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Conditions for an Effective Integration of Educational Technologies in Secondary Schools

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Biography

Monique Grandbastien is professor in the department of computer science of Nancy1 university. She belongs to the CRIN (Research Center for Informatics in Nancy) where she is the head of a team working on the applications of computers to education. She focuses her own researches on knowledge representation and knowledge-based-systems architectures suitable to fulfill educational needs in the frame of a national program funded by the CNRS (National Scientific Research Center). She is also a partner of the LEAST project from the CEC DELTA program and acted as an expert for CEC "Operation 92". She was successively in charge of the introduction of a computer science course at the secundary level and of a national report on new technologies in schools for the French Ministery of Education. She is also adviser to the local education authorities who are defining their policy in the field of computers in secundary schools and related inservice teacher training.

Abstract

Computers have been introduced into French schools on a significant scale for at least ten years now. They are used for several purposes, mainly for vocational training and administrative activities. They are still looked upon as 'newcomers', or 'tools for specialists', by a lot of teachers who are not yet even familiar with computer use for their own needs.
This paper first reminds main possible uses of computers in secundary schools. Then, starting from the results of investigations carried out during the year 1989 by the author on the request of the french ministery of education, it describes which of those uses have been put into practice in French schools and which have not .
Finally, after pointing out the pitfalls which hinder the development of better computer use in schools, a list of possible short term actions is provided, as well as some important research questions that have to be answered, if we want new technologies to really help us face the educational challenges of the next century.

Key-words:
Computers in Education, New Educational Technologies, Computer Supported Learning integration in schools, Teacher Training in new information technology, educational software, computer equipment for schools, equipment allocation, classroom layouts, computer component of a school policy.

Introduction

Computers have been introduced into schools on a significant scale for at least ten years now. They are used for several purposes, mainly for vocational training and administrative activities. They are still looked upon as "newcomers" or "tools for specialists" by a lot of teachers who are not yet even familiar with computer use for their own needs. It can be said that in most countries the use of computers has been imposed upon schools in a climate of national concern for the future. Pressure on educational systems has come from industrial and government circles as well as from anxious families and ambitious local authorities, the relative weight of each of these actors depending on the organisation of each national school system.

The present decade must be the decade of integration; and whereas past initiatives often came from outside the school, we believe that integration plans must come from the school's staff themselves, even if supported by other levels. **The school level is now the key level for an effective and efficient use of computers.** In this paper, bearing in mind possible uses of computers in a school and current or experimental situations observed, we present what should be the main components of an effective use of computers within a whole school project. These proposals were suggested to the author either by the survey she conducted to write a report [2] on the request of the French Ministery of Education or by her position of advisor for regional education authorities on that topic and finally during a summer school she organised on the definition of an "informatics policy" that serves a global school project.

Although a lot of findings and statements can be applied to all kinds of schools, the paper is more specifically dealing with secondary schools. So the reader has to bear in mind this level of education, pupils aged from about 12 to 18 and related sizes of schools, when the word "school" is used.

Computers in schools : How did they arrive there ? What services are they expected to provide ?

At the beginning, computers were introduced in schools either for administrative purposes or by pioneer teachers who were willing to investigate how to improve their teaching with interactive technologies. In the 80's, computers were more and more required for vocational education, as automated process control, assisted design and all kinds of information processing spread all over the world of industry and services. So microcomputers and numerical command machines are now widely spread for vocational training. Some specific computer or programming courses are also given, generally during the last years of secondary education and always as an optional subject or a subject for some specific curricula, scientific sections for example. Finally, mostly in the frame of national programs,many schools provide some kind of computer literacy to their students.

So it can be said that computers are really present and used in schools, mostly because of adaptation of subject matters to the needs of the information society. Such uses will certainly - but have not yet - benefit all teaching and learning activities not only in terms of contents but in terms of new tools, new problem-solving methods, new relations between teachers and students, new management of classrooms and schools. In fact, interactive technologies were proved valuable in many different ways including drill and practice to master basic skills, discovery activities in computer laboratories, simulations, access to remote data, cooperative learning, electronic networking, etc...

All these uses build a quite impressionistic picture rather than the teacher's guide that seems to be expected in schools together with additional equipments and educational software. I am afraid there is no teacher's guide on new technologies in education, because the power of new technologies lies in flexibility, inventivity, adaptation to new situations, etc...But there should be teacher training that allows them to draw all the benefits of computers and telecommunications in their teaching activities, and there should be specific learning goals defined by the school staff that new technologies together with other means will help them to reach.

Much has been written on possible uses of computers in schools [6],[7],[9],[10],[1],[13], so I do not provide additional examples here. I would only remind some general agreed outcomes in the field of pedagogical uses of information technologies. Computers can be used by teachers alone, before they work in the classroom with their pupils, to gather learning material, maybe for instance by exchange with colleagues from other settings or by access to remote databases or after the class for synthetical assessment activities. They can be used during the lesson, mainly for illustrative purposes, to stimulate students interest and discussion. Educational software such as "pictureware" in mathematics can save a large amount of time for drawing figures and transforming them as often as needed. Computers can be used by students under the guidance of the teacher. Practical work in sciences or social sciences may involve such use of computers to acquire data from experimental devices ; discovery or problem solving environments have also proved successful, the teacher being free to provide advices and explanations to each learner or group of learners. Finally, computers can be used by students alone as writing tools, as reinforcement of basic skills and for diagnosing tests.

All these uses may provide their contribution to the improvement of learning in a school. They must be clearly identified and choices must be made according to available means and current priorities. But many teachers are not really obliged to use technology. If they were familiar enough, they would regard pedagogical applications in a way as to bring real improvements to the whole school system without condemning them to belong to the strange category of "hackers". It seems to me that things are changing on that side.

Past and present involvement of school staffs, changes to come

Even if very different figures can be found in schools, it seems that a kind of "standard" may be described as follows. On the one hand, powerful computers are used for administrative activities, mainly student registration and administration, accountancy, file exchange with local or regional authorities. The administrative staff is mainly involved, teachers may "ignore" these computers unless they get some payment problem ; they may appreciate well ordered sheets giving the names of their students or hate the same sheets. But they consider those listings as common administrative pieces of our everyday life, not as outcomes of their own machines for which they could suggest changes and additional services. On the other hand, a lot of microcomputers are used by some teachers and some students ("all" students only if a computer literacy course is required for all). There remains a number of teachers that have nothing to do with the computers.

Why do we have that situation ? Let us look at the French development of computers in secondary schools. In the 70's, 58 schools were given a minicomputer with 8 terminals. The selected schools were willing to investigate possible uses of computers in different subjects, that meant that in each school at least one teacher received a full years training in computer science and then try to develop short pieces of courseware for his lessons and for colleagues working with him. In fact, around five teachers were involved in a school. At the beginning of the 80's, several microcomputer equipment plans were successively decided.Each plan was a national one, schools received their microcomputers without having asked for them and often without having time and previous experience to think of pedagogical uses and possible changes in the organisation of the students activities due to the computers. They had to to select a group of teachers that would be given training and were expected to disseminate knowledge among their colleagues, mostly this dissemination technique did not work. The team that volunteered to be trained was not self-assured enough and could not provide colleagues with pedagogical examples of uses in each subject. Only a limited number of teachers (less than 10%) became users. Experimental researches and courseware tests were also organised in each subject involving one teacher or a group of teachers in a school, never all the school staff. Even in one of the last national experiment called "collège for success" that was proposed to schools and not to people, only some divisions in the school were involved, mainly because there were not enough computers. Of course all these experiments were valuable in terms of increasing number of users and of new findings, but they could not lead to define school policies.

What is changing now ? Teacher training should change, but unfortunately has not really yet changed. That means that new teachers should be familiar with computers at least for personal use and for basic pedagogical applications in their domain. Technology is becoming less expansive, we may hope an increasing number of networked computers in schools. Software becomes more userfriendly, hypermedia provides attractive activities that teachers did not even imagine some years ago.

Moreover, a new category of computer applications [3] that are called Educational Management Information Systems (EMIS) and for the existing prototypes of which I prefer the term "pedagogical management" is spreading throughout the schools. Those programs summarize pupils results into a graphical display, on an individual point of view (for a discussion with the student or with his parents for instance, allowing quick comparison with average results in the same school or in other schools), or on a class point of view or on the whole school point of view. Links are established between individual files of results owned by teachers, school results management and files transmitted to external authorities.for statistics on education and costs forecastings The main difference between these new applications and the previous ones is that everybody is concerned by computer applications in the school, every teacher has student results to provide and has something to say about the kind of disk he would like to provide from home or where keyboards should be in the school to enter these results or what kind of software the school should buy to improve these new services. Other members of the staff

are recording absenties or menus for those having lunch at school, the menus can be accessed by parents on telecommunication services. Pedagogical management also includes the generation of flexible time-tables, the processing of exam results and in the future help to curricula choice. Briefly, they allow quick and global views of what is going right and what is going wrong in the school.

All these new available functionalities create the need, and at the same time allow to build, a school policy for computer uses. How to achieve it ? I propose that each school defines its policy either for computers as teaching subjects or for computers as available ressources to help each member of the school (administrative staff, students and teachers) to work.

Components of a school policy for the use of new technologies.

Information about new technologies potentialities
Many projects are worthy but only some will be put into practice, it is necessary for the whole school staff to be aware of all the computer potentials in the administrative sector, for pedagogical management, for information exchange within the school and with partners of the school, for information retrieval both for learners and teachers needs, for teaching and learning both in vocational or computer courses and in general subjects. It is the responsability of the Head of the school to organize this first step.

The choices of the school
After having reviewed where technology could be of valuable help to solve main identified problems in the school (for instance communication with families, networking and telecommunication so that teachers and students can send data from home, individual help for newcomers, student motivation for scientific curricula, etc.), choices have to be made, taking into account existing local ressources as well as in terms of equipment , in terms of staff capabilities or companies partnership. A wise choice would be to have a project in which parts are well distributed into the different sectors mentionned previously. These choices generally imply modifications in buildings and classrooms, equipment and software purchase, staff member's training, steps for project realisation and assessment procedures. This often needs to be planned over several years taking into account forthcoming changes.

Implications in terms of buildings and equipments
Two concepts will be of utmost importance. Firstly, as recalled at the beginning of the paper, there are many ways to use computers, layout problems must not forbid some of them. Building ajustments, security assessment can be needed. It should be possible to connect the classroom computer to a large screen, thus involving the entire class at once in various activities. It should be possible to have one or two machines at the back of the room at another moment, a computer room for working under the guidance of the teacher and freely accessable machines for the students and (preferably others) for teachers preparing lessons. The distribution of the machines within the school must be thought of in a highly flexible and evolutive way. Secondly, the trend is certainly to networked sets of computers. Networking opportunities lead us to have a cable in each room in order to plug in any microcomputer.

Implications in terms of pedagogical organisation
The use of new technologies implies training for teachers and other staff members. I am afraid this will remain true even with more teacher's awareness and more powerful software. So training needs must not be underestimate and training should be a clear part of the project. Commonly, one or several teachers will attend external sessions, but the transfer of the capabilities they acquire to their colleagues must be organized, if not, previous experiences have shown that it does not work. Even with such an organisation, problems remain to be solved such as to build the project, to be in charge of the tracking of it, to be aware of technological changes, to negociate equipment and software purchase, etc. For all these tasks and many others, it is necessary that at least one school member (or several depending on the size of the school) is more aware of all aspects of computer uses in schools. A three months training session would be the minimum to acquire such capabilities.Finally, the classical 45 or 55 minute period is probably not the most appropriate to draw all benefits from computerized activities, for instance to solve problems of meaningful complexity. Neither is the class notion, maybe the idea of pupil groups with teacher support is more suited. However, this is perhaps a further step towards a complete reshaping of the system as a whole.

Conclusion

I have given guidelines to set up a school policy aiming at a real integration of new information technologies in the global short-term and mid-term school strategy. A successful project needs the agreement of all concerned people. Such an agreement can be obtained by a deep and continuous involvement of all the actors in the definition of the project, in the scheduling of the forecasted steps, in the assessment activities as well as in the running of the project itself.
Teachers should be confident and enthusiastic. A lot remains to invent in terms of contents. They should become more "facilitators of learning" and less "knowledge providers". This is a difficult task which needs deep knowledge in the subject to be learnt, in learning processes and in the current misconceptions that are found among beginners and in remedial proposals. Main research directions should be to individualise learning so that students assume more responsability in their own learning activities, to free the teacher from repetitive tasks in order he has time for personal or small group explanations, to make a better use of interactivity and multimedia potentialities. Strong links should be established between basic research and applied research in this field, aiming for instance at bringing in common teams full time researchers and teachers who are still active in schools. Research and development are also necessary on quality educational software, but never forget that technology is not an independant variable, it should be strongly imbedded in the school.
I would like school staffs to consider these proposals. They should understand that they are not intended to promote any kind of fashionable educational theory, neither to support any computer industry as it might happen in the past. They only aim at a better quality of education and at a higher efficacity in the use of teaching and learning ressources.

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CONSENSUS ON COMPUTERS IN EDUCATION

Do teachers, parents and pupils share the same expectations and attitudes toward computers?

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Do teachers, parents and pupils share the same expectations and attitudes toward computers?

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1 ABSTRACT

Attitudes and expectations are important factors for the use of NICT (New Information and communication technologies) in education. This study comprises three sets of data on attitudes toward NICT, collected in 1990 from teachers (N=500), parents (N=800) and students in primary and lower secondary schools (N=2,100). The same basic set of questions is used in the different samples, with relevant modifications according to characteristics of the three different populations.

The aims of this paper are (a) to study if teachers, parents and pupils share the same expectations and attitudes toward computers? and (b) eventually find some important factors influencing active use of computers in education.

The study is part of a parallel survey of parents', students' and teachers' attitudes toward new facets and content of curriculum (home economics and computers) in primary and lower secondary education in Norway.

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2 INTRODUCTION & BACKGROUND

In the spring of 1970 I completed a survey of Norwegian teachers on how they collected information for their daily work, the main sources used for this and their media preferences for future use. Some of the questions were directly oriented toward the computer-based dissemination of information, others toward the use of computers and newer media and methods of instruction and teaching.

