fullan, 1982).

Without a clear understanding of the innovation, it is not surprising that many teachers feel 'marginalised' from the technology and can see nothing worthwhile in its use. As a result many computers acquired initially were stored away in cupboards. If the use of computers is to be implemented successfully and their use in schools is to be sustained, teachers have to work out and develop their own sense of meaning in relation to the technology. They have to "own" the some processes that the children they are teaching are experiencing.

Research into the work of advisory teachers in one LEA has shown that trying to impose change upon teachers, for example by an advisory teacher giving a 'model' lesson, is not an effective change strategy. One reason for this failure is that the two participants (teacher and adviser) do not share the same meaning nor do they have the same relationship to the processes as the children in the classroom. The process of establishing 'ownership' is not easy.

In a school setting the successful development of computer use throughout the school is dependent upon all teachers experiencing a sense of meaning in relation to computers. In a paper submitted for consideration at the seminar, Charles Crook (University of Durham) described a small scale action research project carried out in a primary school to illustrate one way in which this can be achieved. In this case, a network of twelve computers had been established throughout the school.

> "To maintain the daily running of a network certain management chores are necessary (initialising servers, taking backups, locating stations etc). We have distributed this responsibility among the staff according to a rota. Of course, this serves to ensure efficient system operation but it also creates a vehicle for everyone to develop an increased familiarity and confidence with the underlying technology."

Another feature of the network is a flexible user interface which has been developed to allow teachers to select and construct their own menu options. The system also facilitates and encourages participation between individual pupils in the school.

> "Simply being more aware of the breadth of activity within the school increases the possibility of effective coordination. For the staff, the shared responsibility for maintaining the smooth running of the network – as well as the need to configure a particular environment of options within their own classes – serves to promote a common familiarity with the underlying technology".

The way in which this establishment of the networked system of computers in this school, has overcome some of the organisation barriers to innovation is discussed further in Appendix A.

2.2 *INSET*

That there was a need for appropriate in-service teacher education was acknowledged by all participants. An ESRC Seminar in 1987 had this specific theme (Gardner and Megarity, 1987). Two models of INSET were distinguished at this seminar, each of which was based on a different view of the teacher as learner.

2.2.1 *Models of INSET*

The Deficit Model

In courses based on the deficit model of the teacher, the teacher's fear of the innovation is regarded as the primary barrier to be overcome. In IT courses which adopt this model, the emphasis is on giving teachers confidence in using the hardware and the software. In such technology-led courses the technology is central whilst the educational issues assume a secondary role.

In a recent study into INSET provision (Cox and Rhodes, 1988), over one fifth of the total time on the Teacher's Centre short courses was spent instructing teachers how to operate the hardware and the software, and more than two-thirds of the time giving the teachers the opportunity to experiment with the software. References to the educational goals of the software were minimal. At the end of these courses many teachers said they were unable to implement computer use in the classroom and several teachers said that they needed more training and time to practice their newly acquired skills.

Participants at the seminar contended that, one major problem with this type of course is that it 'deskills' the teacher by reducing them to the position of a novice. Another difficulty is that the training is seen as a self-contained activity which is physically distinct and separate from what is happening in the classroom. On returning to school teachers find that they have no time to reflect upon what they have learned and no time to consider what they need to do to implement the new ideas.

The Skills Model

Participants suggested that in contrast to the above, INSET courses based on a skills model acknowledge the teachers as experts who possesses the knowledge and skills of their profession. Therefore they, rather than the technology, are central to the course. In this model the barrier to innovation is recognised as being a psychological barrier. In this type of course the emphasis is on encouraging teachers who are the expert practitioners, to use the technology in the classroom and then return in order to discuss the educational outcomes. [For an account of such a course, see a preliminary report by Hoyles et al. (1989)]. In such courses the "how to use" eminates from the teacher not the tutor. It was accepted that using this model, in which teachers are evaluators of the innovation, the central question is not "What can you do for IT?" but "What can IT do for you?". INSET which adopts this model needs to be longer than the six to twelve hours over four to eight weeks typical of many Teachers' Centre short courses. However, Somekh (1988) gives an account a such courses being successful.

2.2.2 *Strategies of INSET*

How to provide all teachers with adequate training in the use of the technology is a major problem. Under the "Micros in Schools" scheme, only two teachers from each participating school were required to attend a two-day training course. The follow-up action of the Microelectronics in Education Programme (MEP) adopted a cascade approach which was a strategy discredited twenty-five years ago. This approach trains a relatively small number of teachers with the intention that they will act as trainees for other teachers in their schools. However, experience has shown this does not happen in practice, not least because there is no allocation of time in school.

