INSET for IT

a review of the literature relating to preparation for and use of IT in schools

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Published in February 1999
by the National Foundation for Educational Research,
The Mere, Upton Park, Slough, Berkshire SL1 2DQ

Registered Charity No. 313392
ISBN 0 7005 1500 3

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1. INTRODUCTION

1.1 Background

The last 20 years have seen considerable changes within schools. Computers began to become widespread in schools in the 1980s, have steadily increased in number and are today regarded by many as essential tools. We look towards the millennium and the opportunities to be provided by the National Grid for Learning (NGfL). Information technology (IT), or, as it is more commonly referred to nowadays, information and communications technology (ICT[1]), permeates our lives in shops, libraries, doctors' surgeries, etc. The present Labour government places considerable importance on awareness of, and competence in, ICT. This was signalled in opposition by the initiatives which established the Stevenson inquiry into ICT in schools (Stevenson, 1996) and led to the setting up of the NGfL. Since Labour came to power, the allocation of funding for training and for purchasing hardware suggests that ICT remains an educational priority.

However, the introduction of any new resource brings an associated need for training and support. This report presents the findings of a literature review conducted in order to collect evidence relating to:

- the provision of training for practising teachers for using IT (in-service education for teachers – INSET)
- factors relating to the use of IT in the classroom
- the implementation of IT in schools.

Each of these areas is presented in turn. The report closes by considering some of the issues that need to be addressed when looking towards the future.

However, before moving on to the findings of the review of the literature relating to the areas listed above, it is appropriate to rehearse some of the background pertinent to the preparation for, and use of, computers in schools.

1.2 Early strategies to promote computers in schools

A major source of encouragement for schools to acquire computers occurred in the early 1980s, when the Government subsidised the purchase of computers for schools in a scheme operated jointly by the then Department

[1] *Both terms are used within this report; in general the use of each reflects what was/is common at the time.*

of Education and Science (DES) and the Department for Trade and Industry (DTI). Under this scheme, schools were able to purchase hardware on a matched half-and-half cost basis, so that if the school could secure funding for half the cost, the other half was met under the DES/DTI scheme. However, the choice of hardware was restricted to three options:

- the Acorn (BBC) Model B
- the Research Machines 380Z
- the Sinclair Spectrum.

Most schools taking advantage of this scheme opted for either the Acorn or the RM machine, possibly because the Spectrum was a smaller machine with an unusual (at that time) feature of a smaller than standard keyboard with rubber keys.

As the range of software available for these machines was very limited, the Government funded the provision of packs of programs distributed as the Micro Primer Pack. This consisted of several short programs which focused predominantly on basic skills in mathematics and English. The software for these early systems was stored on cassette tapes and had to be loaded on to the computer before use; each time a new program was required, the loading process from the cassette had to be followed. This process was time-consuming for the teacher, and caused a noisy distraction within a classroom.

Subsequently, programs were stored on 5¼" floppy disks. This development was welcomed as a considerable improvement on the cassette versions, although these disks were vulnerable to damage due to being protected only by a thin plastic carrier.

From the early forms of hardware and software, ongoing developments have increased the ease of use of computers in schools as much as anywhere else. Improvements that have enhanced convenience and ease of use include: the move to 3½" floppy disks (enclosed in hard plastic cases); machines with hard disks to store programs; software with graphical user interfaces (GUIs), e.g. Microsoft Windows ™; and the use of networks. More recently, access to the Internet has become less costly, and increasing numbers of schools are using the World Wide Web and e-mail as resources.

1.3 IT in the National Curriculum

A National Curriculum that applied to children aged 5-16 years began to be implemented in England and Wales in 1989. At that time, three core subjects were identified: English, mathematics and science. Information technology (IT) was designated as part of one of the foundation subjects (technology), which also included design technology. As with other subjects, the implementation of the Orders was phased in over a period of years, in this case, from September 1990 and over the subsequent three years. As a result

of the Dearing Review (1994) of the National Curriculum, the structure of the Order for technology was revised, such that design technology and IT were formally separated. Most recently, from September 1998 ICT has been designated as one of the core subjects.

In addition to the statutory Order, from the earliest stages of introducing the National Curriculum, the then National Curriculum Council (NCC) provided non-statutory guidance which identified different strands of progression in IT:

- communicating information
- handling information
- modelling
- measurement and control
- applications and effects (NCC, 1990a).

The first four of these were clearly related to development of skills in using IT, whereas the fifth was concerned with awareness of the social contexts in which IT is used. These strands have not only been used by teachers for planning IT-based work; they have also been used by others (such as INSET providers, OFSTED inspectors) as useful classifications of different types of IT activity, and as such, remain pertinent.

In addition to its original status as part of one of the foundation subjects, early guidance (NCC, 1990b) also prescribed a number of cross-curricular themes and competences which were intended to cross subject boundaries and permeate children's experience throughout both their primary and secondary schooling. IT was one of the six skills identified (the others being communication; numeracy; study; problem solving; and personal and social skills).

1.4 Methodology

1.4.1 Sources of information

Relevant texts were identified by searching the International ERIC CD-ROM database. Keywords for the search were as follows: primary education; secondary education; computers; information technology; INSET. These were chosen so as to restrict the texts identified to the phases of education under consideration and to focus on the use of computers within schools rather than in other sectors.

In addition, the author of this report was aware of two additional useful sources of information. Firstly, a major international study concerning the use of computers in schools was organised by the International Association for the Evaluation of Educational Achievement (IEA) in the late 1980s. Some texts relating to this study and which seemed relevant to this review had already been identified by the author in connection with other work,

and were used as sources for this review. Secondly, national surveys of the use of computers in schools have been carried out by the Department for Education and Employment (formerly the Department for Education and prior to that, the Department of Education and Science). These were known to be reliable sources of data and were therefore also consulted.

Finally, many of the texts consulted included lists of references, and a number of these were followed up where it was anticipated that they would extend the evidence/discussion relating to particular points. For example, texts relating to the IEA study mentioned above included a number of references to other research carried out in the The Netherlands and in the United States. Some of these documents have been reviewed since they contain material which relates to issues under discussion, rather than to specific national initiatives.

1.4.2 The scope of this review

As stated above, the last ten years have witnessed considerable changes in education in the United Kingdom as well as in computer technology and use. The strategies adopted by the Government to promote the use of computers within schools are necessarily unique to the national situation; similarly, the expectations and guidelines relating to curricula are country-specific. Changes in computer technology are frequent and wide-ranging. Resources that were state-of-the-art a few years ago are now regarded as obsolete.