Looking back, 1970 was somewhat early to put ordinary teachers in front of a computer-based educational environment. Computers were well known for their administrative functions, but their role as the teacher's tool was not well perceived.

The fact that we were in the beginning of a new era intrigued me, caught my interest and was the main motivation for replicating some of the 1970-questions in 1978 and 1990 surveys. Doing this, it was possible to study some of the main trends among teachers concerning their attitudes toward, acceptance of and potential and practical use of computers in education. (This is described in a preliminary report on the "longitudinal study", to be presented at the IFIP WG 3.1 Working Conference in Santa Barbara, USA, August 4-9, 1991 (Kristiansen 1991).)

As time passed, other aspects came to my consciousness, and the 1990-study is therefore more extensive than the previous. In this paper, however, I'll restrict the presentation to attitudes and expectations preferences of relevance to teachers', parents' and students' acceptance of NICT, leaving the rest for another occasion.

3 METHODOLOGY

The study was part of a cooperative study of two emerging subject areas or domains of importance throughout the next decade. From the question:

> **What are the basic knowledge requirements for students who will be adults in the next century?**

two different fields of knowledge were chosen: Home economics and New information and communication technologies. These fields are focused on in the national curriculum plans in Norway, and were, in 1990, the main theme of a survey of 500 teachers, 2,100 students and 800 parents. The data was collected from a random sample of schools, stratified according to regional and ecological variables.

The main aim of this project was to study students', parents' and teachers' attitudes and expectations concerning daily life in the future. Both society and technologies are changing rapidly, and the idea is that students must be prepared to meet rapid changes.

Who is going to be responsible for the preparation of the next generation's fellow citizens? Is it the school, the parents or both - and how do the respective parts expect this to happen? Both an extended content of home

economics and NICT is outside the established curricula in most countries, leaving these subject areas in something like a "terra incognito".

An innovative project with a very close cooperation between home and school has been started, and where the ideas have been implemented in home economics in 7 lower secondary schools.

So far the experiences from the project indicate both motivation and interest among all parts for a closer collaboration. This implies that the home (parents and student!), as an equal partner with the school, participates in defining educational objectives and the planning and evaluation of the teaching process in home economics. Home economics may be seen as an ideal opening for better home-school relations, but in many ways the home may also be seen as a valuable resource for the school as regards NICT.

It is essential for the cooperation between home and school that the three parties involved, teachers, parents and students, share the same, or at least not too deviating, opinions and attitudes toward the subjects taught. The main questions are therefore:

> How do the three groups correspond to each other concerning attitudes and expectations to NICT,

and if different views exist between the groups,

> How can we approach the problem to facilitate learning and a cost-effective use of computers in the schools?

4 NEW INFORMATION AND COMMUNICATION TECHNOLOGIES

Technological development often creates an impression of change and a need to redefine realities. This has been very clear when studying the use of electronics and microelectronics in society and education.

New information and communication technologies is a complex and mixed field. It spans from mass-communication media to notebook computers and calculators. We can go back to the early days of film production and how the use of sound tracks transformed this new medium into a very powerful communicator. In the beginning it was a mechanical/optical invention - afterwards, with the transition to radio, TV, video and computer technologies, microelectronics has become the focus. The concept of multimedia emerges, and with hypermedia techniques, the versatility of this new integrated medium is more apparent.

4.1 NICT goods as a commodity

New information and communication technologies are today more or less treated as commodities in a consumer market. This tendency has been clear in several product groups. Calculators and watches are good examples, together with TV and video, cassette-recorders and compact disc players. Here we have integrated circuits with high capacity, and combined them with laser-

technology and high density information storage.

The rapid development in the electronic commodities market has changed the attitudes toward these new media. Similarly, the development of computers into a "household size and cost" creates a new understanding and possibly a new set of attitudes toward their potential, power and practicality.

The consumer commodities represent a market for technological development. Special education and rehabilitation is another sector where new technologies are very important, and where spin-offs from other research and applications are already integrated in a very fruitful way.

4.2 NICT - Teacher's competitor or stumbling block?

NICT goods are an everyday experience for children, and for their teachers. But are the new technologies friend or foe? Francis Balle gave a presentation to the European ministers of education, describing the conflict between media and education:

> The age of communications is here and no one can fail to realise it. We are thus witnessing today the end of a misunderstanding which for years caused the media and the education system to take opposing sides. Each claimed for too long to have the monopoly of what Montaigne called "L'institution des enfants", that is to say not only their education but also their upbringing in the broadest sense of the word (Balle 1989, p. 14).

If this has been the situation, the educational environment is vulnerable to the effect of negative attitudes among teachers.

> There is the question of attitude - hostility born of incomprehension or the perception of threat in the case of new technologies, more outright rejection of a "polluting" influence in the case of the media (Council of Europe, 1989, p.5).

This citation may seem very dramatic, but in many ways it sums up experience from the implementation of new media and methods in schools. If negative attitudes and teacher anxiety can be modified, it should provide for a more balanced use of NICT in education, also preparing the student for the work environment in the beginning of the next century.

4.3 NICT and equal opportunities

Another concern is equal access to educational computing. With NICT as a main contributor to the work environment and society in general, it is necessary to explore the possible function that the technologies - or knowledge about them - may have as a segregating factor.

Knupfer (1987) found that "equity of student access to instructional computing is closely related to the attitudes and opinions of the teachers who work with those students." If we intend to have equal opportunities regardless of sex, age, social position etc., it is necessary to work with the attitudes of

teachers, parents and the students themselves (Kristiansen 1989).

An interesting observation concerning gender differences is found in the throughput of students in the educational system. In France, while the participation of female students at lower levels in the technology education is relatively high, a dramatic dropout is registered at the upper levels (Musnil 1989):

Baccalauréat "informatique":	34%
Enseignement supérieur technologie:	15-18%
Ecoles d'ingénieurs:	7%

In the European Communities this problem has received much attention. A centrally organised R&D program has been initiated to map the field and to prepare projects for attitude change (Valabregue & Aebisher 1989). A similar project has been initiated in Norway to study which mechanisms are active in this segregation process (Berg & Kvande 1987, Kvande & Rasmussen 1988).

A test of equal access can be to see if there are gender differences concerning computer ownership or availability at home. In Norway nearly 45% of students in lower secondary have access to a computer of some type at home. This is fairly close to figures from Canada (Collis, Kass and Kieren 1989), as shown in Tab. 1. The Norwegian sample is drawn from ages 13-16 in 1990, whereas the Canadian material is from ages 15-17 in 1987. In both samples there was a significant relation between gender and availability of computer ($p<.001$).

Tab.1. Availability of computer at home. Percent of sample.

Gender	Norway	Canada
Males	56.1	50.2
Females	32.2	35.4
N-sample	2,100	3,000

5 ATTITUDES TOWARD NICT

The study of attitudes, or anxiety, related to NICT is complicated. Attitudes may be seen as a readiness construct containing an affective, a cognitive and a behavioural dimension. In some sense the anxiety concept is closely related to the affective element.

The scope of the questionnaires was not to describe the whole complex of these concepts, and the data must therefore be interpreted and evaluated according to that. This study is therefore not aiming at a complete survey of the total attitude or anxiety concepts, but is an effort to find some of the relations between elements of the concepts and certain background variables and processes.

5.1 Teacher attitudes in previous research

When we are discussing teacher attitudes, it is interesting to study how age, gender, teaching level or experience may account for attitude differences. Neither Gressard & Loyd (1985) or Baylor (1985) found age to be a significant variable, but like other researchers they found that experience with computers (Elkins 1985, Jones & Wall 1985, Lillard 1985, Honeyman & White 1987) and participation in projects or teacher training (Baylor 1985, Martin & Lundstrom 1988) were important factors. In Jones & Wall's and Baylor's studies, gender was not defined as a predictor of computer anxiety, but it is interesting to see that gender has a stronger influence concerning practical teaching and tasks in the subjects (Reid 1986).

Kay (1989) found "no significant differences between males and females in either cognitive or affective attitudes toward computers". However, there were differences concerning commitment to and use of computers, literacy and locus of control.

In a study of age differences, Baack, Brown & Brown (1991) found that young adults "revealed more positive attitudes toward computers and computer applications than did the older adults". Even if this was a comparison between college students and a sample of members of retirement groups in midwestern (US) churches, we may find the same relations between younger and older teachers.

Several projects in recent years have studied computer phobia and anxiety among teachers. Baumgarte (1984) describes the contradiction that -

> While the computer is commonly viewed as a tool for simplifying and enriching lives, many individuals react to this technology with feelings of anxiety, paranoia, and alienation. These reactions may have potentially serious career and educational consequences. Fear of computers reflects a generalized fear of current technology and is most prevalent in already-anxious individuals who are forced to deal with computers, especially in subordinate roles. External locus of control has also been identified as a predictor of computer anxiety.

Another approach to this is that distance engenders admiration. Among 450 teachers most of them answered that "computers are valuable tools that can be used to improve the quality of education" (85%) and that "teachers should know how to use computers in their classroom" (81%); whereas only 66% would welcome one in the classroom (Norris & Lumsden 1984).

This is to some degree in correspondence with a near-vs.-distant hypothesis concerning media prefernces and new technologies among teachers from Norwegian primary and lower secondary schools in 1970 (Kristiansen 1971). The previously reported locus of control (Baumgarte 1984, Kay 1989) is also supportive to this.

Reed (1990) used a writing course to familiarise English education students with computers in the classroom. He found that "the computer anxiety of the entire group reduced from pre- to post-treatment" and "In all analyses, the subgroup that showed the greatest change was that entering with no prior

experience with computers". These findings are in concordance with Honeyman & White (1987), where previous level of experience was the only variable to have a significant relationship with initial levels of anxiety and the reported changes in those levels during a course period of two years.

A previous analysis from Bellando & Winer (1985) concludes:

> Although the number of computers in the school system is increasing, many schools are not using computers to their capacity. One reason for this may be computer anxiety on the part of the teacher. A review of the computer anxiety literature reveals little information on the subject, and findings from previous studies suggest that basic controlled research is needed.

An inspection of present research validates this description, and if attitude and anxiety are believed to be factors in the implementation process of NICT in education, more research has yet to be completed.

5.2 Computers and home-school relations

If we look at the different participators in this three-partite cooperation, we know something about teachers and students, but parents are an often overlooked partner in the game. In a study of other technological panaceas in education, like radio or television, we very often would find an optimistic attitude among the active proponents of the new methods and media. The same applies to computers.

Guicquinta and Lane (1990) surveyed some of the literature on the use of computers in the home, stating that

> "The early home microcomputing literature contains strongly held expectations about the educational empowerment of children and parents through the use of microcomputers (p.27)."

After having passed through a discussion of different aspects of this literature, they conclude that

> "It also follows that most existing work fails to question <u>why</u> children do or do not engage in home academic microcomputing. Put another way, researchers have overlooked the dynamics behind differences in children's academic microcomputing (p.28)."

The optimism reported by Guicquinta and Lane is in concordance with the buying motives of many parents, but where the facts may be slightly different. Riccobono (1986) reported an "apparent dissatisfaction by many in terms of actual compared to anticipated use for a variety of purposes". As regards education, this conclusion may be a little antiquated for two reasons: The distribution of computers reported in American households 1985 need not be the best selection for informal learning in the home, and the general availability of educational software is totally different today. Riccobono also points out that <u>awareness of suitable material</u> may be one of the main predictors for use.

Among parents with students at the same age/educational level as in this study, the perceived helpfulness of computer games or programs as learning resources appeared like this (Riccobono 1986, p.D.38):

Very helpful	23%
Somewhat helpful	24%
Not helpful	53%

The study of Guicquinta and Lane found that the absence of home microcomputing for educational purposes could be explained by

> "the lack of parental pressure and support for home academic microcomputing, the schools' emphasis on programming and computer literacy, the unreceptivity of the children and their peers to home academic microcomputing, and the dearth of academic software in the homes (p.27)".

In their discussion they sum up:

> "Our findings and the literature review suggest that if home academic microcomputing is to flourish, parent/school relations in particular will have to change considerably (p.36)".

The two studies of Guicquinta and Lane and Riccobono are primarily among technology users. A third study by Collis, Kass and Kieren (1989) among secondary school students in general

> "revealed little integration of computer use within curriculum-referenced contexts, substantial inequities with respect to student access to relevant technological experiences, and little evidence that convenient access to technology in the home translates into any shift from school to home as a locus of intellectual educative activity (p.77)".

Even if the computer should not be available in the home, the attitudes and expectations of parents are of vital interest. Conflict or concensus with the teacher is the basis for the main question in this paper.

6 THE MAIN QUESTION

As already mentioned the main question in this study is:

> Do teachers, parents and pupils share the same expectations and attitudes toward computers?

To clarify a little, a decomposition of the main question can be done:

6.1 What should be the relative weight or importance of technology-related subjects in the curriculum?

In the questionnaire the respondents were asked to indicate the importance of a set of curriculum elements. Some of them were of a "technological nature":

What is your opinion of the importance of ..... to prepare the student for daily life in the future?

To use a computer
To know how the computer is functioning
To know that the use of computers may have both positive and negative effects
To use a calculator

As Fig.1. indicates, students and parents have different opinions concerning how important the knowledge areas are. Except on the use of computers, every difference is significant ($p<.001$) for both student-teacher and parent-teacher comparisons. Teachers and parents are weighting the use of computers equally.

****
Fig.1. to be placed around here
****

If we go into details, we can also see that knowing about computers having both positive and negative effects, is rated much higher by teachers than by students and parents. On the other hand, knowledge concerning computer functioning is quite the opposite. In this case it may seem that teachers have a more mature opinion than the two other groups, who are more concerned with details at a lower taxonomic level.

The use of a calculator was brought into the questionnaire to be a "control" versus the computer. The high teacher rating of calculators reduces the previously mentioned maturity. In the long run there is no doubt that computers will be a far more fundamental tool in the home, school, work life and society in general, than will calculators.

6.2 How do the three groups perceive themselves as a computer user?

All three questionnaires had a common core of alternatives following the question:

If you think of yourself as a computer user for work or leisure activities, would you then feel .....

Interested
Confident
Calm
Curious

Fig. 2. may give a visual impression of more harmony between the groups. Going into the statistical tests (chi-square), we will find significant differences ($p<.001$) except between teachers and parents as regards being

confident, and between teachers and students concerning curiosity.