Consequently, it has been necessary for LEA's to provide appropriate INSET courses to meet the needs of the substantial number of teachers who have had no opportunity to gain any IT experience. Two types of in-service training were distinguished by participants at the seminar:

a) Out-of-school courses;

b) school-based INSET programmes.

a) Out-of-school courses

Some research findings relating to out-of-school courses were described during the seminar by Cox and Rhodes. As mentioned above, short courses (typically 6-12 hrs over 4-8 wks) are often based on the 'deficit model' and the needs of primary teachers were not met. Teachers were introduced to a range of open-ended software which could be used across the curriculum. The choice of this type of software meant that teachers spent the majority of the course time learning how to operate the programs. Overall less than 5% of the time was spent discussing educational issues. Many teachers believed that this type of course was of little practical value, although it did give them personal confidence in using technology.

In contrast, long courses of 150 hours (one afternoon and evening per week over one school year), were able to provide a balance between instruction, use and discussion about the educational uses of computers. One of the advantages of the long courses identified, was that it gave teachers the opportunity to practice and develop classroom skills that they were introduced to on the course. However, this kind of more intensive training is available to a minority of teachers only. Less than 2% of primary teachers in the LEA studied, attended such a course in the year that the research data was collected.

b) School-based training

School-based INSET was viewed as one of three types, either training provided by an outside advisory teacher or personal development in which the teacher acts as a researcher, or as a curriculum developer.

b1) School-based advisory teachers

Under the Educational Support Grant (ESG), advisory teachers for IT have been employed specifically to work alongside teachers in school. A three-year Training Agency project in Cumbria and Lancashire has been set up to examine the role these advisory teachers adopt in schools. (For an outline of the project see InTER/8/89, p32). It is hoped to learn about successful strategies employed by advisory teachers working in schools and to develop a series of packs of material

which will be used in training the next generation of such teachers. Experience of the role is being drawn from ESG teachers in other disciplines (see various internal reports, e.g. Shin, 1986 & 1987; Yates, 1988).

b2) Action research

The idea that change is an incremental process which takes time, (a factor which is not considered in the short technology-led courses), underpins the action research method. Using this model teachers acting as researchers initiate and control their own process of development*.

The PALM project which involves 24 schools in Essex, Cambridgeshire and Norfolk, sets out to overcome barriers to innovation by involving teachers in action research. A summary of the barriers identified by the project, prepared by Bridget Somekh, was presented in one of the seminar papers (an extensive extract appears as Appendix B). These include personal barriers concerned with self image, taking risks, feeling inadequate, recognising appropriate classroom uses and the lack of technical expertise. There are also institution led barriers such as the provision of computers for teachers' personal use, insufficient access to hardware generally and lack of time. Using an action research strategy, in which "the establishment of action research teams in schools" is emphasised, the project aims to overcome many of the barriers to IT identified above.

One participant felt that a major difficulty with the action research approach was its limited impact, suggesting that, whilst it may result in some positive developments in the use of computers for a teacher at a personal level, the results cannot be generalised easily to other teachers. This is, however, a major problem with many INSET strategies. An interesting approach to explore would be the combination of action research with a strategy of whole school development led by senior staff (see Somekh, 1989).

b3) Teachers as developers

Supporting teachers in their development of IT curriculum materials was seen as another positive approach to INSET. This may be incorporated into the design of long INSET courses (see, for example, Lewis, 1983) or, as discussed at the seminar, by in-school activity.

Working with one class of seven and eight year old children in a Gloucestershire school, Watson described a project which is "attempt(ing) to integrate the new technology into the curriculum of the class (and to) improve the quality of children's learning". To achieve this, use is being made of authoring software which allows the user to write a computer program to meet their specific needs (Watson, 1988). Using this software it is possible to produce courseware which is driven by the curriculum rather than vice versa. Working with the teacher, Watson has produced materials to "support and enhance" the topic work in which the class are engaged each term (Watson, 1989). The work is curriculum driven and follows the topic work of the class which in turn tends to follow the BBC TV schools programme Zig-Zag. This project is to be extended to involve ten teachers in five schools. It is intended that: "This In-service project will encourage the

* This model was used by an ESRC/DES initiative during 1986/87 and is reported in ITE Occasional Papers (Lewis, 1986 and 1987). Unfortunately, this pilot programme ceased when direct funding for courses by the DES was stopped in 1987.

production and development of teaching ideas for the integration of authoring programs into the normal primary school curriculum. The outcome of the work will be a range of resources, produced by participating schools, which will allow the computer to be used at the centre of the learning process, particularly in topic and project work".

Some seminar participants supported this approach, which encouraged good teachers to design computer programs which were relevant to their particular curriculum needs. However, it was pointed out that software developers had been working towards this objective since the 1960's and few teachers have the time, knowledge or inclination to become software authors. Software development needs to be undertaken by a team consisting of teachers, programmers, graphic artists, etc. In this team teachers should define the educational goals and ensure that these goa s are met by the final product. In any event, the software produced must have a user-interface which allows consistency of interaction by pupils and teachers.