With these points in mind, it was decided to restrict the scope of the review to a body of literature which was manageable within the duration of the project. In practice, this was effected by focusing the review predominantly on literature relating to England and Wales, and from 1988 onwards. (This year was selected as meaningful since, as well as representing a ten-year period prior to this review, it marked the date of the Education Reform Act, which heralded the introduction of the National Curriculum into England and Wales.) As noted above, other texts (whether international or, in a few cases, published just before 1988) have been included where relevant.

Some of the literature that relates to using computers within schools is concerned with administrative uses, rather than educational uses. This has been largely excluded from this review, since it raises a number of issues outside classroom pedagogy. Similarly, material relating to initial teacher education has been excluded, since the review was intended to focus on training for in-service teachers.

The review includes documents presenting the results of empirical work; government publications (such as OFSTED reports, statistical surveys and curriculum guidance); and some shorter articles which present accounts of existing practice (e.g. written by teachers) and/or express a particular view.

In instances where the empirical work referred to was very small-scale, or there may be other concerns about the quality/reliability of the data, or of how widely the results can be applied, these issues are raised within the commentary.

On the basis that before practising teachers can begin to use computers within their classes, and also use them effectively, some form of in-service education (INSET) is required, the subject of INSET for IT has been the main starting point for this review. This is addressed in Chapter 2, which covers INSET requirements; models of INSET provision; and issues regarding INSET. Chapter 3 looks at factors relating to the use of ICT in the classroom, including: teachers' attitudes towards IT; teachers' competence, confidence and experience; pedagogical issues; and gender issues. Implementation of IT is considered in Chapter 4, which covers the low level of implementation to date; the rationale for using ICT in schools; whole-school organisation/schemes and policies; and patterns of implementation. Finally, in Chapter 5, some of the issues to be addressed are identified, including integrated learning systems (ILS); the National Grid for Learning (NGfL); changing roles for teachers; and resources.

1.5 Summary

Computers began to become widespread as resources for learning in schools in the 1980s. Developments in hardware and software have increased their ease of use. IT was designated part of the National Curriculum in 1990 and from September 1998 has been deemed one of the core subjects.

This review focuses on literature which relates to preparing to use and using IT in primary and secondary schools in England and Wales. The majority of the texts referred to have been published since 1988, the year of the Education Reform Act.

2. INSET

2.1 INSET requirements

The introduction of any new technology into the learning environment brings with it both potential for utilisation and demands for users to be trained in its use. Within schools, the widespread introduction of computers as a resource in the 1980s meant that both teachers and pupils had to become proficient in using new machines. Training for students attending initial teacher training (ITT) institutions has had to be provided within their pre-service courses, and this has been accomplished with varying levels of success by different institutions. There is a body of literature relating to this area and it is not proposed to reiterate that within this document. However, within this chapter, literature relating to the INSET for practising teachers will be reviewed.

Clearly, teachers must be given training in the use of computers within the classroom if they are to be able to make good use of them as an educational resource.

It is by no means safe to assume that recently trained teachers will have had sufficient training in the educational use of computers, although the provision of a national curriculum in ICT for all trainees in ITT institutions from September 1998 signals the increasing emphasis on ICT skills. McCoy (1992) comments:

> *It is a well-known fact that many new teachers have had little contact with computers before entering the profession. So it comes as no surprise that most of these find difficulty in coping with the technology at all, never mind using it productively as an integral part of the curriculum* (p. 20).

More recently, Heinrich (1997a) has observed: 'All primary teachers have been trained to teach the traditional subjects but only those recently at college will have received much IT training' (p. 7).

McCoy (op. cit.) notes that while newly qualified teachers may have had relatively little pre-service training in the use of computers, '...more established teaching staff ... may not only have never used a computer, but actively don't want to use one, a state often described as 'technofear' ' (p. 20).

McCoy goes on to say:

> *Even for teachers with experience of IT, the often haphazard introduction of technology into schools means that the machines they find in schools may be totally unfamiliar to them. Adequate IT training has always been a problem. One INSET day spent*

> *learning a program thoroughly is fine, but what about all the other programs, the choices that are not exploited? And the endless technical hitches, the arrival of a new piece of equipment that needs setting up, or being able to quickly install and trial new software?* (p. 20).

An analysis of primary and secondary schools' IT policies carried out by Harris (1994) revealed that these documents sometimes referred to INSET, whether in terms of INSET received, INSET required and/or a general statement of entitlement to INSET. Interestingly, the number of schools' policies that identified INSET requirements was more than five times greater than those that identified INSET received.

Griffiths and Alfrey (1989b) report on the results of a questionnaire survey regarding computer use in primary schools in Kent. At that time, fewer than half of the respondents (44 per cent) had been on a computer course, and most of the courses had been 'very short courses indeed' (p. 24) (unfortunately the authors failed to define what they considered to be very short). Griffiths and Alfrey also quote one respondent's comment '...that INSET [should] be "not just for computer buffs and scale postholders" '.

Almost a decade later, the situation does not seem to have improved as much as might have been hoped: Gillmon's (1998) survey of teachers revealed that:

> *The great majority of teachers had had no training in either generic or specialist applications; a relatively small number had had up to one day's training in at least one application.*
>
> *Fewer than one-fifth of teachers had sufficient confidence and competence in the use of generic IT applications to enable them to apply and practise them or to develop IT capability in pupils* (p. 12).

Unfortunately, Gillmon provides neither percentages nor numbers of respondents who constitute the 'great majority' that have not received INSET, so it is impossible to establish the scale of the problem. However, since we are told that 10,000 completed questionnaires were returned by teachers, representing a 55 per cent response rate, this certainly suggests a major shortcoming in INSET.

With limited funds available to headteachers for INSET each year, this highlights the issue of how headteachers should prioritise the allocation of funds for INSET in IT amongst their staff. When trying to promote/ develop a relatively new area of the curriculum (IT), should they allocate funds to either:

- **several less-expert teachers**, so as to boost their confidence and make them feel valued, although training at their level could have been undertaken by the IT coordinator within the school (this approach does not take the school as a whole forward a great deal)

or

- **the IT coordinator**, so as to increase their own knowledge, which can then be cascaded to other staff (the problem with this approach is that other staff feel excluded from attending externally provided INSET, and there is the additional problem of finding time for running within-school INSET)?