****
Fig. 2 to be placed around here
****

The absolute figures are closer to each other, but still they are statistically significant.

From a teacher education point of view, and as a fellow citizen, it is alarming that on interest, confidence and curiosity, teachers have a lower score than parents and students, with whom they have to cooperate.

6.3 What do they feel about the use of computers for educational purposes?

The use of computers as a tool for education and training in schools is ...

Of current interest/actuality
Necessary
Exciting
Useful
Handy

Concerning the use of computers in education, it seems that parents have a more active view of actuality/current interest and the necessity of introducing it in the curriculum. On the other hand, the difference between parents and teachers on the usefulness of computers in education was not statistically significant, whereas all other comparisons were significant.

The students had significantly lower scores on the actualty/necessity variables, but had the highest score on computers being handy in education. The last observation should be easy to understand after having seen students using new tools in doing traditional schoolwork.

****
Fig. 3. To be placed around here
****

7 COMPARISON OF THE THREE SUBGROUPS

When compared to students and parents, teachers have in general differing views on knowledge, are less motivated and enthusiastic concerning own use of computers, and seem to underestimate the actuality and necessity of using computers in education as compared to parents. Consensus can not be seen as the primary characteristic of the relation between school and home.

Several reasons for this can be given. Computers are only to a very small extent part of teacher education, and very seldom it can be found as an integrated part of excisting subjects, or as a cross-curriculum acticity. In-service training and further education of teachers have been too much focussed upon programming and pure technological questions, whereas practical teaching and didactical use related to daily life in schools has been left out.

Another reason may be found in the resources allocated. Many schools got equipment in the first half of the eighties. The last years' recession in the economy of the municipalities, and the constrained budgets at local education authorities have not met the previous expectations of "hardware inflow". Together with new standards and equipment with better performance, many schools experience the contrasts, having to live with outdated computers.

Still another reason may be lack of educational software, or awareness of what is in the market - and the inbuilt possibilities of existing tools and packages. There is a conflicbetween having a new set of software for every occasion, and being able, and motivated, to use open-ended software in a creative manner.

Generally, the lifelong qualification of teachers has suffered from meager budgets. During the last years many teachers have been through computer courses, but a relevant question is if they have got the best solution. And, how much have teachers learnt about using resources outside the school for their own activities. This applies especially when parent-school relations are concerned, and where both motivation and often also skill is found to be better in the home than among many teachers.

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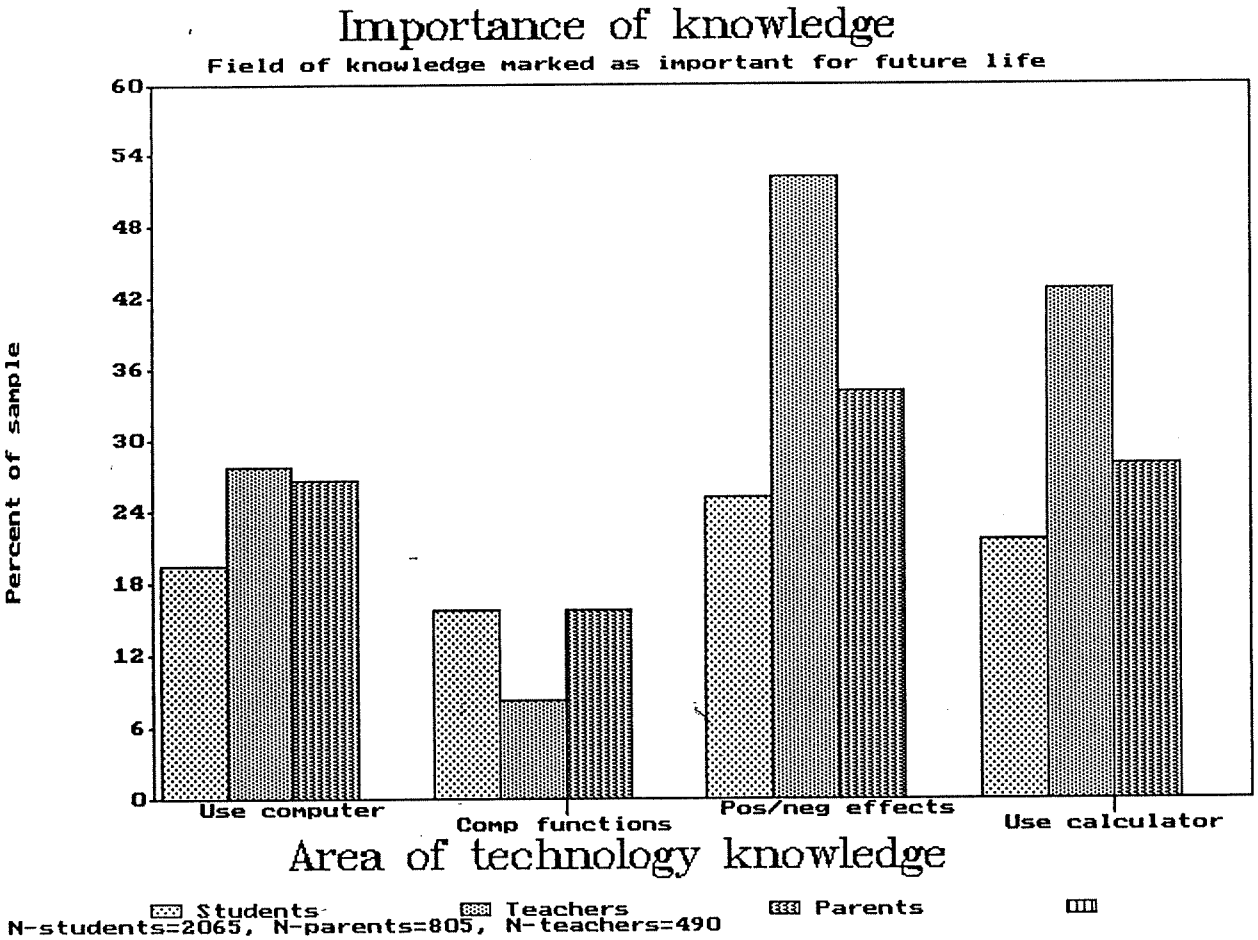
Importance of knowledge
Field of knowledge marked as important for future life
Percent of sample
60
54
48
42
36
30
24
18
12
6
0
Use computer
Comp functions
Pos/neg effects
Use calculator
Area of technology knowledge
Students
Teachers
Parents
N-students=2065, N-parents=805, N-teachers=490

FIG. 1.

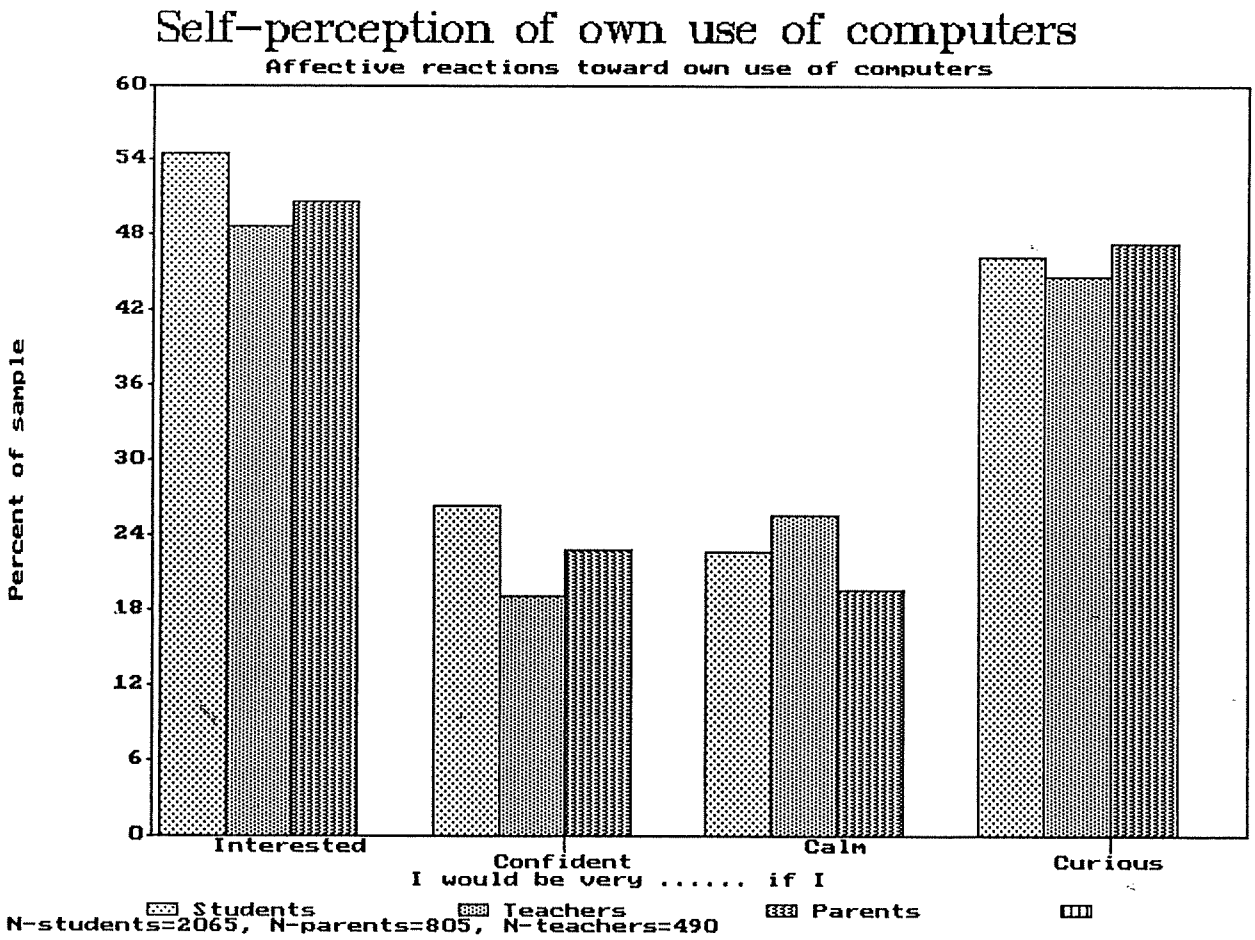
Self-perception of own use of computers
Affective reactions toward own use of computers
Percent of sample
60
54
48
42
36
30
24
18
12
6
0
Interested
Confident
Calm
Curious
I would be very ..... if I
Students
Teachers
Parents
N-students=2065, N-parents=805, N-teachers=490

FIG. 2

Evaluation of the use of computers in education

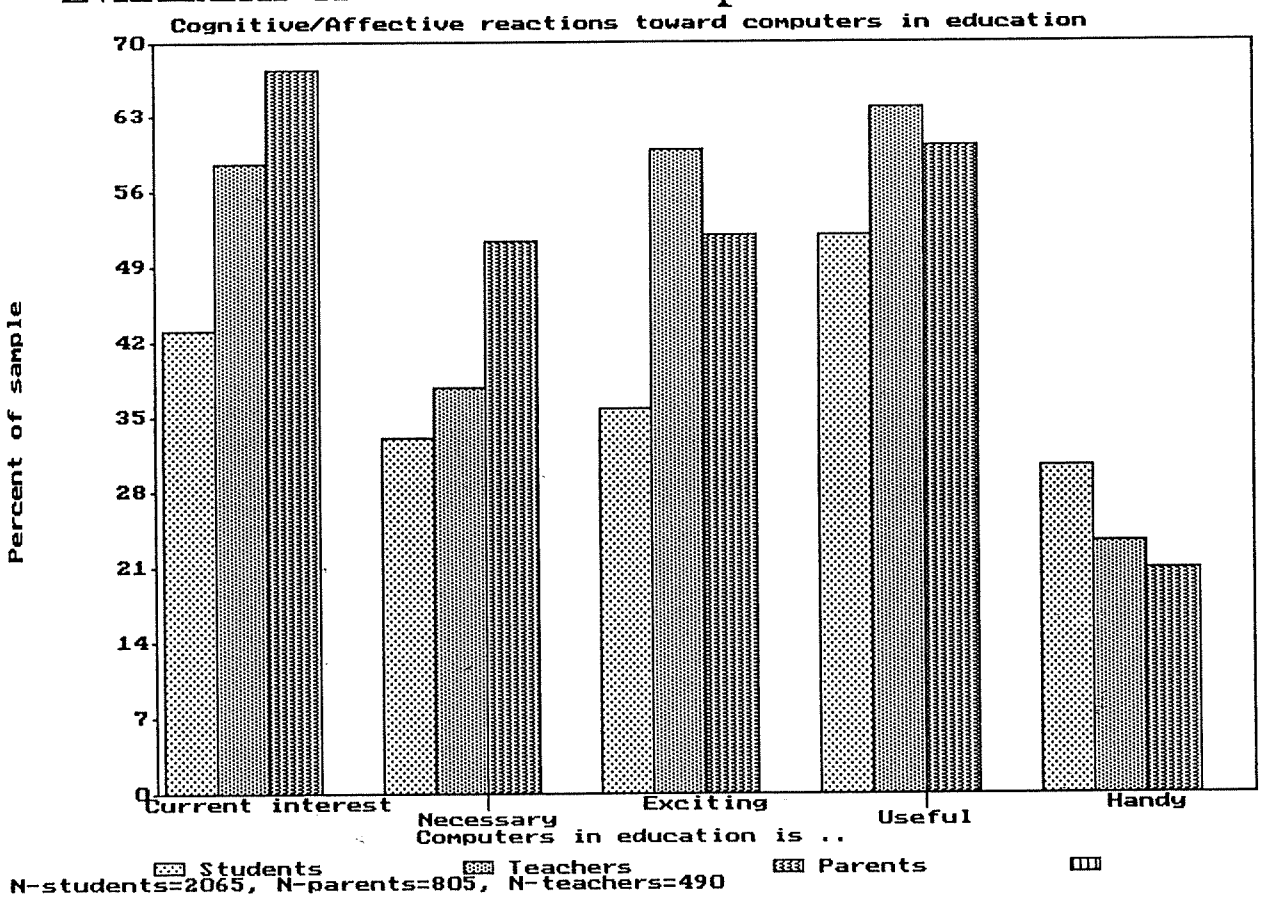

FIG. 3

Grenoble

Effective Computing in Education:

Teachers, Tools, and Training

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Abstract

The emphasis on tool applications of computers in school and business settings continues to grow, but the results of such use are often disappointing. An increasing number of studies are defining the shortcomings of this approach, but the solutions have not been found.
This paper begins with the assumptions underlying the emphasis on tool applications, reviews some of the studies that challenge these assumptions, then presents some suggestions for successful implementation of tool applications, based on more appropriate assumptions.