Participants agreed that there were no short cuts to implanting innovation. The most effective way to disseminate good practice was to ensure that all teachers were exposed to appropriate learning experiences. Evidence from research on curriculum development projects, for example, Nuffield Junior Science (Wastnedge, 1972), indicates that without the relevant experience and training, teachers are not able to make the best use of new curriculum materials.

3. COMPUTERS AND THE SCHOOL

Whilst some of the barriers to the uptake of computers operate at the level of the individual teacher, others are related to the school as a social system. Among the issues to emerge during the seminar were those associated with the level of resource, questions relating to computers and the curriculum and finally the impact of whole school policies on the development of computer use.

3.1 Organisational Barriers

One of the barriers to the implementation of IT can be organisational. Whilst the ratio of pupils per computer has improved considerably from 107 to 1 in 1985 to 69 to 1 in 1989 (Wellington and Macdonald, 1989), the figure is still relatively high. As a result access to the resource is still restricted for many teachers and children.

In a recent study into the use of computers in primary schools (Cox and Rhodes, op cit), the uptake of computers was found to be greatest in schools where computers were timetabled for use throughout the school. However, the choice and use made of software, especially by teachers of the younger (infant and lower junior) children, was constrained by the timetabling arrangements. Many teachers preferred to use short, easy-to-operate programs that needed little teacher intervention and that all the children could use in one day. However, there are some indications that there is an increasingly common pattern of computers being timetabled for use by a class for half a term or more.

In his paper submitted for discussion at the seminar, Crook concludes, that one of the barriers to information technology in the primary school results from its "isolated status" within the classroom which may encourage a "fragmented approach

to developing computer-based work. He also suggests that a problem may arise because, too often, the computer use is not part of the mainstream activity within the classroom.

However, as Heywood and Norman (1988) point out, the lack of organisational support for innovation with computers is not unique. In the past many educational innovations have failed to be implemented because there has been no strategy of change or because there have been inadequate support structures.

3.2 Learning with Computers

Discussion at the seminar focused on two contrasting perspectives of IT in education, the one held by sociologists, the other by those primarily concerned with the promotion of computers in education.

One fundamental area of conflict suggested by a participant, was that developers of computer assisted learning based their work on a rational, organisational, logical and systematic view of the world which assumes that children learn in rational, logical and systematic ways. Sociologists, however, would reject this model as being too simplistic. Evidence from educational research has shown that children learn in complex ways.

Therefore, sociologists ask why should children use computers, and question whether or not children do learn in ways which are beneficial when using the technology. Some of the educational software produced to date, takes no account of what is known about the latest learning theories and is at odds with current educational thinking.

Those participants with a special interest in information technology would argue however, that computers are a 'unique' innovation. Computer-related technology differs fundamentally from other technological innovations, such as educational television, because it is an interactive medium. The latest educational software, rather than inhibiting learning, actively encourages certain types of behaviour in children (such as creativity and role playing), which are valued in education today. Computers create a potential environment for learning that it would be impossible to achieve with other more traditional learning media.

With respect to children's learning and computers, the seminar discussion focused on the relationship between the curriculum and technology. This was seen to have three aspects: the hidden curriculum; the existing curriculum and the product-led curriculum.

a) the hidden curriculum

If there is a hidden curriculum of learning associated with the use of computers in education,

What is it?

Who decides the content?

What are the implications?

According to one participant, the introduction of computers into schools is principally a way of ensuring that the future labour force is equipped with the skills needed by modern industry and commerce. The fact that two major

initiatives (Micros in Secondary/Primary schools schemes) were founded by the Department of Trade and Industry (DTI) rather than the Department of Education and Science (DES) could be cited as evidence to substantiate this view. Concern was expressed that the reasons for using computers in schools was led by market forces rather than for a desire to meet curriculum needs.

b) the existing curriculum

Those with a long term involvement in educational computing would point out that contrary to modern popular opinion the roots of educational technology were embedded in education and not in the technology. In the early 1970's innovators in this area were asking teachers the following questions in respect of their classroom practice:

> How do you teach this now?
>
> How would you like to teach this?
>
> Could your teaching in this area be improved by using a specific computer program?

Practising teachers not only defined the areas in which software was to be developed, they were also active participants in software development groups and consequently had an integral role in the process of software production.

c) the product–led curriculum

Some participants believed that the use of computers in schools has been led by the 'product' model of the technology, rather than on the 'use' model. For instance with the use of word processing in the educational context.

Research has shown many teachers are most concerned with obtaining a print–out of children's work and give little thought to the processes that children could be usefully engaged in whilst using a word processing package (Cox and Rhodes op cit). The findings of this project have shown that in many primary classrooms the reason why many teachers use a word processing program, is to give children the opportunity to type out a corrected handwritten copy of their work in order to produce a perfect printed copy. They are therefore using a word–processor simply because is exists and provides presentable work and not because they believe that it can contribute to the development of children's writing skills. Fortunately, this is not found to be a universally held attitude.