As already noted, technology continues to develop at 'an ever quickening rate' (Goldstein, 1997), which increases the need for appropriate INSET. However, apart from the considerations concerning the cost and prioritisation of INSET allocation, there are other weaknesses that may be apparent in within-school INSET provision, as noted by Goldstein (op. cit.):

> *The bulk of in-service training offered to primary teachers has been in-house, and such training has been valuable in spreading familiarity with IT skills and facilities and National Curriculum requirements. However, such in-house training often stops short of providing sufficient guidance on how to make the most of particular applications of IT tasks in class, and what might reasonably be expected of pupils* (p. 10).

At a more general level, Stevenson (1996) notes that, 'In service training is the key to improving skills and confidence in the use of ICT within the teacher [work] force' (p. 23).

It may be, therefore, that headteachers want to give further consideration to the balance between within-school and externally provided INSET.

Another issue to be considered is how teachers adapt their existing pedagogy to include the use of computers in their lessons. It may be the case that less experienced teachers need more time to develop their classroom management and organisational skills before attempting to include computers within their class, whereas more experienced teachers, who are at ease with the administrative aspects of their work, are more adept at incorporating new technology into their established classroom practice. Some evidence to support this notion is provided by Griffiths and Alfrey (1989b), who found differences in the experiences and expertise of the teachers who were identifed as the greatest computer users (in terms of using them to support the widest range of contexts across the curriculum), but noted that the one area of commonality was that they had all been teaching for ten years or more. More recently, Andrews's (1997) survey of secondary school mathematics teachers revealed an association between *shorter* teaching careers (i.e. younger teachers) and regular, competent computer use. It is not clear whether this finding could be generalised to teachers of other subjects and within primary schools.

Undoubtedly, with schools increasingly conscious of the high cost of IT as part of the curriculum, it is likely that they will be faced with decisions about how best to spend the funds available: whether it is preferable to

allow a small number of teachers to attend some externally provided INSET or to purchase additional resources (e.g. more software/a new laser printer, etc.). This may result in decisions to purchase additional resources in preference to INSET, on the basis that the former will be of benefit to a greater number of individuals throughout the school. However, with the relative paucity of pre-service training, this can lead to a situation where costly equipment is under-utilised. Goldstein (1997) notes:

> *Even where schools had made reasonable investments in hardware and software, the resources they devoted to staff development in IT were often far too limited. This, coupled with the scarcity of teachers with initial training in IT, and the need for most teachers to teach themselves how to use or teach IT, impoverished the quality of provision and achievement in many schools* (p. 11).

This view echoes earlier comments by OFSTED (1995) and the Parliamentary Office of Science and Technology (1991). Apart from these observations, IT coordinators within schools have identified INSET for colleagues as one of their main concerns for the future (Kennewell, 1996).

Finally, these problems are not unique to schools in Great Britain: Casimir (1988) describes an approach used in The Netherlands, in which project schools had to send three teachers for INSET. The schools had to ensure that of the three teachers, one was a novice in IT and one was a female teacher. Three types of INSET programmes were provided:

- beginners (about two-thirds of the teachers)
- partly trained (about one-sixth of the teachers)
- fully trained (about one-sixth of the teachers).

Casimir identifies some of the tensions that were apparent during the training, such as the teachers' desire for ideas that could be immediately transferred into the classroom, in contrast to the trainers' preference for providing skills and strategies that were more transferable and therefore of long-term value:

> *Teachers always ask for examples that can be used in the classroom tomorrow. They want recipes that fit exactly into their way of teaching, and that motivate all pupils. But even if it were possible to meet this demand, it would be short-sighted to do so exclusively. Teachers must be trained to react to changes in the future.*
>
> (Casimir, 1988, p. 318)

At a wider international level, Pelgrum and Plomp (1993) presented data collected from 18 countries as part of the International Association for the Evaluation of Educational Achievement's (IEA's) Computers in Education study. Apart from poor levels of resourcing, the authors note that the major problems were: '...teachers are insufficiently trained and teachers don't have enough time to prepare the use of computers in their lessons adequately' (p. 115).

Thus, the evidence amassed over the last ten years suggests that the provision of INSET in IT has remained problematic since computers were first introduced into schools, and even today there are too few teachers who are competent and confident in the use of IT within the classroom.

In the next section, some of the models of providing INSET will be considered.

2.2 Models of INSET provision

Throughout the 1980s the cascade model of INSET was widely used, in INSET for IT as well as for other subjects. It had the supposed advantages of relatively low cost (by training only limited numbers of teachers in any one school) together with the potential to influence practice throughout the school (since teachers were expected to share their newly acquired skills/ knowledge with their colleagues). In reality, this potential was seldom fulfilled, as teachers were frequently too busy with other items on the agendas of staff meetings in order to allow detailed feedback together with consideration of the implications and possibilities. Russell (1995) also criticises the cascade model on the ground that it fails to address the individual circumstances/ situation/needs of particular teachers and suggests that: '...one to one tuition and development ... is by far the best staff development/INSET strategy available' (p. 3).

The lack of time available within short courses to relate the course content to individual circumstances and school situations can present difficulties. The Economic and Social Research Council (1990) notes that:

> ... *short, out of school, courses were not meeting the actual training needs of teachers. ... Less than 5% of the total course time was spent on considering the educational application of the software in the classroom* (p. 172).

As a result of this approach, some teachers felt inadequately prepared to use computers within their classes without further training.

In contrast, the very small numbers of teachers who were able to attend long courses (150 hours per year, which usually lead to some form of accreditation) benefited from:

> ... *the time that it gave teachers during the school day to review and discuss the educational potential and applications of a range of current software with other teachers. The duration of this course enabled teachers to experiment with programs in the classroom and discuss the outcomes with colleagues.*
>
> (ESRC, op. cit., pp. 172–3)

Govier (1991) also stresses the more thorough understanding of the educational potential which can be gained through long courses:

> *One hundred and fifty hours of contact with lecturers, machines and other learners, linked to a further 150 hours of private study and assessed by a series of written assignments, produces a high level of competence and sophistication in the use of computers in education. Teachers attending long courses become highly effective users of IT within their teaching, with a sound professional grasp of the educational issues* (p. 167).

Although there are undoubtedly considerable educational benefits associated with the teachers who have been able to attend long courses, it must be acknowledged that relatively few fall into this category.

There is some evidence, however, to suggest that some of the problems associated with short, out-of-school courses can be alleviated by the provision of appropriate support within the school after the initial training. Importantly, the timing of courses can assist or hinder the likelihood of school-based support. Wild (1991) recounts his experiences as an advisory teacher seconded from his own school. He notes:

> *One year secondments are not, in general, going to provide the follow up support in schools unless courses are run in the first term. This would apply to both school based and external based INSET ...* (p. 297).