Woe to those who are wise in their own eyes and clever in their own sight.
Isaiah 5:21 (New International Version)

It can be argued that technology sometimes gives us a false sense of knowing or understanding. For example, television can give us a sense of having been an observer at some important event, even though we know that what is seen on television is often very different from the actual event. More important to our discussion, however, is the extent to which our use of computers can be similarly misleading. In the following sections, it is argued that our use of computers as tools can lead us to greatly over-estimate the value of our tool applications.
The original source of concern about tool use has come from our study of elementary school classrooms, now completing its fifth year, shorter investigations in secondary schools, and our current study investigating policy-making at several levels of government. This concern has also been raised in related research by a number of our past and present students, and research from other projects. Several students have also been instrumental in bringing relevant literature to my attention.

Tool Applications

In *Tutor, Tool, Tutee* [53], the tool application of computers is presented as one of three forms of computer use in schools. Over the years, however, the "tutor" role has declined and the "tutee" mode has never had a major role, leaving the "tool" function as dominant. Becker reported that teachers' use of computers change over the course of the first few years of experience [2]. He found that CAI was more popular among teachers just beginning their use of computers, while tool applications such as word-processing, along with programming, were more frequently used by more experienced teachers. Certainly, the schools we have visited and the policy documents we have analyzed also show a large and growing preference for computers used as classroom tools.
An increasing emphasis on computers as tools has also been a part of published research, but some of the emerging results indicate that students are not accomplishing what the tools enable them to do. An associated outcome is that teachers are often unaware of their students' possible or actual accomplishments. A further repercussion is that students are often more confident when they use tools, even when their performance level is lower than without tools, it can be seen that these three outcomes tend to reinforce each other. When teachers give general praise for computer use, but do not monitor student activity with computers, and students are in fact not doing what the teacher expects, it is quite likely that students will become more confident, even when they are not accomplishing what was intended.

The Role of Assumptions

What assumptions do we make about the planned (or current) use of computers in education? More to the point, are these assumptions justified, or are they merely wishful thinking, the restating of hopes and fears into the form of reassuring assumptions? It is important that our assumptions be consistent with, and a reflection of our values. Plato wrote that without absolutes, morals cannot exist; thus our values must be based on absolutes.

The following assumptions are offered, not as the complete set of assumptions undergirding tool use, but to demonstrate the potential danger in using unexamined assumptions and to suggest that a careful review of all assumptions might be in order.

Students learn the tool once, then apply it in many settings

This is the basic assumption of current proponents of computer literacy: that knowledge of computer tools at an early age will make students able to handle more complex problems in later years. My experience has been that people with little tool knowledge, but much job-specific knowledge are able to get and hold jobs, while those who have a greater knowledge of tools are only at an advantage if they have at least as much job-specific knowledge as the competition. This result has also been found in a large scale survey of small business employers [28].

Teachers need little knowledge of the tools their students use

In theory teachers should not be responsible for student knowledge of computer tools, but in practice teachers do monitor their students' use of all tools, such as calculators and reference books and often find that students need assistance in making proper use of these tools. Computer tool use requires as much, if not more support from teachers, so the teachers must not only be knowledgeable about them, but should also be tool users.

Technology has a predictable and controllable "impact" on education

We must be careful in defining what we mean by "the impact of technology", since this may be a simplistic concept. For example, Lincoln and Guba [30] describe the cause and effect model as being inadequate for most evaluation settings and propose "Mutual Simultaneous Shaping" as an alternative.

Slack's discussion is even more illuminating [47]. She points out our mistaken assumption that communication technology is only a cause, never an effect, then challenges the assumption that technology is autonomous. Our "symptomatic approach", acknowledging that technology may be altered by external variables, such as culture, is only half the solution. Her solution is a structural perspective, in which technologies are recognized as integrally related to the social context within which they emerge. For students, this context is primarily determined by teachers, fellow students, and parents.

Salomon, Perkins and Globerson [45] propose that we can distinguish between effects with and of a technology. The former is concerned with "changes in performance that students display while equipped with a technology", while the latter refers to "subsequent changes in mastery of knowledge, skill, or depth of understanding once the student is away from the computer" (p. 3). Though they acknowledge that it is "naïve to speak of the effects of technology as a natural and inevitable phenomenon to be studied", they also assert that "the effects of technology are what we choose to make them" (p. 8). In practice, these effects, if we can use that term, seem to be much less controllable.

Computers as a neutral conduit

The *Cultural Dimensions of Educational Computing* [5] is about the non-neutrality of technology, particularly computers. The focus is not so much on computers, however, as it is on the assumption that language is a "neutral conduit". Bowers says that computers are good at conveying facts (they have this in common with other text-based materials), but not good at conveying culture: the context, and interpretation that should be given to it. That has to be provided some other way. In dealing with novels, or other curriculum materials, teachers provide the context and work with students on interpretation.

Teachers should be providing the context with programs as well, but generally they are not. They miss the "teachable moments" when the students' experience with the program could be related to the theme or principle in our culture [3].

Emerging Issues: Expectations versus Outcomes

Using versus Applying Computers

As stated earlier, emerging results often indicate that even though they are confident, students are not accomplishing what we expect computers tools should enable them to do, and their teachers are often unaware of this result. That is, some teachers have not noticed that although their students are using computer tools, they are not applying them. The following items give examples, though not all in school settings, of tools being used, but not necessarily being applied.

Other Research Results:- Our own results, from six elementary schools with student/computer ratios as low as 6/1, indicate that direct teacher involvement in student computer use is crucial. Snyder [50, 51] supports this view, based on his experience and software he has developed. Support for the position that students need more assistance to apply tools comes from earlier experiences with computer applications, such as that on "Learner Control", indicating that students had to be taught how to make choices before they could take effective control of their learning [34].
Blair & Maron [4] found that lawyers retrieving information from a full-text database were unable to find the material they sought, though they had misplaced confidence in the results. The lawyers, constructing the defense in an actual civil suit, were only retrieving about 25% of the relevant documents, but believed that they were retrieving at least 75%.
Gochenouer [15] found that middle managers who made the most use of a computer tool, though confident of the tool's value, were seen by their superiors as least valuable to the company. That is, not only were computer users given smaller salary increments than the non-users, but those who made greater use of the computers, or used special features such as a programming function, received even smaller increments. It should be noted, however, that while these results hold true for a majority of his subjects (the men), the reverse was true for women in the study. That is, women who used computers were given higher salary increments than women who were non-users. One can only speculate as to the reasons behind this effect, but it might be because women are not interested in using tools unless they can be applied, while men are attracted to the features of the tool.
Kottemann [25] found that MBA students using spreadsheet features to predict business patterns were more confident, but less successful than those without computer tools. It is interesting to note that these effects increased over time, that performance of the groups was approximately equal mid-way through the experiment, but widely different at the end. Kottemann did not report the sex of his subjects.
Sassone [37] reports that U.S. business managers are spending only about a fourth of their time managing, while more of their time is devoted to clerical tasks formerly done by support staff who have been replaced by (incomplete) automation. This is consistent with Garson's finding [13], that office automation has been used to replace clerical staff by middle managers. Kemeny [23] notes a similar result in academia, complaining that mathematicians are using computers to type their own letters, rather than to do research.
Part of the problem may be that those who are cautious about the benefits of computer technology and those enthusiastic about this technology are talking past each other. For example, Nelson [36] argues that the introduction of technology will lead to a continuing emphasis of means over ends, while Jones [21], in rebuttal, claims that technology can be liberating; but both arguments seem to be based on what could happen, not what is happening where technology is being used. Sometimes, the two points of view can appear in the same article such as Soloway [52], who begins with a nod to reservations about technology, but then moves on to a more enthusiastic stance. Soloway states that "no one seriously can defend such a position [Computers will make everything better; ...]", but two sentences later says that "incorrigible optimism ... is a necessary feature" (p. 30). He then goes on to argue that computers can be an effective part of "active learning", but we would add that not only do our studies indicate that computer use within an active learning environment is not necessarily supportive, but active learning without computers is viable in itself.
Soloway's analysis may be an instance of needs assessment being misdirected. That is, one doesn't need computers to create active learning, so computers are not a necessary answer to that need. A more obvious example of this pro-technology thinking comes from a report that Carnegie-Mellon researchers have created a robot to make pizzas "to help physically disabled people obtain jobs" [38, p. 11].

Research by former students:- Our students have investigated a variety of classroom settings where computers have been used. Rose [44], while studying classrooms of teachers using computers for the first time, found that teacher practice with computers was often in conflict with teacher practice away from the computers. One teacher, for example, stressed cooperation away from the computer, but prohibited students from working together in the computer lab, or required them to share computers as punishment.
Studies have also been done on teachers and primary students using computers for collaborative writing, teachers and secondary students using computers as database resources in studying history, graduate students using word processing for thesis writing, and primary teachers integrating multiple networked computers into their curriculum [7, 20, 54 and 9]. Throughout all of these studies we found users, teachers and students experiencing severe problems in implementing computers. In classrooms, it seemed particularly difficult to make the use of computers a part of the classroom while preserving the teacher's style.

Research by current students :- The current studies continue the qualitative emphasis, but are moving beyond the general definition of the problem and becoming more diagnostic.
Laurie Benaloh is attempting to get deeper into the questions associated with teacher style by observing and interviewing teachers and students with varying teaching and learning styles in settings with different subject matter and software application combinations.
Hilda Carmichael is using student protocols to define their exploration processes, with a view to making the links between student behavior and outcomes better understood by teachers. Her preliminary results shed light on the differences between students' problem-finding and problem-solving practices.

Lynda Colgan is focusing more directly on the application of computer tools, developing and testing instructional strategies to support and facilitate tool use in mathematics. Denis McGowan is working on similar problems, but in the field of chemistry, and is also developing support materials to facilitate tool use in that discipline [33]. Both of them have found that successful use of these tools by students requires a substantial amount of teacher support.

Our current study:- "Chaos theory" [14] provides examples of complex, seemingly chaotic systems that appear to defy analysis until large amounts of data are analyzed from the appropriate perspective. Analogies have been drawn from chaos theory to a wide variety of settings and the tool use of computers in education is no exception. As we draw together more observations from our own studies and conclusions from other studies, some patterns begin to emerge.
Our major current study is a three-year investigation of the bilateral relationship between educational policy and practice, including the Ontario Ministry of Education, three Boards of Education, and more than a dozen classrooms. This study is at the end of the first year, but initial findings indicate continuing support for the concerns voiced in this paper. That is, students often receive approval from their teachers for "mindless" activities with computers, while the teachers speak about their students knowledge and accomplishments. Meanwhile, some students do become proficient in tool use and are seen as the norm, when, in fact, they are often the exception.

Wisdom versus Knowledge

Fulghum [12] has shown us that what is important to our lives need not be extremely complex and can be learned very early in life. A simplified view of our position might be stated as the following: Just as we can confuse knowledge with wisdom, so we similarly confuse being able to use a computer tool successfully with being able to apply the tool successfully. Training people so that they will have the knowledge to use a tool is not the same as educating them so that they will have the wisdom to apply the tool.
Many factors come into play in educating students so that they will have the necessary wisdom for tool use. Only a few of them will be mentioned here and then only briefly.

Role of support materials

Support materials, including not only curriculum materials but also teacher support, are crucial in creating a classroom environment that encourages learning. *Responsive Teaching* [6] defines the foundation of such an approach, including the topics of nonverbal communication,

primary socialization, and framing. In our observations, it appears that teachers are more likely to provide these forms of support in non-computer environments than when computers are being used.

Teacher monitoring of student progress

Teacher monitoring is crucial to achieving "mindful" activity rather than "mindless" activity [45]. Both support and monitoring are important teacher activities, but the role of the teacher often appears to be tacked on as an afterthought. In *Interactive Technology and the Young Child* [8] one must wait for the last paragraph before "Summary and conclusions" to read, "It is clear that the full educational potential of technology for children can only be achieved if teachers and parents are involved as central players in the `system'" (p. 7).

Student confidence vs. achievement

Our observations coincide with the results presented above, namely that students can have considerable confidence in their use of computers when they have little understanding of the process. The following is an extract from my field notes:

> Most of the students I interviewed, if they had tried BC Lumbering, said it was too complicated, too difficult. One, not a particularly strong student, said it was his favorite program. When I mention that some people said it was complicated, he says, "Not really, it's just hard to understand, like it's a fun game to play, but it's hard to understand". That, to me, was a good illustration of dividing the program up into compartments. "Can you do it?" was the important part. He could "do" BC Lumbering; he could put in things so that pictures, graphs and so forth would appear. "Can you understand it" was another thing.

Without a "cultural context", a frame of reference developed by the teacher, students may acquire "confidence" from activities unrelated to the skills we expect them to acquire.

Other affective outcomes:- Student motivation is often cited as a positive outcome of technology used in classrooms, both by teachers and researchers. Students are reported to enjoy what they are doing or to spend more time on tasks such as writing when using a computer tool. Our observations indicate that student enjoyment of the task is often correlated with the student having redefined the task in order to make it more enjoyable. In one primary classroom, for example, a student was enjoying the use of a word processing program by simultaneously spinning the trackball with one hand while mashing the keyboard with the other. The result is motivating, but it is not writing.

Implications for Implementation

The preceding sections may have been overkill, but the necessity of careful implementation of computer tools is often overlooked. To accomplish a successful implementation, some of the following have to be considered.