3.3 The School as a Social System

To imply that the barriers to computers as an innovation are purely organisational, would however be misleading. As with other educational innovations the problems related to implementation are multi–faceted. The question of leadership is of particular importance. Recent research into the uptake and use of computers in primary schools (Cox, Rhodes and Hall, 1988) has shown that the attitude of the headteacher to the technology is a crucial factor. In their study, the use of computers was found to be higher in schools where the headteacher had a positive attitude to computers, than in schools where the headteacher had a neutral or negative attitude. Related to the above was the devolving of overall responsibility for the resource to one teacher who undertook its organisation and management.

Computers were used more in schools where they were timetabled throughout the school, than in schools where the decision whether or not to use computers was left to individual teachers. This point is made in the HMI paper (DES, 1989) and the headteacher's role has been well documented for some time (Fullan, 1982).

Other important in-school factors related to the uptake of the technology include adequate support structures, the relationship that exists between teachers and the sharing of expertise. Another finding of the research in primary schools cited above, was that the development of computer use was more likely in schools where there was a sustained programme of school-based INSET and where computers were regarded as an integral part of the school's curriculum development policy. The antithesis to this situation is the 'one person' innovation, where the impact on other staff is minimal and consequently the innovatory practice collapses once the innovating teacher leaves.

An INSET strategy where the 'expert' teacher was released from class teaching duties for sustained periods, (two or three terms), in order to work with other teachers in classrooms was found to be unsuccessful in promoting computer use throughout the school. The use of the computer became the perogative of the 'visiting' teacher. Class teachers did not have the time to observe the computer-based activity and computer use in these classrooms usually ceased altogether when the support was withdrawn. This is precisely the concern of LEAs in their deployment of ESG Advisory Teachers and has been exacerbated by a reduction in the level of DES support.

4. COMPUTERS AND SOCIETY

A significant part of the seminar was spent discussing the relationship between computers and society. It was argued by some participants that computers cannot and should not be considered solely in the context of education. They are social phenomena which increasingly pervades the society in which we live and work. It is crucial therefore, that the role of computers in education is considered in a wider social context.

Some participants argued that information technology is fundamentally different from other innovations which have been introduced into our education system. As mentioned above the Government initiatives (DTI 'Micros in Schools Schemes' 1981-1984) which subsidised 'pound for pound' the purchase of the majority of schools' first computers, did not have an educational rationale. The principle motivating element, was to ensure that children in the schools of today, would enter the labour market with the skills necessary to ensure that Britain had the ability to enter and compete in the increasing technological industrial and commercial world. As Margaret Thatcher wrote when announcing the first scheme aimed at secondary schools;

> "Britain's greatest national asset has always been the inventive genius of our people. This is the asset which we must tap if we are to profit from advances in technology. In microelectronics and information technology, we must do everything to encourage and train people with the ability and skills needed to design systems, write software and develop businesses and products.

> We must start in our schools. The microcomputer is the basic tool of Information Technology. The sooner children become familiar with its enormous potential the better. At present only some schools have microcomputers. That is why the Department of Industry had introduced its 'Micros in Schools' scheme. This scheme, closely linked with the Education Departments' Microelectronics in Education Programme, is the first in a series of initiatives which the Government is taking to ensure that Britain stays with the leaders in the rapidly growing Information Technology market".
>
> (Department of Industry, 1981)

At the seminar, it was argued that computers cannot be regarded solely as a tool which is used in the classroom for educational purposes. The social, economic and political implications of their use must also be considered. Some of Michael Apple's (1986) ideas about computers being the 'electronic texts' are particularly worth considering in this context. He argues that content of the curriculum in the majority of schools is defined by the standardised textbooks and that computers are the latest example of such 'texts'. It is important to ask therefore who decides what is produced in these texts and what ideological and economic decisions underly them.

Whilst educators and parents may believe that the increasing use of computers will result in increased life chances for their children, will they? There is, Apple argues, a strong link between computers in schools and the need for a computer literate workforce. Given the rapid expansion of computers in schools, Apple considers the relevant political, economic and social issues. These include, the effects of computers on the future labour market and the possible effects on teaching in the curriculum.

According to Apple, increasing use of technology in industry and commerce will result in a 'deskilling' of the workforce, as traditional skills are devalued and as control of the workplace is taken over by management. This loss of control results in a reduction in earnings, as jobs become more mundane and may even disappear. An increase in the number of 'high-tech' jobs also increases the economic divide between a small number of specialists and the growing number of workers in other sectors of the industry. Overall, increasing automation results in a decrease in the total number of jobs available. Furthermore, as technology becomes more sophisticated the technical knowledge needed to operate these machines declines.