On the basis of responses to a questionnaire survey sent to teachers who had attended INSET courses in IT within the previous 12–18 months, Wild concludes that rather than relying on attendance at INSET courses alone, the priority (so as to ensure increased use of computers within schools) should be the establishment of internal support systems, in the form of support from senior management and the IT coordinator.

Of course, the extent to which schools are able to benefit from ongoing support and input from an advisory teacher is more open to question since local education authority IT support centres have had to work on a cost recovery basis.

There are, nevertheless, alternatives to attending out-of-school INSET courses and/or those provided for staff at one school (or a cluster of schools). Higham and Morris (1993) and Russell (1995) describe projects in which student teachers worked with experienced teachers. In both cases, the practising teachers and the student participants felt that their knowledge and confidence in using computers had increased, although in neither case is it clear whether the benefits directly related to the project work were transferred to other aspects of IT work.

Project INTENT (Initial Teacher Education and New Technology) (Somekh, 1993) aimed to improve the IT capabilities of initial teacher education tutors so that they could better prepare students to use IT in schools. Somekh concluded that an effective model for IT training (arguably not only in ITT institutions) was the approach used in INTENT: 'on-the-job' training and

support for tutors together with the involvement at the institution of two key personnel:

- a staff development tutor (who may/may not have been the IT coordinator)
- a senior manager.

This has clear parallels with the key people within schools that Wild (1991) identified as crucial in ensuring within-school support.

Maddin (1997) provides illustrations of different approaches to the provision of school-based training. She describes five strategies that have been used in a project in Cincinnati:

- **shadowing**: as used in the business world, a learner follows a mentor working in his/her environment so as to gain insights into the successful use of ICT in the classroom
- **one-on-one for one**: a teacher coach works with one learner on a specific focus for a one-hour session
- **rotating topics**: at least three tutors work with small groups of teachers; each tutor focuses on a different aspect of ICT and the teacher groups rotate so that they cover all three aspects
- **walk-in clinics**: teachers attend a drop-in clinic, having notified their area(s) of concern in advance; in addition to addressing the needs identified by teachers, the clinic might also run a 'troubleshooting' session to help teachers solve problems with hardware, and organise a hands-on session for teachers to learn a new skill
- **student exchanges**: students who have acquired particular ICT skills may be 'loaned' to other classes to share these skills with other students; also, students may visit another class where new applications are being covered, then return to their own class to share their new-found expertise with their peers.

In suggesting that one topic that could be covered in a walk-in clinic might be troubleshooting (i.e. fixing problems), Maddin observes, 'Teachers without troubleshooting skills are less likely to use technology' (p. 58).

Like others (e.g. Pelgrum and Plomp, 1993), Maddin (op. cit.) emphasises the need for teachers to have sufficient time to become familiar with the technology:

> *Time is one of the most critical factors in adopting any new initiative. Time to learn, time to practice, time to reflect ... Training must be accompanied by a well-designed maintenance plan that provides opportunities for teachers to talk about issues, ask questions and get feedback. By viewing the adoption of new technology as a process that takes place gradually, schools can provide both the time and the resources to help teachers implement technology effectively* (pp. 58–9).

However, time for teachers to become familiar with new hardware and software and then to consider how it may best be included in their pedagogy can often be difficult to find. Bell (1997) notes:

> *It seems obvious that if teachers are to be instrumental in developing new skills in children, teachers must be trained in the use of information and communications technology (ICT). But meeting this need isn't necessarily straightforward. Providing IT training for teachers has been on the agenda in the UK for many years; since the 1980s, it has been 'a critical issue'. Millions of pounds and a great deal of effort has gone into trying to raise the level of ICT skills among teachers, but with limited impact* (p. 6).

Bell's solution to the problem of needing to make more impact on teachers' confidence and competence in ICT than previous initiatives have done is that teachers should have access to their own computer which can be used at home and at school. So as to encourage this, Bell suggests that teachers might be given some sort of financial help if purchasing a computer for educational use, as it is relevant to their work. In support of her suggestion she cites schemes to promote computer ownership amongst teachers in Singapore and Tasmania funded by their respective governments. It remains to be seen whether or not this radical approach will be explored as a possible solution to the problem of costly technology being underused by inadequately prepared teachers.

2.3 Issues regarding INSET

The preceding sections have focused on teachers' INSET requirements and means by which INSET may be provided. This final section in this chapter will draw together some of the issues relating to INSET, and look at possible future developments.

One of the great strengths of ICT, that it is constantly evolving and developing to offer more opportunities, surely causes one of the major problems faced by those responsible for ensuring teaching staff are provided with appropriate and adequate INSET, and that provision is made for updating knowledge and skills. This was noted by Harris (1992):

> *As schools replace older computers with new models, teachers are frequently faced with familiarising themselves with a different operating system and using newer, more complex software ... Consequently, as a result of developments in relation to hardware and the enhanced capabilities of new software, there is an increased need for INSET for teachers* (p. 39).

This weakness was also identified by Goldstein (1997) in his review of school inspections carried out during 1995–6:

> *Initial and in-service professional training and technical support for IT-based work have not kept pace with the rapid changes in*

> *technology. The situation is exacerbated where IT co-ordinators have virtually no time during the school day to help teachers to evaluate and develop their work in IT* (p. 6).

Since statistical surveys carried out by the DfEE, and formerly the DFE, and the DES, suggest that the number of schools with IBM PC-compatible computers is increasing (GB. DfEE, 1997a), and more schools are working with systems using a Windows™ environment, the problem of adapting from one operating system to another is likely to diminish if schools continue to purchase similar systems. However, technologies that were relatively rarely found within schools a few years ago, such as CD-ROMs, multimedia, e-mail and the Internet, are increasing their stronghold on schools, and consequently sustain the demand for INSET.

McCoy (1992) identifies four features that characterise good INSET:

1. *Assess experience and training needs, i.e. is a basic computer literacy course required or should the emphasis be on developing a special interest in say, language databases or library software?*
2. *Choose a suitable method of training, i.e. an introductory video followed by a workshop or a training program.*
3. *Training should include hands-on experience and be tailored to educational needs.*
4. *Limited numbers in a class are best and only one person to a machine is preferable* (p. 20).

More recently, Selinger (1998) has listed seven key features of ICT INSET identified by the Teacher Training Agency (TTA):

- *focus on pedagogical skills in subject context*
- *emphasis on the need to set clear learning objectives*
- *development and evaluation of teaching approaches*
- *assessment of needs*
- *use of ICT-based materials with on-line support*
- *access to multimedia computers*
- *action plans for further development* (p. 10).