Needs Assessment

If we consider that the most important future uses of computers might be hidden from us and that the current applications themselves are not clear, then planning our future use of technology is a problem. For example, how might we prepare teachers to deal with the unknown effects of unspecified applications? One part of the answer is that we should not build our plans on the hopes of those who wish to see computers provide the answers to all the current problems of education (or any other domain). In fact, we must go much further than that, questioning seriously the assumption that computers in general, or any computer application in particular must, by definition, have positive effects which outweigh the negative effects. The most promising alternative approach is to determine important needs which it is reasonable to expect computers to satisfy.
In the past, needs assessment seems to have been limited to determining the needs of the technology, rather than the needs of humans, such as students and teachers. That is, concern is often for "showing what computers can do", rather than defining the kinds of assistance students require. However, it would be unfair to give the impression that needs assessment is a clear-cut uncomplicated process. Though this paper is not the proper environment for a careful analysis of the needs assessment process, it must be acknowledged that the definition of "need" itself is in dispute, the determination

of needs is usually subjective, and the entire process of assessing and meeting needs is heavily influenced by values [46, 43, 26, 17 and 30].
An example of needs assessment for implementation is Wideman's study [56] of teachers who had made some substantial change in their classroom practice, particularly his emphasis on "What helped you?" and "What hindered you?"

Development of support materials

Support materials are a "need" in implementing new technology, but how can their important characteristics be defined? Our studies indicate that one has to get this information from the users while they are attempting to use the new technology.

Observation and interview:- Collecting data about computer use without being able to verify the use through observation can present great risks. At least four examples of this came to my attention several years ago.
Gayle Rose [44] documented a systematic over-reporting of computer use by teachers, including `lying' to students, colleagues, and administrators. Lee [27] notes that computer labs seem to be used much less frequently than teachers report, with Mathinos and Woodward [32] finding the same result and attributing it to teachers being "overwhelmed". Archer [1] also reports that many of his observation sessions in lab settings were unproductive because classes did not show up. He also reports that computers on trolleys, when scheduled for classrooms, were often not used, or used briefly at the end of the period (and this when an observer was there!).

Teacher Development (beyond training)

In order to develop professionally, teachers must be motivated and this can only occur when the development process leads to skills that the teachers themselves have determined to be important. Where educational authorities have provided teachers with relevant development opportunities, teachers have responded with enthusiasm (Pearlman, 1991).

Training:-Formal training can be a part of the teacher development process, but it is important that teachers can take part in the implementation of tools with a minimum of formal training. This can be facilitated through a focus on pedagogical objectives, not technological objectives.

Coaching:- Teachers with varying experience levels, both in teaching and using computers, can work together more effectively when coaching is a part of their everyday experience (Phillips, [40]). This is not only a mechanism for teacher development, but also helps to keep a curriculum focus.

Teacher as researcher:- The notion of teacher as researcher has not been as successful in North America as it has been in Europe, particularly Britain. This teacher role is most important for computer applications, since we desperately need feedback from the "grass roots" as to what is actually happening when students apply computers in different ways [43].

Student attitudes and perceptions

Failing to adapt to changing student attitudes and perceptions is likely to be a fatal flaw in any implementation. Other technologies are influencing students in powerful ways each day.

Role of television:- One reads that today's generation "learns" via television, but our observations indicate great variability in the amounts and/or types of learning. For example, one 13-year old girl, an excellent student who was not allowed to watch television during the week, was able to give a succinct summary of the last comedy show she watched, complete with a statement of the "message". At the other extreme was a 13-year old boy (the same one who was asked about the BC Lumbering program) who claimed to watch four to five hours of TV per night, plus Nintendo and sports activities, and who summarized a recent program as follows:

> Yeah, like yesterday they were on strike, going on strike and he made all the signs up and he wanted a raise and that, and Angela never, that's her name, Angela never gave it to him and then it was over and then he still wanted a raise. But then they work things out all the time.

(RGR: So what would be the message or theme of last night's program?)

I don't know, I didn't watch the whole thing, I just basically watched the end. Um. I don't know.

The questions about television were asked because the teacher had said the students did not seem to know much about the themes of TV programs, just as I had said they didn't understand the computer programs. It appears that "channel hopping" and "software smorgasbord" produce similar kinds of understanding.

Photocopying versus note taking:- This topic was suggested to my by a recent exchange between one person who was proposing that it is no longer necessary for students to take notes when they can photocopy material, and another who said that an important purpose of taking notes was to have the note-taker "process the material" [31, 35]. Whichever position we take, we must be clear in stating the purpose of the activities being assigned.

Computer Interface

Turner (1990) takes exception to David Suzuki's opinion that computers should be banned from elementary schools so that children can spend more of their time outside. Turner suggests that students can learn more about the environment through simulations than through actual contact with it. This disagreement is based on deep philosophical differences, but intermediate points of view might be held, depending on a consideration of other factors.

Pointing Devices:- The increased use and availability of pointing devices, such as the mouse, trackball, etc., has made computers more accessible for children. It gives them an avenue to explore, but does it also restrict or at least influence the computer activities they might pursue? This bias is certainly present in some software, where it is easier to do some tasks by typing, rather than by pointing, so the process is likely to differ, depending on which mode is used.

Screen Resolution:- Is an obvious factor affecting the fidelity of any experience that is presented via a computer, with sound fidelity having a similar impact. If a child is going to understand the environment through using a computer, the screen resolution will have to be better than most monitors I have used.

Concealed Elements:0 Computers are important for what they reveal, but also for what they conceal. In creating software, the developer makes decisions about what must be revealed and what may be omitted. Simulations are obvious examples of this type of issue, where the number of variables included in the simulation is almost always smaller than the number present in real life.

Cultural Context

Computer applications are often seen as being independent of cultural context, or at most, being somewhat altered by culture. Technology, in the form of television and telecommunications, is being promoted as a vehicle for learning about other cultures, as though technology offered a "neutral conduit". In *The Fate of an Innovative School* [49], however, the authors acknowledge that social and cultural context were major factors in determining the results of the innovations.
The continuing dispute between Macintosh and IBM proponents in the domain of word processing offers an interesting example of cultural effects. Halio [18] wrote about her perception that students using the Macintosh lab were producing written material at a lower level than those using the IBM lab. Her later interviews seemed to confirm that student expectations were different in the two settings, that the Mac reminded them "of the games they play at home", while they "seemed to associate `The Big Blue' with seriousness of purpose" (p. 18).
Halio's comments produced a storm of reaction, mainly negative [48, 22, 57 and29], along with her response [19]. The responses contained a strong emotional component, consonant with an attack on one's culture. The effect of various computer interfaces on writing style, if validated, may be a validation of Slack's assertion [47] that technology is an effect as well as a cause. That is, since the Mac and IBM grew out of different environments (or are effects of different cultures), we should not be surprised to find that they produce different outcomes.

Guided Discovery versus Free Exploration

Discovery learning can be a powerful way of learning, so that the learner has a personal and deep understanding of new concepts. Many people make a false distinction, however, between "guided discovery" and free exploration using computer When we use technology to explore, we are guided by the technology. I have traveled between Oslo and Tromso by plane, train, bus, and boat, "discovering" very different things with each form of transportation. In particular, crossing the arctic circle by train was very different from crossing it by plane or boat.
An illustration of the non-neutrality of technology can be seen in the HOTS, Higher Order Thinking Skills program [41, 16]). Pogrow [41] maintains that "understanding conversations" between teacher and student are crucial to the development of higher order thinking skills, but Ferrarotti [11] asserts that mass media mean "the end of conversation". That is, technology is not a neutral force that will work better if accompanied by conversation, but rather, technology works to decrease the conversation required to make it a more effective tool.

The Good News

We can have an effect on the way computers are used and their effect on us, but only when our use is based on a value system derived from moral absolutes. As Ellul points out, one can't make an a balanced evaluation of technology while being dependent on, in love with, or otherwise "inside" technology [10]. Therefore, he proposes that we become "mutants", that is users of technology, but not disciples of it. His answer to the need for a viewpoint outside of technology is to use the Judeo-Christian value system, defining acceptable bias to replace the "pro-technology" bias.
Ellul describes two contradictions of our use of technology which may help us to derive some steps toward improvement. One is that our attempts to counter the undesired consequences of technology lead to more technology, more serious consequences and less control over the processes we have created. For example, it is not uncommon for several drugs to be prescribed, with some of them intended to counter the side effects of the rest. Or, we can consider the continuing creation of military technology, each step designed to increase our safety, but at the same time increasing the possible destruction while decreasing human control over it. Our conclusion should be that more technology is not necessarily the answer to our problems with technology.
We also have a contradiction in that the discipline required by our society is becoming more severe (due to technology) in areas such as tax reporting, traffic control, building regulations, etc., while at the same time the society has lost its values. Since discipline must have an acknowledged value base to be accepted, we are increasingly ready to challenge all discipline, while discipline continues to increase because of technology. The conclusion here is similar to the first; discipline problems are not solved by increasing discipline, but by restoring the value base.
One of the encouraging aspects of computer use in schools is the frequent reporting that it increases the amount of time students spend working together. (This may be, in fact, the most important effect computers will have on education.) The importance of cooperative work can be supported in many ways. One is the evidence in support of peer tutoring, which need not be repeated here.
We cannot afford to be passive observers of technological applications, absorbing their values. It is important that our reliance on technological fixes be reduced through an increased emphasis on values derived from moral absolutes, leading to a restoration of the value placed on meaningful human interaction.

Effectiveness of Technology - Human Context

If students interact with subject matter entirely via technology, this will limit their experience and require that it be supplemented by an interaction with teachers and peers. More importantly, the quality of students' interactions with technology is going to be a function of cultural context, primarily determined by their teachers and peers. Therefore, arising from the preceding points, and from the experiences in many classrooms [24, 42], we can confidently state that **the effectiveness of technology ultimately depends on relationships between people.**

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[For ITE Programme papers, see outside back cover.]

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

Jackson, A., Fletcher, B.(C). and Messer, D.J. (1986) A survey of microcomputer use and provision in primary schools. *J. Computer Assisted Learning, 2*, 1.

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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 anthology. 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.)

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 challenge 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.

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

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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

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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> 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.

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.

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 goals 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

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.

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.

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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

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
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Barriers to Innovation – a seminar report

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Current Practice and Policies for using Computers in Primary Schools: – implications for training

Occasional Paper: InTER/15/90
September 1990

Valerie Rhodes and
Margaret Cox
Centre for Educational Studies
King's College London

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An ESRC video and booklet on the Project:

Time for Training

Valerie Rhodes and Margaret Cox
Centre for Educational Studies
King's College London

This 20-minute video addresses some of the issues which confront those with an interest in developing the use of computers in primary schools. The title of the video was chosen specifically to highlight some of the important findings of the research project discussed in this Occasional Paper. Teachers need to acquire adequate *training* in order to make the best use of computers in the classroom. However, providing the right kind of training takes *time*. Teachers need to be become familiar with the technology, to try out new ideas in the classroom and to reflect upon classroom practice. This implies that if teachers are to be adequately equipped to meet the demands of IT in the primary school of the 1990s, they need to be involved in an ongoing programme of in-service training.

The video features interviews with teachers with a range of experience and training. These teachers describe some of the problems they have encountered when using computers in the classroom and explain how in-service training has helped to overcome their initial fears and lack of expertise.

A 40-page booklet accompanies the video using evidence from the research to reinforce the most important points.

The video and accompanying booklet cost £36.80 (including VAT and postage and packing). Bulk orders of 10 of more cost £29.50 including VAT. Additional copies of the booklet are available for £8.95, or bulk copies at £7.25.

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[illegible] of the origins and scope of the InTER Programme, is given inside the [illegible] of this paper, a list of current papers in this series appears on the back [illegible]

Current Practice and Policies for using Computers in Primary Schools: implications for training

A Project Report

PREFACE

This Occasional Paper is based upon reports submitted to ESRC. It focuses on certain aspects of those reports and readers are referred to the source documents for additional detailed analysis.

The project, *An Investigation into the Uptake and Use of Computers in Primary Schools*, was financed in a number of stages by ESRC and by the Inner London Education Authority and Research Machines Ltd. of Oxford. It was an extended study but, due to restricted periods of funding, could not be planned as such from the beginning. Its outcomes are due to the tenacity of the small research team in the face of uncertainty of continued funding.

The significance of the work lies in the clarity with which features of innovation and change are identified from a basis of substantial research data. As acknowledged in the Introduction, many of the findings simply reinforce the intuition of practitioners. This is not to denigrate the contribution which the project has made; rather it stresses the importance of this kind of field investigation in underpining and emphasising impressions based on experience. The importance lies in the strength of the messages conveyed to policy makers who are difficult to convince without such substantive evidence.

One of the strongest messages relates to the nature of in-service courses for the professional development of teachers. In earlier reports from the project*, it has been noted that many in-service courses fail to acknowledge the expertise of the members. The "skills model" uses that expertise by overtly building upon the fact that course members know about children's learning and about classrooms. This contrasts with the tacit frame of "deficit model" courses which sees members as lacking something and sets out to remedy the deficit (lack of computer experience) without making use of the latent skills of members. Such courses often fail to achieve subsequent impact on classrooms.

The authors mention the relevance of these particular research findings to issues arising from the National Curriculum; in addition the way in which in-service development is undertaken following the devolvement of much of the responsibility to individual schools under the Local Management of Schools in the UK should also be informed by the messages contained in this Paper.

I am grateful to Margaret Cox and Valerie Rhodes in making their findings available through this series of Occasional Papers and also for their other dissemination efforts through the production of the ESRC video-pack referenced.

Professor R. Lewis, Coordinator, ESRC-InTER Programme

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* Of particular relevance is the project's contribution to the ESRC-InTER Seminar on innovation and change, reported in Barriers to Innovation, InTER/11/89, edited by Valerie Rhodes.

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Acknowledgements

The authors would like to thank: the ESRC, the ILEA and Research Machines Ltd. for their support throughout the project; the secretarial staff in the Educational Computing Unit for their hours of report preparation; the Consultative Committee for its advice and guidance; and most importantly, the many pupils, teachers, tutors, advisers and inspectors who tolerated our numerous visits, intrusions and questions during the lifetime of the project.

1. INTRODUCTION

In September 1992 the last of the nine subjects in the National Curriculum (three core and six foundation) is expected to be introduced into the primary schools in England and Wales. By then, Information Technology (IT) is required to be an integral part of these subjects as well as being a major component in the Design and Technology curriculum. For example, in science at level 3, pupils will be required to "retrieve and select text, numbers, sound or graphics stored on a computer". These and similar requirements in other subjects have been introduced since the investigation described in this paper was carried out. They will clearly have a major impact on the practice of teachers and their INSET needs.