In education, therefore, the increasing use of computers needs to be considered in the context of the 'rationalisation of teaching and curricula in general'. As computers become accepted increasingly in schools, teachers like workers in other areas will become 'deskilled' as they lose control over the content of the curriculum. As Apple explains, "If it can be packaged to fit computerised instruction, it will be, even if this is inappropriate, less effective than methods that teachers have developed after years of practical hard work or less than sound educationally or economically". A large proportion of teachers have little training in computers or on their social effects. Consequently they have to rely on using pre-packaged sets of commercial materials and software. However, there is no guarantee that the software has any major educational value. A situation which is exacerbated by the fact that teachers do not have time to evaluate thoroughly much of what they use beforehand Apple argues that as educators, we have a duty to ensure that computers are in schools primarily to serve education and not

the needs of commerce and industry. As teachers, we need to ensure that the use of computers in society benefits all our pupils and not just a select few.

It was suggested therefore that one should ask:

> What software is available to schools?
>
> Who makes the decision about its content?
>
> On what model of the teacher and/or the lesson are these programs based?
>
> What values are associated with this software production?

Some participants considered that research into the place of information technology in schools should encompass this broader based dimension. For instance, computers need to be considered in relation to the use made of them in the home. Do particular social groups of children have access to computers at home? If so what is the result of this inequality in access in the context of education? Are boys more likely to have a home computer than girls? If so what are the educational implications?

Schools cannot, and must not, be looked at in isolation from the society of which they are a part.

5 FUTURE RESEARCH AGENDA

Having discussed some of the issues and in the light of what has been said, the participants went on to consider future research needs.

5.1 The Role of Computers in Education

"Does the computer play a unique role in the learning process?" was seen to be one of the major research questions. The 'added value' the appropriate use of computers can bring to the learning experience needs to be identified and articulated. Related to the above is the question, "Does the attitude and role of the teacher influence the outcomes?"

The proponents of the use of computers in education argue that the technology has the potential to make a significant impact on children's learning across the curriculum. If computers are good for certain types of learning activity such as problem solving, then questions relating to how or why this is so have to be addressed. If computers are capable of enhancing children's learning and of helping teachers to achieve things that they would be unable to achieve otherwise, then the rationale has to be articulated. Research into the impact of computers on children's learning is especially important, because the majority of teachers will not be persuaded to use computers in their teaching until they have been convinced of the educational advantages.

A three-year research project, financed by the DES, to evaluate the impact of information technology on children's learning had recently started at King's College London. Known as the IMPACT project, it aims to measure the effect of IT use on pupils' learning in both primary and secondary schools, focusing on four curriculum areas: science, mathematics, geography and English.

5.2 Social Aspects of Computer Use

It was suggested that the scope of research should be widened beyond the school to encompass the home, the community and the workplace. Much of the research in this area to date, has focused upon the lesson. The fact that children also spend a considerable amount of time in schools not being taught by teachers in the classroom has not been considered. Research needs to take more account of the social factors in operation. Therefore questions such as "How does the family influence what is happening in school?" should be addressed.

5.3 Teacher Development

More research is also needed into teacher-led development. Questions such as "How do the professional values of teachers and the way they perceive children's learning affect the use they make of computers in the classroom?", should be considered. There may be for instance, a correlation between teachers' views on education and their choice of software.

5.4 Developments in Software Authoring Environments

The final area of importance identified, was developments in generic software environments. Three key questions were defined in this area.

Is enough known about software authoring environments?

What are the characteristics of a system which would allow teachers to personalise and have ownership of the software?

What do these environments look like?

6. THE DEVELOPMENT OF COMPUTER USE – THE FUTURE

It was argued that teachers are a product of their own learning experience in which, for many, technology has had no part. The present difficulties many teachers encounter when using computer software may be a particularly 'time-based' phenomena. As adults they are having to become familiar with using a new technology, having to reflect on the effect this technology could have upon their current teaching practice, as well as on the learning experience of children. HMI (DES, 1989) suggest that "Teachers are increasingly making use if IT for their own professional purposes and for the organisation and planning of the curriculum, for school management and for pupil assessment. . . . As their confidence grows, teachers may increasingly offer useful models to pupils." Furthermore, they are having to assimilate new learning and thinking in respect of the technology and to balance these demands with the other demands being made on them in regard to the introduction of other educational innovations. In particular, one might consider what effect the new legal requirements of the National Curriculum will have on the development of computer use in our schools.

The situation in relation to information technology in education might be very different for the teachers of tomorrow, who are the primary pupils of today. They will have had time to experiment, to learn and to become familiar with using computers not only in school, but also in their homes.

Many of the barriers to the educational uses of computers identified in this paper focus on the technological rather than on the educational aspects of computer use. It may be that for tomorrow's "computer literate" generation of teachers, the change effort will focus on the more important aspect, that is on the educational applications of the technology in the curriculum.