Evidently, there is common ground in these two sets of features. However, arguably more important than identifying appropriate content for INSET is ensuring sufficient funds for this purpose. In January 1998, the Government announced that funding of £235 million would be available to provide INSET and new resources in ICT. At face value, this sounds like a substantial investment, and one destined to make a considerable impact on teachers' competence and confidence in ICT. This sum is also in addition to the investment of £100 million in new resources for schools to replace obsolete classroom equipment which was announced by the new Labour Government

shortly after taking office in May 1997. However, both Selinger (1998) and Selwood (1997) have pointed out that, in reality, the benefit to individual schools will be relatively limited. Selwood notes that the investment of £100 million in resources equates to approximately three new computers per school: too few to have a noticeable impact. In addition, he questions how INSET will be provided for all 500,000 practising teachers, since the advisory teacher infrastructure which was available in the 1980s has been dismantled. Selwood also considers that, with the very limited time available on one-year PGCE courses, there is little opportunity for students following this route to teacher accreditation to develop their own skills to use ICT effectively in the classroom. This makes these teachers even more dependent on the level of competence and confidence of practising teachers in schools. Selinger suggests that the sum allocated to INSET amounts to approximately '... £450 per teacher, so some creative solutions will be needed if this is to raise all teachers' use of ICT and awareness of how it supports teaching and learning' (p. 10).

In theory, the new National Curriculum for ICT for students undergoing initial teacher training (ITT) which was introduced in September 1998 should improve the capabilities of newly qualified teachers when they enter the workforce. However, these benefits will not be felt for at least four years, and they do not address the issue of improving the competence of existing teachers. Interestingly, Veen (1993b) considers that there is more benefit to be gained from training practising teachers than student teachers, largely because newly qualified teachers tend to (have to) focus on classroom management issues (such as discipline and administration), and therefore are less likely to attempt to incorporate ICT into their classroom practice. Yet Veen's observations led him to conclude that teachers attempted to incorporate the use of computers into their established pedagogy, rather than experiment with new approaches. Similar findings have also been reported by Chalkey and Nicholas (1997), Somekh and Davies (1991) and ESRC (1990). Reinen and Plomp (1993b) analysed international data collected by the IEA's Computers in Education study, developing a scale to rate the extent to which teachers used computers in their lessons, and concluded that when training focused particularly on pedagogical aspects, it contributed to the integration of computers within the classroom.

However, alternative strategies for training practising teachers surely need further exploration. A particular problem identified by Harris and Preston (1993) was the difficulty reported by half of the primary teachers working in rural schools in reaching IT training centres. Mutual support through mechanisms such as the NGfL may improve the situation for teachers in such schools.

The gap between teachers' expectations that INSET should provide them with material that can be readily transferred into a classroom context and trainers' desires to develop knowledge, skills and strategies that will enable teachers to cope with future development in ICT (Casimir, 1988) has already been discussed. Similarly, Casimir drew attention to the issue of whether it

is best to focus training in schools which are already making use of IT, or those which are not:

> *And we hesitate to provide* [training for] *the more enthusiastic and active schools first. Will this widen the gap between them and the reluctant ones? On the other hand, if you do it our way, will you frustrate the schools that were very active and now have to wait for the others to join in?* (p. 321).

Whilst one may assume that, ten years after it was first asked, this question is no longer relevant, the relatively low levels of implementation of ICT in both primary and secondary schools, together with Goldstein's (1997) observations that the quality of provision and student achievement in ICT in many schools is 'impoverished' and 'IT is the least well taught of the subjects of our National Curriculum' suggest that it remains pertinent.

2.4 Summary

A National Curriculum in ICT for trainees undergoing initial teacher education was implemented in September 1998. Research evidence suggests that as recently as 1998, a large percentage of practising teachers had not received INSET in IT. The pace of technological development creates further demands for INSET. The relative benefits of within school and externally provided INSET have to be considered. The use of new technology places additional demands on teachers: some research evidence suggests that teachers are reluctant to modify their established pedagogy. Casimir (1988) identifies tensions between teachers' preference for ideas that can be immediately transferred into the classroom, whereas trainers prefer to develop skills and strategies that are transferable and therefore of long term value.

Gillmon (1998) found that only a minority of teachers were sufficiently confident and competent in their use of generic IT applications to use them effectively and develop IT capability in their pupils. Long INSET courses (usually leading to accreditation) allow teachers time to discuss the use of IT resources and to reflect on the educational potential of applications, whereas short courses, of necessity, allow few opportunities for this. Commentators such as Russell (1995) and Somekh (1993) have stressed the value of one-to-one training which is customised to the individual. Alternative strategies for providing within school training are proposed by Maddin (1997).

Many researchers have pointed to the need for time for teachers to familiarise themselves with new hardware and software (e.g. Maddin, 1997; Pelgrum and Plomp, 1993). Similarly, IT coordinators within schools have too little time available during the school day to assist their colleagues and contribute to their professional development.

Goldstein's (1997) observation that the quality of provision and student achievement in ICT is 'impoverished' suggests that the need for INSET is as great as ever.

3. FACTORS RELATING TO USE OF IT IN THE CLASSROOM

3.1 Teachers' attitudes towards IT

Teachers' attitudes towards IT may be influenced by the attitudes of others around them, such as:

- IT teachers within the school
- senior managers within the school, e.g. the headteacher
- regional personnel, e.g. local education authority (LEA) advisers
- national policies and initiatives regarding IT.

Commentators such as Pelgrum (1993) and Van den Akker *et al.* (1992) have identified the substantial impact that external influences have on teachers' use of IT.

Pelgrum (op. cit.) developed a series of attitude scales which were based on the responses of headteachers and teachers in primary, lower secondary and upper secondary schools to survey questions used as part of the IEA's Computers in Education study. One of these was the educational impact scale, which comprised statements concerning the role of computers in the classroom. Pelgrum found evidence of a link between positive attitudes of headteachers towards educational uses of computers and similar views amongst teachers within the same schools. It is not clear whether this was a causal link or merely evidence of a correlation. In addition, the headteachers and teachers may have been influenced by local education authorities stipulating that computers should be used (perhaps providing resources to help achieve this) and/or by in-service training courses (INSET).