Whilst many will agree that the next few years will place many new demands on primary school teachers generally, it can be argued that information technology will be an area where the pressure will be the most acute. Teaching in most other National Curriculum subjects, with the possible exception of science and music (Barnes and Shinn-Taylor, 1988), will not be a new experience for the majority of teachers of younger (5-11 year old) children. Information technology however is different in one fundamental respect. For although many primary school teachers may not feel that they can teach science and music adequately, they should have met these subjects during their initial training. Apart from a minority of recently qualified teachers, the majority of the current teaching population did not have regular access to a computer when they were at college or university. Familiarising teachers with computer use and equipping them with the necessary skills to use the technology in their teaching is a real problem, which has been compounded by the fact that many initial teacher training institutions are failing to provide adequate provision in this area (Govier and Keeling, 1988).

Information technology therefore is to be part of the National Curriculum both in its own right within Design and Technology, and as an integral element in other curriculum areas. In order to understand the task ahead it is valuable to know what impact computers have had on primary education since their use became generally accepted in the mid-1980s. What is the attitude of teachers to the use of computers in primary schools? What factors are associated with their successful integration (or otherwise) throughout a school? What in-service education and training (INSET) has been available to teachers and how effective has it been in practical terms?

Some answers to these and other related questions are provided in the findings of research carried out by researchers based at King's College London from 1985-1989, a short summary of which is contained in this Occasional Paper. It is anticipated that the results of this study will provide useful data which will inform both policy makers and practitioners involved in the implementation of the National Curriculum.

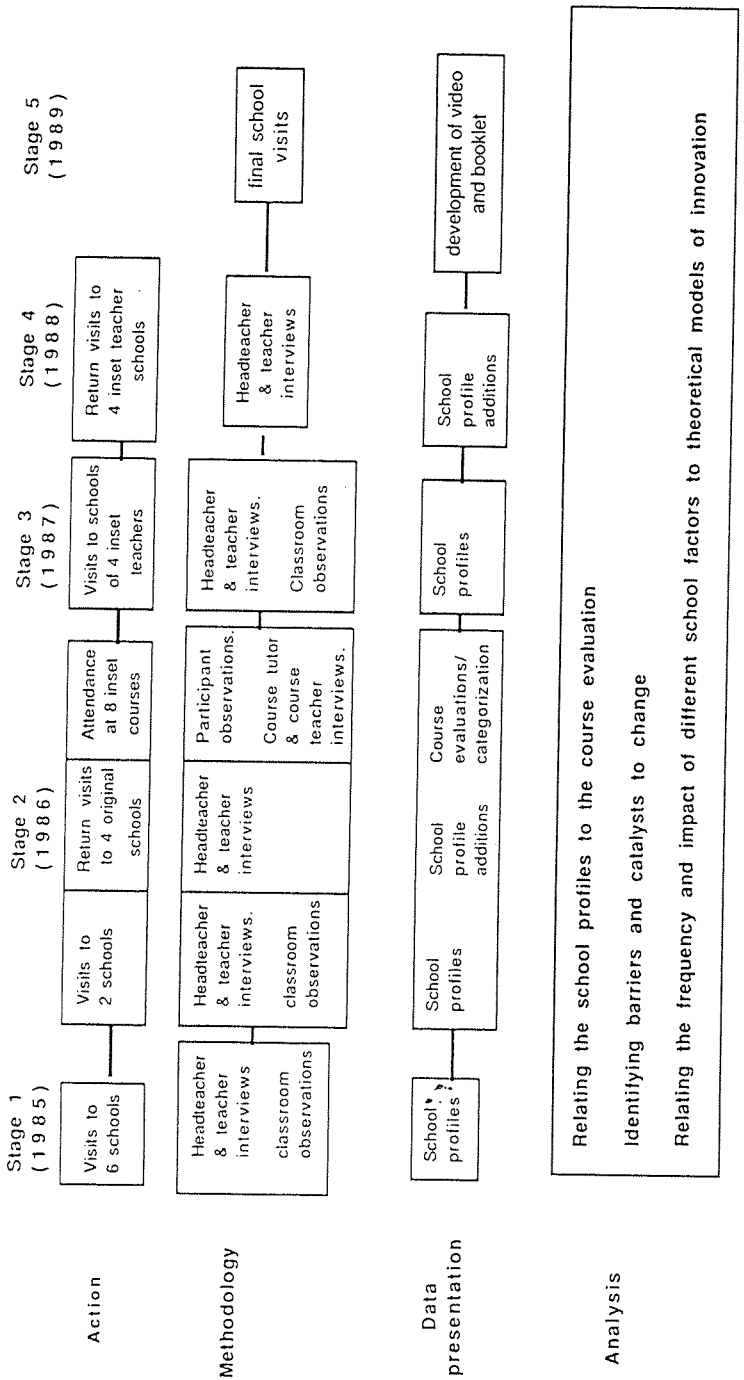

Figure 1: The uptake of microcomputers in primary schools project (1985 – 1989) – Research Plan

2. BACKGROUND TO THE PROJECT

The research described below comprised a series of linked research projects set up to investigate the factors which promote or inhibit the use of microcomputers in primary schools, with special reference to teacher training. Funding for this has been from the Economic and Social Research Council (ESRC), the Inner London Education Authority (ILEA) and Research Machines Ltd. The different stages and methodologies of the five years' work are shown in Figure 1.

During the first year (1985), case study investigations were carried out in six ILEA primary schools and a number of positive and negative factors which affected the uptake were identified and reported. Fuller details of these findings are available in Hall and Rhodes, 1986; Cox, Rhodes and Hall, 1986; Cox and Rhodes, 1988.

One of the principle findings during the first year's research was that whilst INSET courses were said to be of value in increasing teachers' confidence in using the technology, most primary teachers who had had some training, still did not use computers because they believed that computers were irrelevant to the primary curriculum. A second finding was that other teachers who had received some training and still did not use computers, expressed the need for more training before they were sufficiently confident to use them in the classroom. These and other findings led to the decision to investigate the content and nature of training provision, as provided through INSET courses and to evaluate the influence of such training upon the uptake and development of microcomputer use in primary schools.

Consequently in 1986, observations were made of eight INSET courses run for teachers in the Authority. This subset of courses was chosen to reflect a variety of provision. Courses included:

- Teachers' Centre 'after-school' courses for beginners and for more advanced users;
- a 150-hour certificated course;
- half-day courses organised at the LEA's Educational Computing Centre
- school-based INSET.

Further case studies were also carried out in two more primary schools which had been involved in an ILEA project to develop the use of microcomputers in project work. Return visits were made to four of the original six case study schools which were judged to be the least successful in terms of computer use, in order to record, assess and evaluate any changes which had taken place in the use of microcomputers over a twelve month period.

In order to assess the long term impact of the in-service training on the use of computers in the classroom and to evaluate the cascade effect of INSET, additional case studies investigations were carried out in 1987 at the schools of four teachers who had attended an INSET course. Return visits were made to these schools a year later in order to provide longitudinal data. This four-year research programme is described in more detail in other reports (Cox and Rhodes, 1988 and 1989) and is illustrated in a video and accompanying booklet which presents examples of classroom practices and the perceptions of teachers and course providers (Rhodes and Cox, 1990).

The findings from each phase of the project were used to inform subsequent work. As a result, the conclusions described below inevitably draw upon the results of all stages of the research.

3. RESEARCH METHODOLOGY

A number of complementary research methodologies (questionnaire survey, interviews and observations), were employed during the research.

3.1 Case Study Schools

Over a three year period (1985 – 1987) visits lasting from between two to fourteen days were made to twelve schools selected for case study investigation. Headteachers were interviewed and all teachers in the schools were also interviewed using one of three schedules.

Schedule A was designed for use with teachers who were currently using or had considerable experience of using computers in the classroom.

Schedule B was devised for use with teachers who had some limited experience of computer use and/or who had been on a course.

Schedule C was used with teachers who had little or no experience of computers.

The headteacher's interview was designed to give information in a number of areas including their attitude to computers in general and in education and the organisation of the resource in the school.

A summary of the main areas covered in each of the three teacher interview schedules (A, B and C) is given in Table 1 and there are extracts included Appendices.

Observations were made of children working with computers whenever possible. The activities were recorded in full and timed where appropriate. Whilst the main focus was on the computers and their users, other classroom activities of relevance, such as general instructions to the class by the teacher, were also recorded. The observational data includes information on the size and gender of groups, interactions between users, between users and the computer, and teacher interventions.

Table 1: Areas of information covered in teacher interview schedules A, B and C

Area of Interest	Interview Schedule A	B	C
Attitude to computers in general	√	√	
Details of training	√	√	
Attitude to the use of computers in own school	√	√	
Organisation of the classroom	√		
Hardware features	√		
Views on software	√		
Attitude to computers in education	√	√	√
Future plans with regard to computer use			√

Eight of the twelve schools were revisited one year after the original interviews (see Figure 1). All headteachers and teachers were interviewed (some for the second time), using one of five further interview schedules. These were for headteachers who were new to the school; other headteachers; teachers new to using information technology; new staff members; and teachers who had used the technology since the first visit.

Information relating to any development in the use of computers over the previous year was collected from the headteachers. This included changes in the levels of hardware and software; changes in the organisation and management of the resource, details of the provision of any school based INSET courses; and proposed developments with respect to computer use.

The class teacher interviews provided data in the following areas: changes in computer usage and classroom organisation; details of additional training and other types of support given or received in this area; and teachers' views on the use of computers in their own school.

The data obtained from the school visits was initially written up in the form of school profiles.

3.2 INSET Courses

One of the researchers, acting as a participant observer, also attended a number of INSET courses. The content of the courses was recorded in detail and tutors and teachers were interviewed where possible using one of two interview schedules. The tutor interview was designed to establish, amongst other things, the aims and objectives of the course and the tutor's perceptions of its effectiveness. The course tutors' interviews provided data in a number of areas which included the following:

- school background;
- previous training;
- expectations and evaluation of the course and
- future training needs.

3.3 Data Collected

Over the course of the project detailed case studies have been carried out in twelve primary schools and at eight INSET courses and the following types of data has been collected.

Interviews with thirteen headteachers (six more than once), two hundred and twelve teachers (fifty – five more than once) and five course tutors.

Observations have been recorded of over one hundred and twenty hours of children working with computers in forty – four classrooms and more than eighty hours of INSET courses have been observed.

3.4 Nature of the Results

Inspite of the five – year study, much of the extensive data collected by the project has yet to be analysed. The school profiles and detailed categorisation of the INSET courses are available in the documents already referenced. The following summary (Sections 4 and 5) of some of the main findings revealed so far supports the findings of other studies and the many experiential accounts of practitioners (see for example, Govier, 1988).

Although it is not reasonable to attribute the successful uptake of microcomputer use in primary schools to any single factor, some specific factors were found to be positive in almost all cases of successful integration. Some of these and the issues which relate to them are discussed in the following section.

4. FACTORS AFFECTING THE UPTAKE AND USE OF COMPUTERS

The development of computer use in primary schools was found to be influenced by a number of diverse factors which included, the attitude of the headteacher, timetabling arrangements, teachers' attitude to the technology and the fabric of the school building. Whilst the provision of in-service training would seem to be an important factor, evidence from the case study schools indicated that short INSET courses were not as effective in promoting computer use as had been expected by course tutors. Teachers' acceptance of the value of microcomputer use in classrooms did not necessarily lead to regular, integrated use.

4.1 Teachers' perceptions of the value of microcomputer use in the primary curriculum

Through interviews with class- and headteachers, perceptions of the *value* of microcomputer use was related to their actual use.

Microcomputers were regarded by many teachers as a necessary part of modern primary education, the use of which increased their working commitments. Of the 89 teachers who were interviewed with schedule A or B, over half (63%, n=56) with some experience of using computers felt that it was a teacher's duty to introduce children to computers (Table 2).

Almost half the teachers, (47%, n=42) believed that computer use resulted in an increase in a teacher's workload (Table 3). Reasons given for this increase in workload included the time needed to set up and put away the equipment, to review software and the time which the teacher had to spend in the classroom, organising and supervising the children and dealing with running problems.

More infant teachers had a negative attitude to microcomputers than junior teachers. A number of teachers of younger (five to seven year old) children felt that microcomputers were unsuitable for use by children of this age. This was reflected in the amount of computer use in the junior and infant classes. Exactly half the junior classes, (50% n=33) were observed using microcomputers compared with just over one fifth, (22%, n=11) of infant classes (Table 4).

The lack of use of microcomputers with infant children was considered by the teachers to be caused by a number of factors. These included:

- the lack of good quality software for infant children;
- the extent of teacher supervision of the activity perceived necessary with infant children;
- the storage of equipment in safes rather than on trolleys on the ground floor of schools.

The first two difficulties had been overcome by some infant teachers who had put an effort into finding out what software was available and organising the activity in the classroom. The classroom practice of the teachers who reported some use of computers was also observed in order to relate how their perceptions influenced their actual use of computers with pupils.

Table 2: The responses of teachers interviewed with schedule A & B (n=89) to the question "Do you think it is a teacher's duty to introduce children to computers or not?"*

Teachers' Answers	Teachers Interviewed Number	%
yes	56	63%
no	23	26%
don't know	8	9%
other	2	1%

Table 3: The responses of teachers interviewed with schedule A & B (n=90) to the question "Do you think the use of a microcomputer increases or decreases your workload?"

Teachers' Answers	Teachers Interviewed Number	%
increases	42	47%
increases then decreases	7	8%
decreases	5	6%
neither	19	21%
both	7	7%
don't know	8	9%
other	2	2%

Table 4: Proportions of infant (n=49) and junior (n=66) classes observed using computers in the twelve case study schools.

Classes	Infant Number	%	Junior Number	%
using computer	11	22%	33	50%
not using	38	78%	33	50%

* This question was erroneously omitted in the interview with one respondent

4.2 *Teachers' perceptions of how microcomputer use affects their classroom practice*

The use of microcomputers was reported to have had little effect on teaching styles or on the content of learning. The majority of teachers interviewed with schedule A, who had considerable experience of using computers, said that there had been little or no change in the way they taught (75%, n=53) (Table 5), or on the content of the curriculum (66%, n=48) (Table 6). This was confirmed through the classroom observations. Computer based activities were regarded as being most appropriate for supporting or reinforcing existing class work, rather than initiating new types of learning activities.