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APPENDIX A. On Defining a Computer Environment for Innovation – a case study in open plan computing.

Charles Crook, Durham University

BACKGROUND

This paper outlines some progress that has arisen from two years of action-based research in one primary school (7 classes of children aged 5–11). Our aim has been to document the evolution of a computer environment that will support certain educational innovation. It must be stressed that our approach has not been to mobilise the most sophisticated technology – intending to show what could be achieved under ideal conditions (although there is obviously an important place for such state-of-the-art initiatives). rahter, we have triedto explore what can be achieved within the realistic limits of *available* technology and circumstances.

Typically, discussion of IT innovation in the primary sector takes to natural themes:

- the characterisation of adequate INSET experience and
- the elaboration of how particular items of software can extend curriculum activities

There are good examples of practice in relation to both of these themes. INSET courses for IT have proliferated and often (but not always) are judged to be stimulating experiences; and the professional literature is rich in case study examples of the innovative use of software. Yet, despite such exemplary models of practice, the overall pace of development seems slow. our own view is that something can be gained from atrtending to the *infrastructure* of computing within a school: such an orientation considers how we may best integrate computer-based activities and, thereby, it encourages a less piecemeal discussion of the innovation problem.

Our project has been to implement and develop such a computing environment in one school. A fairly non-directive and participatory stance has been adopted throughout in order that obstacles to effective implementation can be more readily recognised. However, the specifics of the computing environment could hardly evolve from a vacuum and certain specific goals have been promoted; in particular, the following (in decreasing order of current priority):

1. *To equip children with some fluency in the basics of IT*
   To some this might be termed "computer literacy". Emphasis is directed towards principles of text manipulation on electronic media and on file manipulation (owning, editing, transporting etc).

2. *To facilitate on-site INSET opportunities for staff*
   Two problems are recognised here:
   i) most teachers cannot spare the time that is needed to simply become aware of (and then familiar with) available software. We have tried to address this problem by easing the ritual of accessing an item of software on a classroom computer and by encouraging a system-based collection of staff commentary on such items.
   ii) Many teachers need more confidence in using the basic technology. We have tried to approach this by drawing staff towards using the computer for sensible purposes that meet their own needs, or the needs of the staff in general. For example, we have providede for the individual teacher an

accessible means of configuring what is to be currently available on their own class computer(s).

3. To facilitate more coordination of activity among children

Here there is an influence from certain themes in contemporary educational theory (for example, the recent work of Bruner, or ideas such as those represented in Edwards and Mercer's *Common Knowledge*). Various practical possibilities arise from this orientation but at its core is the aim of sustaining collaborative work within and between groups of children.

SOME INGREDIENTS

We regard a local area network of computers as a central ingredient in meeting these various purposes. Unfotunately, the traditional realisation of a school network is a dedicated computer room. To some extent, there are acceptable reasons for this strategy (intensive cabling may be physically awkward and there are technical problems as the cable run gets longer). However, the computer room vision of a network tends to inhibit, rather than promote, aims such as those mentioned above: the physical isolation of computers can serve to isolate the work they support; this bolt-on apporach may also make it easy for reluctant staff to sidestep participation.

Thus, we have spread our own network 9an Econet of 12 computers) throughout the school premises. But we must deal with another limited conception of what a school network offers. it may be seen as no more than a central file server that eases the ritual and paraphenalia associated with loading software. It certainly is that, but it does offer more; the real chalienge of a network is to exploit the "common space" implicit in the notion of a file server in order to develop new educational practice. (If the network is defined only as a means of centralising a software library then we can expect LEAs to remain cautious in making the necessary investment.) In our own case we havefocused on developing a number of distinctive features. The first is a general management strategy and thus refers to things people *do*. The remainder are things people *use* - software tools of various kinds - these will be briefly defined and a general commentary on their use then follows.

1) A structure of local management

To maintain the daily running of a network certain management chores are necessary (initialising servers, taking backups, locating stations etc). We have distributed this responsibility among the staff according to a rota. Of course, this serves to ensure efficient system operation but it also creates a vehicle for everyone to develop an increased familiarity and confidence with the underlying technology. The current "manager" also negotiates a timetable of usage across classes that opotimises the deployment of the still limited number of computers in the school.

2) A flexible user interface

Access to resources on the network is via a specially-written front end. A standard format menu offers 34 options selected by moving a background highlight. Teachers may compose these menus by drawing from an underlying structured library of network resources.

3) *A school notice board*
A teletext – style bulletin board carried items contributed by various classes (past and present) in the school. This system also carries teacher notes on various items of available software.

4) *Work folders*
Children's writing (or other displayable material, eg. Logo constructions) can be entered into electronic "folders", each associated with individual children and/or projects. these are then accessible for immediate reading or viewing across the network.