Pelgrum's analysis showed that teachers who make *extensive* use of computers believe that they have a *positive* educational impact. This raises the important question: which condition exists first, valuing the educational use of computers, or using them extensively?

i.e. value ⟶ use a lot

OR use a lot ⟶ value

This question raises the related issue of teachers' expertise in the use of IT (which will be dependent on INSET received), since previous research (e.g. Reinen and Plomp, 1993a) has shown that INSET is an important factor influencing the integration of computers.

Van den Akker *et al.* (1992) identify four categories of variable influencing the implementation of innovative resources such as computers within classrooms:

- national and/or regional contexts: in England and Wales these may be interpreted as firstly, national initiatives such as the 1983 DES/DTI scheme to subsidise schools' purchase of computer hardware and, more recently, the establishment of the National Grid for Learning; and secondly, local education authorities' policies regarding recommended hardware and software licences (the latter before the changes to LEA systems led to IT advisory teams working on a cost-recovery basis)
- characteristics of the school, in terms of the organisational structure
- external support, such as the provision of INSET
- characteristics of the innovation itself.

Van den Akker *et al.* (op. cit.) refer to other research having identified encouragement and support from headteachers and administrators as being of vital importance, and go on to comment:

> *Also conducive to the implementation process is a positive school climate where teachers give mutual support by exchanging ideas and experiences and by providing feedback* (p. 67).

Van den Akker *et al.* (op. cit.) also suggest that IT coordinators in schools can provide a positive lead to colleagues, especially if they not only have IT expertise but good interpersonal and organisational skills too.

As noted above, research has shown that the headteacher's attitude to IT is important and can influence the extent to which teachers utilise IT in their classroom practice (see, for example, Pelgrum, 1993; Harris and Preston, 1993; ESRC, 1990).

Research carried out in primary schools in Kent (Griffiths and Alfrey, 1989a; 1989b) suggests that this may be explained by their finding that in primary schools, IT coordinators are likely to be headteachers/deputy headteachers/ mathematics/science coordinators. In other words, the school's IT coordinator is likely to be either one of the senior managers within the school, or in a position of influence as coordinator of one of the core subjects under the National Curriculum.

On the basis of responses to two surveys of mathematics teachers, Andrews (1997) found that substantial numbers of teachers appeared to be unconvinced of the value of IT: when asked to justify the use of four types of software (databases, spreadsheets, Logo and BASIC programming), the percentage of respondents who made neutral comments ranged from 40 per cent to 55 per cent for each of the four named types. Even the applications which attracted the highest percentages of positive comments from teachers (Logo and spreadsheets: 49 per cent and 45 per cent positive comments respectively) were regarded favourably by fewer than half the respondents, possibly prompting Andrews to comment: '... unless teachers

become convinced of the value of IT, their using computers will remain peripheral to their teaching' (p. 254).

Other considerations will also affect the extent to which teachers use computers. Research reported by ESRC (1990) found that teachers thought that using computers would increase their workload: 'Almost half of the 90 teachers with some experience of using computers felt that their use resulted in an increase in their workload' (p. 172).

There is also evidence that there are differences in attitude towards computers which are gender related. This is explored in Section 3.4.

3.2 Teachers' competence, confidence and experience

Within the last ten years, teachers who have attended INSET have reported that the courses have helped to increase their competence and confidence in using IT (see, for example, Higham and Morris, 1993; ESRC, 1990). Yet despite the fact that passing years have presented opportunities for more teachers to increase their skills in IT, weaknesses identified by McCoy (1992) seem to be still evident (Gillmon, 1998; Goldstein, 1997). This suggests that we need to look for explanations other than attendance at INSET courses for the reasons for the apparently poor state of teachers' competence and confidence in IT.

Reinen and Plomp (1993b) found that there were higher levels of computer integration within the classes of teachers who had been using computers for a longer period of time. Becker (1993) analysed additional data collected in the US to supplement those collected as part of the IEA's Computers in Education (Comped) study and concluded that those schools that were relatively late in adopting the use of computers (late adopters) did not have to go through the same patterns of experience as the schools that were early adopters of the technology, but rather were able to proceed to more sophisticated uses. However, there are two weaknesses in this analysis, the first of which is acknowledged by Becker himself:

- the data was not collected longitudinally: it is therefore probably unrealistic to hope to be able to identify differences between early and late adopters;
- the pace of technological innovation in IT is rapid, and therefore late adopters were likely to be using hardware and software that was different from that available to the early adopters.

Analysis of two projects funded by the Dutch government in the 1980s conducted by Brummelhuis and Plomp (1993) showed similar results: there were no major differences in the use of computers in schools which were involved in only the second project as opposed to those which had been involved in both.

Yet at the same time, research such as that by Reinen and Plomp (op. cit.) suggests that those teachers who have more experience of using computers are likely to make more extensive use of them in their teaching. One way in which teachers may extend their experience of using computers is to use one at home. However, this may not be an opportunity open to many teachers, since there is some evidence that the number of teachers who have access to computers at home is relatively small (e.g. Cuthell *et al.*, 1997, who found that fewer than half of the teachers surveyed had a home computer, and only about half of those that had access to one made use of it).

In contrast, Becker (1994) carried out an analysis of data collected as part of the US dataset for Comped in order to determine which variables were associated with teachers becoming 'exemplary' in their use of computers in the classroom. Perhaps surprisingly,

> ... *exemplary computer-using teachers were as likely to be found in low-income districts and low-socio economic status schools as they were in other schools* (p. 298).

In other words, exemplary teachers were not found only in schools that were better resourced. As a result of his analysis, Becker identified four criteria likely to lead to teachers becoming exemplary in their use of computers within their classes:

a) *the existence of a social network of computer-using teachers at the same school;*

b) *sustained use of computers at the school for consequential activities, that is, where computers are used to accomplish a goal other than learning, for example, writing and publishing, industrial arts, or business applications;*

c) *organised support for computer-using teachers in the form of staff development activities and a full time staff member in the role of computer coordinator; and*

d) *acknowledgement of the resource requirements for effectively using computers, for example, smaller class sizes and funds for software acquisition* (p. 303).

Importantly, Becker also emphasises the crucial role of INSET:

> ... *the survey findings indicated consistent associations between the presence of exemplary teaching practice using computers and substantial investment in support and training of personnel* (p. 305).

A further point identified by Becker (1993) was that, across the countries involved in the Comped study, teachers that had been early adopters had been more involved in decisions about how to use computers and had greater personal access to computers (in their homes).

Finally, within the UK, Goulding (1994) studied the use of computers in secondary school mathematics lessons by student teachers and experienced teachers over a two-year period. Goulding classifies the software used into two main types:

- **problem-solving**: having specific content, but able to support discussion and group work
- **applications**: more open-ended and investigative programs, e.g. graph plotters, spreadsheets and databases.