Table 5: The responses of teachers interviewed with schedule A (n=71) to the question "Does using a micro in class influence the way you teach?"*

Teachers' Answers	Teachers Interviewed Number	%
yes	16	23%
no	53	75%
don't know	1	1%
other	1	1%

Table 6: The responses of teachers interviewed with schedule A (n=73) to the question "Does using a micro in class influence the curriculum?"

Teachers' Answers	Teachers Interviewed Number	%
yes	21	29%
no	48	66%
don't know	2	3%
other	2	3%

The results are not surprising as the level of use by even the most dedicated teachers was not extensive, and the amount of hardware available to them was very limited. The most frequent use of computers in the schools was by a few pairs of pupils at a time and not as part of an organised, integrated class activity.

* This question was erroneously omitted in the interview with two respondents

4.3 *Practical affects of using computers in the classroom*

The 73 teachers interviewed with schedule A were asked a range of questions relating to using computers in the classroom. Almost half of the teachers reported that the use of computers had influenced the physical organisation of the classroom. The need to site the machine near to a power socket was said to be a particular problem. The difficulty of accommodating equipment in small classrooms and organising children to use the computer was also commented on by some teachers (Table 7).

Table 7: Teachers' perceptions of the effect of using computers on classroom activities and organisation - reported by teachers interviewed with schedule A (n=73)*

Impact	Questions relating to the effect of computer use on: Classroom Organisation	Relationship with children	Discipline	Distraction to other children
yes	33 (46%)	21 (29%)	15 (21%)	23 (32%)
no	39 (54%)	50 (68%)	53 (74%)	40 (56%)
don't know	0	2 (3%)	0	0
other, eg. some children)	0	0	4 (5%)	9 (13%)

(The percentage of teachers in each category are given in the parentheses.)

Less than one third (29%, n=20) of teachers said that using the computer in the classroom affected their relationships with the children they were teaching. The majority of teachers (74%, n=53) did not believe that having a computer in the classroom was a disruptive influence. The remaining teachers (26%, n=19) said that it was or that it could cause discipline problems for some, if not all, children (Table 7).

When asked whether or not the computer was a distraction to children not using it, opinions were divided. Whilst over half (56%, n=40) said that it was not, a large minority of teachers (45%, n=32) said that it was or could be. However several teachers added that this effect applied equally well to other classroom activities and was not a feature specifically related to the technology.

* One teacher was unable to answer three of the four questions as she had only used a computer out of the classroom

4.4 *Gender bias in the use of computers in the classroom*

The level of expertise in the area of computing indicated a significant bias in favour of male teachers. This was indicated by the ratio of male to female staff involved with the most use of computers.

An official post of responsibility for computers existed in less that half (5) of the twelve schools. Of these, most posts were held by male members of staff with only one position occupied by a female teacher.

Reference to official responsibility however, does not present an accurate picture of the actual circumstances in the schools visited. Whilst *official* posts incorporating the use of computers existed in five schools, in five other schools one teacher oversaw their use throughout the school, albeit in an unofficial capacity. For example, in one school the headteacher undertook this role and in another a teacher who had a keen personal interest in computers (although no scaled post) willingly used his own time to produce school guidelines and review software. Using these figures, whilst the ratio of male to female staff occupying a position of authority with respect to computers is more even, the imbalance in favour of male teachers is still significant, seven of the ten "experts" being male.

An examination of the figures relating to the use being made of computers at the time of the school visits reveals a similar imbalance in favour of male users. Just over three-quarters (76%, n=19) of the male teachers interviewed were observed or known to be using a computer, compared with only one quarter (25%, n=26) of the female teacher sample (Table 8). The lower overall male numbers is due to the higher proportion of female primary school teachers. In the twelve case study schools there were four times as many female as male teachers.

Table 8: Number of male and female teachers observed using or not using a computer in the twelve case study schools, at the time of the initial visit

Using a computer	Teachers Interviewed Male	Female
yes	19 (76%)	26 (25%)
no	6 (24%)	78 (75%)

4.5 *The affect that the attitude of the headteacher has upon uptake*

The uptake of computers was highest in schools where the headteacher had a positive attitude to computers and an active interest in promoting their use throughout the school (schools 1-4 in Table 9). The percentage of class teachers observed were those who made any use of computers in their teaching. Therefore, it is also a measure of the uptake of computers across the school. In all but one of these four schools (school 2), one teacher assumed overall responsibility for the management of the resource and computers were timetabled throughout the school. However, school 2 was exceptional as the level of resource (thirteen machines shared between nine classes) was such that no timetabling was necessary.

Table 9: The twelve case study schools arranged in rank order according to uptake (% of class teachers) observed using computers.*

Rank Order	% of Class teachers observed	Headteachers' Attitude (positive/negative)	Headteachers' Action (active/passive)	Responsibility by one teacher (yes/no)	Timetabling of Computers (yes/no)	Number of computers
1	88% (n=7)	P	A	Y	Y	6
2	78% (n=7)	P	A	Y°	N+	13
3	78% (n=7)	P	A	Y	Y	2
4	71% (n=5)	P	A	Y	Y	3
5	45% (n=5)	N	P	Y	Y	3
6	38% (n=3)	P	P	Y	N	3
7	25% (n=2)	N	P	Y	N	3
8	23% (n=3)	P	P	Y	N	3
9	19% (n=3)	N	P	N	N	3
10	14% (n=1)	P	P	N	N	5
11	8% (n=1)	N	P	N	N	1
12	0% (n=0)	N	P	N	N	2

Return visits were made to the schools a year later. In school 9, the previous headteacher had retired and the newly appointed Head, who had a positive attitude to the use of computers in primary education compared with a negative attitude of his predecessor, was in his second term at the school. The new headteacher reported that the majority of staff had shown a "dramatic" increase in interest in the technology since he had joined the school. This change of attitude was reflected in the number of teachers making regular use of a computer in their teaching at the time of the two school visits. Three of the sixteen teachers (19%) were using a computer at the time of the first visit, compared with nine of the fifteen teachers (60%) who reported regular use a year later (Table 10).

Table 10: Summary of staff use of computers in school 9 in years 1 and 2

Year	Number of computers	Number of classteachers	Computer post	Headteacher's guidelines	Number (%) of staff regularly using micros
1	3	16	N	N	3 (19%)
2	3	15	N	N	9 (60%)

Notwithstanding outside pressures and the natural development of interest by individual teachers, the accelerated development of computer use in school 9 could be attributed to the change of headship, as no additional hardware had been acquired, no official policy changes had been made and there had been very little other staff change.

* At the time of the initial visit
° responsibility undertaken by headteacher
+ timetabling unnecessary as 1+ computer available in class

4.6 *The affect on uptake of planned management of microcomputer use*

As reported previously, some formal organisation of the resource was an important factor in encouraging whole-school uptake. The use of computers was higher in schools where microcomputers were timetabled than in schools where there was no formal organisation.

However the research also indicated that the timetabling of computers to classes on a daily basis often restricted the use made of the software, especially with classes of younger (infant and lower junior) children. Frequently teachers would choose short easy-to-use programs, which needed little or no teacher intervention, in order to enable all the children in their class to "have a turn at the computer".

4.7 *In-school support structures*

The development of computer use was found to be greatest in schools where computers were an integral part of the school's ongoing curriculum development programme. Schools in which one 'expert' teacher was released from class teaching duties to work with colleagues in the classroom were less successful in encouraging the long-term uptake of computers. In such instances the use of the computer came to be seen as the responsibility of the visiting teacher. Class teachers did not have the time to observe the computer based activity whilst they were teaching. Computer use in these classrooms would often cease when support was withdrawn.

4.8 *The provision and effectiveness of in-service training*

Many INSET courses on the use of computers were criticised by the teachers as having limited application to the primary school curriculum. Two fifths (n=52) of the 129 teachers interviewed during the initial school visits, had received some out of school training which had focused on computer use or had included some instruction in this area. These included courses to meet the requirements of the Department of Trade and Industry, other courses organised by the local authority and by further education establishments as well as training received as part of initial training courses. Whilst many teachers reported that courses had provided a useful introduction to the technology and had resulted in an increased level of personal confidence, they were said to have little relevance to classroom practice.

Table 11: Teachers observed using a computer at the time of the initial visit and attendance at an out-of-school course.

Teachers who had attended a course	Teachers observed using a computer: yes	Teachers observed using a computer: no
yes	31 (69%)	21 (25%)
no	14 (31%)	63 (75%)

Despite criticisms of these in-service courses (described in more detail in the next Section), teachers who had received some external training were more likely to be using a computer in their teaching than untrained teachers. Of the forty five teachers observed using a computer, over two thirds (69%, n=31) had attended an out of school course (Table 11). This could, however, be attributed to the fact that teachers motivated to go on courses are those who are already more likely to be innovative in their classrooms.

However it is interesting to note that, out of the 52 teachers who had been on a course, 21 (40%) did not subsequently use a computer on a regular basis in their classrooms. A detailed investigation into INSET provision formed a major part of this study (Cox and Rhodes, 1988). Some related findings are discussed in the following section.

5. A STUDY OF INSET PROVISION

The research showed that short in-service courses are not able to provide teachers with the breadth and depth of experience that is required to enable them to make the best use of computers in the classroom. In order to develop the necessary level of expertise and skill associated with "effective" use, teachers need the support of an ongoing training programme.

The courses provided by the LEA were longer than the minimum two days required by the Department of Trade and Industry but the LEA was constrained by the enormous task of training teachers in over 600 primary schools. There was therefore a conflict between the need to train many teachers and the need to provide extensive training for each teacher. With limited resources and an insufficient number of expert tutors, it was impossible to meet both these needs adequately.

5.1 *How the LEA's perception of teacher training needs is reflected in INSET provision*

In the study briefly described here, the LEA's perceptions were deduced from the INSET observations and teachers' interviews. The LEA was constrained by national schemes to provide INSET to a large number of teachers. This meant that most INSET was in the form of short courses, except for the 150-hour certificated course which teachers attended on a part-time basis over a school year.

There was inevitably a mismatch between the content of short Teachers' Centre courses and the actual training needs of teachers. Research was carried out at four Teachers' Centre courses; three for teachers with little or no previous experience of computers and one for more experienced users. The emphasis on these LEA short courses (6-12 hours over 4-8 weeks) was on software operation and use, not on the educational applications.

One of the aims of the short courses studied was to give teachers confidence to use the hardware and software. Course members were introduced to a range of open-ended software which could be used across the curriculum. The effect of this emphasis on open-ended software, which is complex to operate, was that tutors spent a large proportion of the time instructing teachers how to operate the software and giving teachers time to experiment with the programs (Cox and Rhodes, 1988). Less than three per cent of the total time was spent discussing the educational applications (Table 12). The LEA had to assume that teachers themselves would have sufficient ideas about classroom practice to be able then to apply these skills in the classroom. As noted already, this assumption was found to be false.

Many teachers said that the training was too short, and the software too complex, to be covered in a short time. Several teachers felt they were unable to incorporate computers into their teaching. Frequently, teachers using computers regularly in the classroom expressed a need for additional training to help them use computers more effectively.

Table 12: Percentage of time spent on different activities during the four Teachers' Centre short courses

Activity	Percentage of total course time
Tutor instructing teachers using hardware/software	29%
Teachers experimenting with hardware/software	61%
Discussion about educational issues	3%
Other (including setting up equipment)	7%

5.2 *The difference between teachers' perceived and actual training needs*

Teachers with little or no previous experience of computer use, often do not know what they need to learn, in order to use computers effectively in the classroom. The two principal training needs expressed by teachers attending Teachers' Centre short courses for beginners, was to become more familiar with the hardware (73%, n=19) and the software (42%, n=11) (Table 13).

At the end of these courses, which focused on hardware and software operation, several teachers reported that they still did not feel able to initiate computer use into their teaching. Often teachers said that they would have liked more ideas on how best to incorporate computers into the curriculum, yet at the beginning of the course only one teacher had expressed a need to learn about how to use a computer with children. As another example, one teacher who had been on a short course was interviewed a year later and said that, in spite of having used a computer almost daily since then, he felt he was still not making the best use of the computer in the classroom. He realised that he needed further training which emphasised the curriculum applications of the software.

Table 13: Training needs as reported by teachers attending the three Teachers' centre short courses for beginners (n=26).*

Training needs	Number (%) of teachers
To become familiar with hardware	19 (73%)
To become familiar with software	11 (42%)
To gain confidence	3 (13%)
To receive basic instruction in computer use	2 (8%)
To find out how other schools use computers	1 (4%)
To learn how to use a computer with children	1 (4%)
To improve classroom practice	1 (4%)

It is clear from the data shown in Table 13, that very few teachers knew what skills, and therefore what training, they would need in order to use computers effectively in the classroom. Such knowledge is not acquired until they have had some in-service experience. It is therefore very difficult for teachers with no experience of computers to choose the most appropriate training, and, as is shown

* Some teachers gave more than one answer

in the following section, it is often difficult for some tutors to know what skills are needed either.

5.3 *The adequacy of INSET in training teachers to use microcomputers effectively*

Short courses in themselves cannot provide teachers with the necessary skills to use computers effectively in their teaching. Teachers need time to become confident in using the hardware and the software and to consider the curriculum applications+. Long out-of-school courses which aim to develop teachers' skills and experiences over an extended period, provide the time and opportunity to assimilate what is learnt into classroom practice.

The imbalance in the content of the short courses, (an emphasis on software operation and not curriculum use), was reflected in the use made of software in the classroom. For instance, in the use of word processing packages, many teachers see the purpose of the activity as to provide a perfect hard copy of the children's work. Children were frequently observed copy-typing corrected handwritten work onto the computer. Whilst children did use the editing facility to correct punctuation and spelling errors, in only one classroom were children seen to be encouraged by the teachers to edit for composition or content. On short courses, teachers did not discuss how to use word processors for creative writing, for restructuring stories or collaborative writing. It can be concluded that, to be effective, short courses needed to provide a better balance between instruction, experimentation and discussion about the educational aims and objectives of using the software.