5) *Electronic mail*
An integrated mail system has been written to support the transfer of text and other files between users on the network. These users may be defined to be individual pupils or teachers, or they may be defined by (group) projects. The system is shortly to be expanded to allow mailing to users on econet networks in other schools (via a modem and telephone).

The innovative application of these generic items can be summarised in relation to a number of organising concepts.

Participation:
This computer environment captures something of the open – plan spirit. this is particularly facilitated by the *flexible interface* and by theexistence of a strong set of *management practices*. More of the life of the school community – as represented in the achievements and activities of groups and individuals within it – is made accessible on this medium. Simply being more aware of the breadth of activity within the school increases the possibility of effective coordination. For staff, the shared responsibility for maintaining the smooth running of the network – as well as the need to confiture a particular environment of options within their own classes – serves to promote a common familiarity with the underlying technology.

Audience:
Facilities such as the *notice board*, the *work folders* and *electronic mail* allow the products of children's effort to become more public. That is, they can be made available to other children accessing the network. This furnishes a powerful motive: the knowledge that one's efforts will be witnessed by and shared with others. indeed, cultivating a sense of "audience" must be an important strategy for fostering creativity and this medium may offer some support to that enterprise.

Leaving tracks:
This idea extends the concept of audience in at least two ways. Firstly, the network allows the cumulation of any child's work over the whole of their time within the school. such a folder of achievement may well prove a useful resource for that individual: it provides an opportunity for the individual author to reflect upon the process of development in their own work. Secondly, the leaving of tracks may be a valuable inspiration for future generations of pupils. Having the opportunity to indirectly witness the struggles of one's predecessors may be a potent experience – when carefully managed.

Collaboration:

Most discussions of the innovative potential of IT for cooperative work stress the possibility of interactions *around* computers. This networked environment also offers the opportunity of interaction *through* the technology. Careful management of the *flexible interface* and use of *electronic mail* allows a collaborative effort to be easily sustained and coordinated, even across different classrooms. Familiar items of generic software are important in supporting such collaborations: eg. a word processor to manipulate a shared text file, or a simple desk top publishing package to edit cooperativelya newspaper, magazine or antho)gy. such experiences of joint activity may not only be valuable because they are forums in which cognitive development is promoted, but also b;ecause they reflect how intelligence is actually exercised within the world at large - a skilled coordination with others.

CONCLUSION

Some of the "barriers to innovation" with IT in early education arise from the isolated status of the classroom computer. The creative activity that a class computer might support cannot easily surface elsewhere within the school community. this may encourage a fragmented approa ch to developing computer-based work. It also fails to support initiatives that require coordination of effort among children. Moreover, it seems that too often the computer may als9o be fractured from a mainstream of activity within even its own classroom. the possibility of computer work blending into the "common knowledge" of the class will be enhanced in a computer environment that makes such work permanent and readily accessible within a structured framework. Finally, the individual pupil is likely to have more engagement with a system that has a strong communicative potential and which offers a personalised space for that individuals's own achievements.

APPENDIX B: The PALM Action Research Project

Bridget Somekh, University of East Anglia

A great deal of time during the first term of the PALM Project has been devoted to analysing and overcoming barriers to innovation. This has been on two levels: barriers to the use of computers; and barriers to carrying out action research. In both cases these barriers were expected and the rationale underlying PALM (which is a two year project) sees success in overcoming the latter as predicating success in overcoming the former.

The research literature on innovation is ably summarised in Fullan's (1982) book, *The Meaning of Educational Change*. Successful innovation is elusive. In many cases, as Bussis, Chittenden and Amerel (1976) pointed out, innovation in classrooms remains at the level of surface changes and there is no fundamental change in the nature of the learning experience of the children. PALM is concerned to engage teachers in researching the fundamental change to learning made possible by the use of computers, and, through the process of engaging in research move teachers beyond the level of mere surface changes (which might be characterised, for example, in wheeling the micro in, loading software and organising the children to use it). The roots of innovation failure are seen by Fullan and others as lying within unsupportive institutional contexts and the failure to relate change to the concerns of teachers as individuals. Within this context, it may be useful to list some of the barriers to innovation which PALM has identified.

A Personal Barriers

1. A teacher's personal self-image may conflict with the innovation: for example, in defining him/herself as a non-technology person (computers) and/or a practical as opposed to an academic person (action research);
2. Teachers may have a concept of teaching which values expertise and does not value experimentation and risk-taking – with this goes a belief that the teacher, not the children, is responsible for learning taking place;
3. There may be a loss of professional confidence leading to anxiety: teachers may feel ashamed to admit inadequacy to colleagues and/or to children in the classroom – they may lose the sense of enjoyment in teaching;
4. Teachers may be unable to imagine uses for the computer without *first* using it with children, and paradoxically, as professionals, they may wish to see a purpose for using the computer *before* using it with children;
5. Often teachers are likely to experience frustration with failures of technology, or blocks to its use arising from their own lack of technical knowledge – what Pirsig (1974)* calls "gumption traps".