On the basis of classroom observations, Goulding concluded that experienced teachers used problem-solving software more than applications software, whereas the reverse was true of the student teachers' use of software.

A further point to be borne in mind is that, according to Goulding,

> *Towards the end of the first year, students were asked to identify their needs for an intensive period to be spent on IT. Most of them asked that time should be spent on applications software. In the next year, more time was spent on Logo, spreadsheets, and graph plotting* (p. 104).

It is therefore not surprising that in the second year of the study, more students reported using applications software since they had had more of their course time allocated to it. This may be regarded as evidence that when teachers (or, in this case, student teachers) have had more extensive training on some aspect of IT (such as applications software), they are then more likely to be confident in its use and utilise it in the classroom.

However, it would be unwise to draw any other than tentative conclusions from this research, since it was based on a very small sample, and different students and different schools were studied each year.

3.3 Pedagogical issues

Arguably, the introduction of ICT into classrooms has been the most significant development to impinge on teachers' pedagogy that has been witnessed in recent years. Even the introduction of the National Curriculum may have caused less trepidation to teachers, since it was emphasised that although the Orders specified *what* should be taught, teachers retained freedom to decide *how* to cover the curriculum.

The issues to be addressed regarding the use of computers to support the curriculum include:

- **the availability of appropriate resources**: hardware and software;
- **technical skill on the part of both teachers and students**: the ability to use the hardware and software and utilise their capabilities;

- **pedagogical skill**: how to integrate IT resources effectively into teaching programmes, for example, as an introduction to a topic, as practice or reinforcement of other work, or as extension work; classroom organisational issues, such as the advantages/disadvantages of using stand-alone machines as opposed to networked systems; and
- **organisational structures**: timetabling arrangements may either restrict or facilitate exploration of software, e.g. in secondary schools, double periods allow more time than single periods.

It is worth noting that whilst appropriate ITE and INSET can prepare individuals to address the second and third of these issues, the first and fourth are dependent on particular schools' circumstances.

Gardner *et al.* (1994) suggest that although theoretical debates regarding the value of IT in education may be of interest to policy makers and academics, schools have other priorities:

> *... these reflect practical matters related to teachers' confidence and competence in the use of computers, teachers' time and access to computers, and the provision of sufficient resources for teachers and pupils to use* (p. 4).

With regard to schools' organisational structures, ESRC (1990) report on research conducted in primary schools in London, and note:

> *... computers were more likely to be used in schools in which there was some formal organisation of the resource (such as timetabling), than in schools where teachers used computers as and when they wanted to* (p. 171).

However, it must be remembered that at the time of the study reported, there were far fewer computers in schools and, as a result, there was likely to be more consideration given to sharing the resource between classes. Today, this is less of an issue since schools generally have more computers available (see Section 4.1). Nevertheless, some of the practices that were evident in schools may still be relatively widespread today, such as that described below:

> *...many infant teachers tended to use short, simple programs which required little teacher intervention, in order that all the children in the class could have a turn on the computer in one day* (p. 171).

A body of research evidence exists suggesting that the innovation of IT in the classroom has not necessarily led to innovative pedagogy. Somekh and Davies (1991) note that 'Computers, of themselves, are not transforming' (p. 153) because teachers tend to incorporate their use into their own established pedagogy. ESRC (1990) observe: 'The majority of teachers said that computer use had little effect on the way they taught, or on the content of the curriculum' (p. 171).

Watson (1992) comments:

> *The effectiveness of classroom delivery of curriculum objectives, how far these objectives sit comfortably with teachers' strategies and styles, and assessment of pupils' learning and understanding are only some of the many variables that will influence the reality of using computers in classrooms* (p. 61).

Or, in other words, in the years following the introduction of the National Curriculum and its associated assessment arrangements, teachers' own pedagogical practices will necessarily influence both the extent and the type of use of computers in classrooms.

Veen's (1993a) observations of teachers in a Dutch secondary school led him to conclude that teachers' own pedagogical beliefs and practices influenced not only the ways in which they used computers (see also Section 4.4), but also the approaches which they used most often:

> *The teachers' beliefs on the content of their subject matter and their pedagogical and educational beliefs appeared to be the most influential factors. They did not change their beliefs and attitudes but adapted the use of computers to their existing teaching routines. When the use of computers and software made the teachers deviate too much, they decided not to use them at all* (p. 1).

One possible reason why some teachers tend to incorporate the use of computers into their existing pedagogy is an absence of willingness to change their established routines and approaches. Van den Akker *et al.* (1992) note that:

> *Computers challenge teachers' existing instructional routines by requiring a shift from expository teaching towards a role in which the teacher is more of a partner and guide of the students* (p. 70).

Apart from the inconvenience of amending their own pedagogy, many teachers may be resistant to using computers because of the perceived threat: a change in the balance of power. This was identified as a main issue by Somekh and Davies (1991), who comment that the introduction of a computer within a classroom changes the traditional structure of the environment, in which students are dependent on the teacher as a source of knowledge and information: the computer can be an alternative source of both of these. Also relevant in this context is the view expressed by Cuthell *et al.* (1997), who argue that the benefits that students perceive they gain from using computers in the production of their work (e.g. improved presentation; greater range and accuracy of information) may lead to teachers having to rethink some fundamental assumptions:

> *Curriculum delivery may have to be rethought, in that assumptions about developmental stages and theories of learning may no longer be appropriate. Children who have mastered computer routines are freed from the limitations of their developing motor skills* (p. 21).

Possibly with tongues in cheeks, Cuthell *et al.* (op. cit.) conclude that:

> *Student-centred learning may yet re-define itself, cloaked in The Web and, Phoenix-like, arise in the new respectability of Lifetime Learning* (p. 21).

Finally, we should reflect that it is questionable whether or not we should accept the considerable variation in practice with regard to utilising computers in schools, with some teachers being exemplary in their use of new technologies, others reluctant to utilise computers at all, and others falling somewhere between these two extremes. On the basis of evidence collected from school inspections, Goldstein (1997) considered that there was a gulf between primary schools that are well-resourced and have competent teachers who develop skills and confidence in pupils and those schools which lack both resources and competent teachers, whose pupils leave the school with underdeveloped IT knowledge and skills.

3.4 Gender issues

Much research has shown that the use of computers is dominated by males. Andrews (1997), Culley (1993), Reinen and Plomp (1993a), Griffiths and Alfrey (1989b) and Culley (1988) have all identified male teachers as using computers more frequently than female teachers.