Table 14: Percentage (%) of time spent on activities in the four Teachers' Centre short courses and on the long "Certificated" course.

Activity	Percentage (%) of total course time Long course	Short course
Tutor instructing others in using hardware/software	10%	29%
Teachers experimenting with hardware/software	34%	61%
Discussion about educational issues	12%	3%
Other *	44%	7%

Course organisers were able to plan a more balanced content during the long "certificated" course with 150 hours of tuition plus an additional 150 hours working on written, school-based assignments. [This compares with an average duration of 9 hours for the Teachers' Centre courses.] Whereas nearly one third (29%) of the time on short courses was spent instructing teachers on how to use hardware and software, this task occupied only one tenth (10%) of the long course (Table 14). Similarly teachers on short courses spent more than three fifths (61%) of the time using the software, in contrast with the long course where just over one third (34%) of the total session time was spent on this activity. On the long course 12% of the total time was spent discussing the educational implications of using specific software packages compared with 3% for the short courses.

+ Hoyles and colleagues (1990) report on a two-phase approach to developing effective classroom use.

* This included, on the long courses, visiting schools and preparation of written assignments and, on the short courses, setting up equipment and waiting for late arrivals.

6. CRITICAL FACTORS WHICH INFLUENCE UPTAKE AND DEVELOPMENT AT THE LEVEL OF THE LEA, SCHOOL AND TEACHER

As a result of this study a number of key-factors which influenced the uptake of and use of computers in primary schools, at the level of the LEA, the school and the teacher, were identified. A summary of these is given in Table 15.

Table 15: Positive and negative factors influencing the use of computers in primary schools

Level	Positive Factor	Negative Factor
LEA	Resource provision (The 12 schools had a total of 49 computers {at the time of the last school visit}, giving a mean of 4 and a range of 2 - 13)	Insufficient number of long courses
		Inappropriate short course content
	Good servicing facilities	Insufficient staff to provide long-term in-school support
	Software support	
School	Headteacher with positive attitude	Headteacher with neutral or negative attitude
	Teacher with overall responsibility for computers	No identified teacher to support inexperienced teachers
		Loss of most experienced member of staff
	Formal organisation of the resource throughout the school	Physical difficulties of using hardware (insufficient trolleys, secure storage in safes.)
		Problems of access to hardware in multi-storey schools
	High number of machines relative to classes	Small number of machines relative to classes
	Developmental approach to computer use	
	Sustained school-based INSET programme	
Teacher	Confidence in using the hardware and software	Lack of confidence in using the hardware and software
	Sustained training programme (in-school or out-of-school)	No initial training which is perceived to be essential
		Limited knowledge of software
	Knowledge of educational goals	Limited knowledge of educational goals
	Supportive classroom practice	Perceived as not suitable for infant children
		Lack of time Lack of motivation

7. SUMMARY AND CONCLUSIONS

The majority of teachers acknowledged that computers were an essential resource in the modern primary school. Computer use was reported to have resulted in an increase in teacher workload and was said to have affected the physical organisation of the classroom. However, teachers reported that computers had had little effect on their teaching styles or on the content of the curriculum.

The belief by some teachers that computers were not suitable for use with the younger (5-7 year olds), was not substantiated by classroom observations. Infant teachers reported the lack of good quality and appropriate software, and the need for greater pupil supervision as being particular problems.

Lack of time is an acute problem for primary school teachers, who do not have the opportunity to become familiar with using the hardware and software during the school day and often have to rely on out-of-school training. However, short courses are not able to provide the variety of experience necessary to make effective use of computers in the classroom. Whilst long courses can provide teachers with the necessary breadth of experience, such INSET is only available to a small number of qualified teachers each year.

The attitude of the headteacher was shown to have a crucial influence on the uptake of computers in primary schools. Schools judged to be most successful were those where teachers were involved in the development of computer use across the curriculum. Whilst the extent of usage, in terms of the number of teachers using the technology, was positively related to the formal organisation of the resource, in some instances, positive management strategies resulted in a more restricted use of the software.

Whilst the majority of teachers in primary schools were female, there was a strong bias in favour of male teachers both as "experts" and "user" teachers.

Short INSET courses focusing on the use of IT were criticised by most teachers as being of little practical value. Despite this teachers with some out-of-school training were more likely to use a computer in their teaching than teachers with no such training. The research findings show that the majority of time on short Teachers' Centre courses was spent learning how to operate complex software, little time being available to consider curriculum applications. The failure of short courses to provide a balanced content was reflected in the inappropriate use of software in some classrooms.

Teachers who are inexperienced in computer use naturally find it difficult to know what in-service courses would be of most benefit to them and so selection of appropriate courses may be somewhat haphazard.

The findings of this research has shown that the introduction of computers in primary schools has not resulted in major changes in teaching and learning styles as advocated by some of its more avid proponents (see for example Chandler (1984) and Papert (1980)).

With the advent of the National Curriculum all primary school teachers are being obliged to integrate computer use into the teaching of subjects across the curriculum. Whether this legal requirement will result in a dramatic increase in the use of IT to extend and enhance teaching in primary schools, or whether it will

restrict computer use to a narrow range of programs chosen to meet the specific objectives as laid down in the Statutory Orders, remains to be seen.

The provision of good quality in-service education would seem to be a crucial factor in the equation. The results of this study, particularly those relating to INSET provision, have highlighted some of the problems associated with providing effective in-service courses in this area. Training teachers to make the best use of computers in their teaching requires them to be involved in much new learning which takes time to assimilate. It is not possible to provide teachers who have little or no previous experience of computer use, with the range of necessary skills in short one-off courses. Teachers need to become personally confident and competent in using the hardware and a range of software. They also need to be aware of the educational potential that particular software packages have to offer and know how best to implement these programs into a classroom in order to achieve the desired objectives.

This means that the majority of practising teachers need extended professional training supported by practice in schools, and a clear curriculum development programme backed by the headteacher and the whole school if IT is going to be part of an integrated curriculum activity. Whether Government will respond to the challenge and provide schools with the necessary resources, in terms of hardware and software but more importantly with the provision of adequate INSET training programmes, will be revealed in time. Further research focusing on the effect that patterns of INSET provision have on the use of IT across the curriculum would make a valuable contribution to knowledge in this area.

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APPENDIX 1: *Questions used in interviewing Class Teachers**

abc How long have you been teaching?
abc How long have you been at this school?
abc Do you have a post of responsibility?
abc Were there computers in your previous school?

Attitude to computers in general

ab When did you first encounter computers?
ab What were your first impressions?
ab Have your views changed? How do you feel about computers now?
ab When did you first use computers in the classroom?

Training

ab Have you been on any courses (details: day, residential, school based, etc.)
ab What did you learn on the courses (list)? What value has this been since?
ab Whose idea was it for you to go (inspector, Head, other staff, self)?
ab Do you feel competent in handling the machine in the classroom now? If not, what else would you like to be able to do?
abc Have any school-based INSET courses related to computers been organised? If yes: whose idea was it? who organised them? how many have taken place in the year? when were these meetings held? did all the staff attend? what form did they take (workshops, visiting speakers, formal discussions, demonstrations,. . .)? what did they aim to do (introduce computers to staff, further computer use in one area of the curriculum, demonstrate new software)? in your opinion were these aims successfully achieved?

Computers in school

ab Do you discuss the microcomputer at all with other members of staff (formally at staff meetings, informally in breaks, etc.) and how often?
ab How do you feel the Head in this school views the micro and its use?
ab What about other members of staff?
ab Would you say that the use of the micro increases or decreases your workload (distinguish between preparation time and work within the actual class and assume reasonable competence)?
a What are your views of the support given from a) the inspectorate, b) ILECC primary advisory team, c) servicing (technical) facilities?
a What happens on a day-to-day basic when something goes wrong? Who do you ask for help within school?
a Do you feel you need further help with the technical side of computing?
a And what about the educational side?

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* a, b, c indicate that these questions were used in schedules A, B and/or C. In compressing the questions for inclusion here, some wording or emphasis that guided the interviewer may have been lost.

Organisation of the classroom

a How frequently do you use the micro in your classroom / with your class?
a Has your classroom organisation been affected by the micro?
a Does using a micro influence the curriculum; what about the way you teach?
a And what about your relationship with the children, has that changed at all?
a How do you use the micro in the classroom (whole class/ group/ pairs/ individuals)? If it varies, in what situation do you use it in each way?
a Do all the children use it? If no, who is it that uses it/ doesn't use it? Why? If yes, do they all use it to the same extent? If not, who uses it more/less? Why? How do you decide who uses it and when?
a Do any discipline problems arise as a result of the micro in the classroom?
a Do you worry about it getting damaged at all?
a Do you find it a distraction to the children who aren't using it?

Hardware features

a Do you personally have experience of using more than one type of computer? If so, what have you used? What micro do you like using most/least? Why?
a Have you used both disk and cassette tape based programs? Which did you find easier to use?
a Do you usually use a colour or b&w monitor? If colour, do you think that this improves the visual displays and the value of the programs you use? Does it affect the children's interest?
a Do you use a printer? If so, when do you tend to use it? How useful do you find it? Could it be useful?

Views on software

a Which programs do you use (list)?
a Do you relate each of these to a particular skill or subject area?
a Which programs do you find most useful? What aspects?
a What are your main information sources for learning about software (advertising, newsletters, courses, other teachers)?
a Where is the software kept? Is it catalogued? If so, how is it catalogued? Who did this? Are there other resource materials related to using the micro such as teachers' manuals, pupils' books on computers, accompanying worksheets, work cards, reference books, etc. If so, where are these kept?
a Have you written or altered software yourself? If so, what have you done?
a When you are choosing a program, what influences your choice (have used it before, someone recommended it)?
a What are your views on the software available for use in primary schools?
a Is there anything else you would like to see available?
a Which programs are most popular amongst the children?

Attitude to Computers in Education

a Can you outline some advantages of computer use in your classroom?
a Are there any disadvantages?
ab Do you think the use of a computer helps children to learn more easily, or earlier, than they would have otherwise (some/all children)?
ab Do you tend to use other audio visual aids (if so, what and in which areas)?
ab Could you give me a description of the way you think a micro is best used in a primary school classroom. I'm thinking of things such as whether it is used for independent work only or as a backup to lessons, and whether by individuals or in groups. [Ask the rationale for each preference stated.]
ab Do you think young children should be taught how to program (reasons)?

ab Do you think it is a teacher's duty to introduce children to computers? Why?
ab Do you think micros should be used across the board in primary schools or are they best suited to a particular age range?
bc What are your views on the use of computers in education generally?
bc Would you ever contemplate using a computer in school in the future? If yes, in what circumstances; if no, why not?
ab A lot of money is being spent nationally on computers, peripherals and software for schools. In your opinion, is this money well spent? [Record all qualifying statements, eg. only if there are enough books, and any other priorities mentioned.]
ab And what about in your own school. What is your opinion of the amount of money being spent on this sort of technology?
ab What are your views on the role of computers in society in general?
c Have you had any contact with computers out of school?
c Have you ever used a computer in your teaching?
c If no, have you ever used the school computer?
c If no, have you ever seen it used?

abc Please indicate which age group you are in . . . . .

APPENDIX B: *Questions used when interviewing Head Teachers**

How long have you been teaching?
How long have you been as this school? How long have you been Head?
Has the school acquired any computers since you arrived? Were there computers in your previous school?

Development of computer use

When did your school acquire its first micro? 19 . . .
Were you Head of the school then?
What model was it? Was the machine bought as a part of the DTI scheme?
What prompted the school to acquire its first machine? Were other members of staff involved in the decision? Did you receive advice from outside the school (eg inspectors, advisers, other schools)?
How many computers are there in school now (list types)? When was each acquired? Were other members of staff involved in the decision? Was anyone other than staff (eg. parents, governors) involved in these decisions?

Attitudes to computers in general

When did you first have contact with computers (college, home, the media, etc)?
What were your initial impressions? Have your opinions changed since then?
Have you attended any courses to do with computers (record details)?

* Depending on the answers to some of the questions, some were omitted or asked in a different order. In compressing the questions for inclusion here some wording or emphasis that guided the interviewer may have been lost.

Attitudes to computers in education
There are many different views regarding the usefulness of computers in primary schools. What do you think is the value of having a micro in the classroom?
Are there any problems associated with it (specify)?
Do you think its educational value is the same for all children, or does it vary (bright/slow; as a bribe/reward)?
What are your main information sources for learning about software (advertising, newsletters, courses, other teachers)?
What are your main sources for acquiring software (commercial, ILECC, MEP)?
What do you think of the software for primary schools? Is there anything you particularly like? Is there anything you would like to see made available?

Computers in schools
Do you have any guidelines for your staff regarding the use of computers in the classroom, or do they decide themselves whether they will use it and in what way?
How do you assess the interest of your staff on the whole?
Has there been any resistance or reluctance to use a computer? If yes, did you do anything about it? Is anyone particularly enthusiastic?
Do you think that the use of a computer in the class changes the role of a teacher? If so, in what way?
Have any school-based INSET courses related to computers been organised? If so, who organised them? How many have taken place in the academic year? When were these meetings held? Did all the staff attend? What form did they take? What did they aim to do? In your opinion, were these aims achieved?
Have you any future plans with regard to school-based courses related to computer use?
How many teachers from this school have attended out-of-school INSET courses? How were these teachers selected?
Is sufficient expertise in school in order to use micros effectively in the classroom? If not, could anything be done to improve the situation?
Is there a particular teachers with special responsibility for the computer(s)? Why them? What duties does this involve?
Is there a computer club at school? If so, who supervises this and what duties does this entail?

Organisation of the resource
What storage arrangements are made for micros in the school? At night?
Who gets them out in the morning and sets them up?
Are there any problems with timetabling or moving micros from room to room?
Have you had to make any physical alterations to the school because of the micros (power points, cables, etc)?
What need has there been for technical/advisory support from the LEA?
In general, are you satisfied with the support service?

External influences
Do you maintain links with other primary schools regarding the use of micros? If so, what form does that take?
Is there any other external interest (parents, governors) in the use of micros in your school?

Future development
Do you have any thoughts about future development of micro use in school?

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.