B Institution-led barriers

6. School's (and LEA's/central government's) have focused on computers being used by children; teachers are expected to use computers so that they can enable children to use them. Often this means that teachers are expected to learn how to use computers in the classroom, alongside the children; teachers do not have access to computers (unless privately purchased) and are not using them as tools for their own work (for example, for writing and/or record-keeping);

* Pirsig, R. (1974) *Zen and the Art of Motorcycle Maintenance*. Bodley Head, London. (Reprinted in Corgi 1976.)

7 There is often a lack of understanding of the personal challenge involved in beginning to use computers for those who perceive themselves as 'non-technology' people;

8 There is still insufficient access to hardware;

9 Teachers always lack time: to learn how to use computers, and to collect data, reflect, engage in professional dialogue etc. (action research);

10 There are often logistical problems cause by lack of consumable resources and/or parsimonious institutional rules designed to limit their use: for example, printer paper may not be kept permanently in the printer; ink or colour printers may run out; and there may not be enough disks to keep back-up copies of children's work."

PALM is undertaking research at two levels: a) the teachers are carrying out action research into their use of IT to develop pupil autonomy in learning; b) the central team is researching the role of action research as a strategy for overcoming barriers to IT uptake. Hence, it seeks to overcome the barriers to IT experienced by teachers in the following ways:

The teacher-centred nature of Action Research places the emphasis strongly on teacher professionalism and goes a long way to counteracting the sense of professional inadequacy induced by lack of familiarity in working with computers. Action Research invites teachers to make judgements based on evidence. This ensures that the focus is on learning rather than on technology.

Contrary to what teachers expect when they first hear the word 'research', Action Research is eminently practical and its focus on the classroom helps the teachers to make personal meaning from engaging in innovation (see Fullan, op cit).

The collection of data and its analysis ensure that teachers begin to look at the deeper issues below mere surface change; and because Action Research presupposes a dynamic process of change it encourages experimentation and risk-taking.

Change in teaching style is further encouraged if teachers decide to engage the children in the research process (for example, by asking them to reflect on their learning either in writing or in interview) the responsibility for learning begins to shift a little towards the learner and away from the teacher.

The collection of data leads to a need to work with a research partner and breaks down the isolation in which anxiety (arising from both innovation and technology) can grow out of proportion. Within the PALM project we are emphasising the establishment of Action Research teams within schools, working under the leadership of IT leaders. Where possible the whole staff of the school is being kept informed of the research and the intention is to use the staff as the first audience for papers and presentations.

For many of the teachers concerned, the process of working collaboratively generates enthusiasm. There is an emphasis on shared exploration of issues. In PALM we are concerned to make the research process enjoyable and demonstrate to teachers that their work is valued. Some extra resources are available (though not on a scale to make the circumstances of the research unreal) and teachers have the support of the PALM team working as facilitators. Symbolic gestures are also significant, such as following on after-school meetings with a "meal in a basket" (cheaper and better value for money than expensive supply cover during school time!).

APPENDIX C: PUBLISHED PAPERS DISTRIBUTED BEFORE THE SEMINAR

House, E.R. (1979) Technology versus Craft: a Ten Year perspective on Innovation. *J. Curriculum Studies 11*, 1, 1 – 15

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APPENDIX D: LIST OF PARTICIPANTS

Mr. Grant Alderson, Roehampton Institute of Higher Education, London

Professor Stephen Ball, Centre for Educational Studies, King's College London

Dr John Beynon, Department of Behavioural and Communications Studies, Polytechnic of Wales

Ms. Pauline Bleach, Reading and Language Information Centre, University of Reading

Dr Margaret Cox, Educational Computing Unit, Centre for Educational Studies, King's College London

Ms. Heather Govier, ITTE Secretary, 219 Oswards, Courtwood Lane, Croydon

Dr Anita Jackson, School of Humanities and Education, Hatfield Polytechnic

Mr. Harry Kahn, Education Development Building, University of Sussex

Professor Bob Lewis, ESRC InTER Programme, University of Lancaster

Mr. John O'Donoghue, Educational Research Development and Evaluation Unit, University of Keele

Ms. Valerie Rhodes, Educational Computing Unit, Centre for Educational Studies, King's College London

Mr. Leon Shuker, (formerly ILECC), 21a Bramshill Gardens, Dartmouth Park, London NW5 1JJ

Dr Roger Silverstone, Centre for Research into Innovation, Culture and Technology, Brunel University

Dr Joan Solomon, Department of Educational Studies, University of Oxford

Ms. Bridget Somekh, School of Education, University of East Anglia

Mr. Les Watson, College of St Paul and St Mary, Cheltenham

Mr Roger Woods, (National Primary Centre), Teaching Studies Department, Westhill College

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