An additional area of interest is that of whether or not there are gender differences in *how* teachers use computers. This is pertinent not only as an issue in its own right, but also because if there is a gender imbalance, this may convey messages to students which may reinforce gender differences in *their* attitudes towards and liking for computers.

Pelgrum (1993), in his analysis of data collected in 1989 by the IEA's Computers in Education (Comped) study (in which 22 countries took part), found that gender seemed to be a more important factor related to teachers' views of the educational potential of using computers than were other factors, such as age and number of years of experience in using computers. Female teachers were reported to be less positive than their male counterparts about the educational impact of computers, although Pelgrum does not present evidence to support this assertion.

Reinen and Plomp (1993b), also referring to data collected as part of the Comped study, considered the types of female role model with which girls were presented with regard to the use of computers in primary, lower and upper secondary education. They found that in each of the three phases, there were large numbers of female teachers, but comparatively few female computer coordinators.

Reinen and Plomp (op. cit.) also analysed the teachers' responses to three self-rating scales about computer knowledge, programming skills and general capability (teachers were asked to respond yes/no to a series of

questions in each case). They found that the female teachers gave themselves lower ratings on each of the scales than their male counterparts. It is not clear, however, whether this is evidence of a genuine gender difference in knowledge and skills, or merely that female teachers are more modest and have a tendency to underestimate their capabilities. In addition, Robertson *et al.* (1995) found that male teachers rated themselves as significantly more confident than female teachers in the use of computers ($p<0.01$[1]). Further evidence of female teachers' lower self-ratings of competence (relative to their male counterparts) in using computers was collected by Andrews (1997), who analysed responses from mathematics teachers regarding their competence in using different types of software to determine whether or not there were interactions with teacher gender. Andrews notes:

> *... men were more numerous amongst the competent and active users. At the other extreme, there were disproportionately more women amongst the incompetent rare users. One explanation is that women, having experienced lifetimes of being told that things technological are the preserve of the male, leave their male colleagues to get on with it. A second, and more plausible, explanation is that women have lower self-perceptions of competence: they expect men to be more competent because that is how they have been encouraged to think and, therefore, a competent woman would rate herself equal to, say, an average man* (pp. 253–4).

Further data analysed by Reinen and Plomp (1993b) concerned teachers' responses to questions which constituted four scales:

- educational implications
- social implications
- training need
- self-confidence.

Responses were analysed firstly, to determine whether there was any significant gender difference in the overall results, and secondly, where there was a significant difference, to identify the relevant scale(s). Whilst there was no significant difference in the results at the primary level, within the secondary education phase there was a very highly significant gender difference in favour of male teachers in both the lower and upper secondary samples ($p<0.0005$[2]): further analysis showed that this was due to a significant difference between the male and female respondents on the self-confidence scale.

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[1] *There is always a possibility that a difference between two samples (in this case between male and female teachers) could have arisen by chance. The level of statistical significance gives an indication of how likely this is. The cut-off point between results which are thought to be evidence of a real difference and those which could have arisen by chance is generally accepted as p=0.05 i.e. a difference in the results is likely to have arisen by chance not more than five times out of one hundred. Where the likelihood of a difference occurring by chance is only one out of one hundred or less ($p \leq 0.01$), the results are thought to be highly significant.*

[2] *The probability of such a gender difference occurring by chance is less than five out of 10,000.*

Culley's (1988) quantitative and qualitative work led her to conclude that:

> *The vast majority of teachers of computing are male. Not only are specialist computer studies teachers much more likely to be male than female but so are the teachers of other subjects using computers as a learning tool. In the schools responding to the postal questionnaire over 70% of teachers using computers in their teaching were male* (p. 5).

Culley goes on to suggest that this finding is likely to be a reflection of '... the fact that the most common users of computers are science and mathematics departments, both often having a majority of male teachers' (p. 5).

In essence, therefore, we have a situation in which girls have few role models of females using computers confidently and effectively and they may be inclined as a result to conform to the stereotype of computer activities being dominated by males. This is also compounded by the strong links between computers and mathematics and science departments:

> *The manner is which computers have been introduced into most schools has tended to link computing with mathematics. The majority of teachers of computer studies in the schools visited were also teaching mathematics as part of their timetable, despite the fact that in most cases separate departments of computer studies or computer education had been formally established ... The siting of computers also tends to emphasise a link between computing and mathematics or science. In the majority of schools the computers were housed in the mathematics or science areas of the school.* (Culley, op. cit. p. 4)

Other research has explored gender differences in students' attitudes towards mathematics and science, and identified gender differences in preferences for particular approaches to learning (see, for example, Boaler, 1998; Solomon, 1997; Sutherland and Hoyles, 1988). Further research conducted by Culley (1993) continued to emphasise the effects of associating computer work with mathematics:

> *Although girls perform well in mathematics... they are less confident in their ability than boys ... If there is a perceived link between computing and mathematics, this may affect girls' confidence in approaching computing. This is not the only factor which might affect girls' participation in computing at* [secondary] *school, but it may be one of some significance. I found several features of school computing which engendered a link between computing and mathematics and enhanced the image of computing as a masculine domain* (p. 148).

Factors which might promote negative attitudes towards computers and computer courses within school, and, arguably, beyond, include the following identified by Culley (op. cit.):

- *ability in mathematics used as a selection criterion for computer courses;*
- *experiences of boys dominating mixed-gender group work using computers;*
- *course option restrictions that make it difficult to combine computer courses with other subjects which have been traditionally popular with girls.*

Opportunities to use ICT within a range of subjects are expected within the National Curriculum. Unfortunately, evidence collected from school inspections (OFSTED, 1995) suggests that students do not encounter ICT in as many different contexts across the curriculum as possible. Ideally, students should encounter and use a range of ICT applications in the context of different subjects, in lessons taught by teachers of both genders. The importance of providing appropriate role models for female students has been stressed by a number of researchers, e.g. Reinen and Plomp (1993b); and Hoyles (1988) who asserts: 'Girls need to see females as competent, confident and enthusiastic computer users ...' (p. 11). If we fail to address the gender issues relating to role models and student participation in ICT, we are in danger of perpetuating/condoning the phenomenon in girls identified by Collis (1985), which she summarises as the *'We can, I can't'* paradox, in which girls believe that as a whole, their gender is as capable of using computers as males, yet at the same time perceive themselves individually as lacking skills and competence in this area.

3.5 Summary

The attitude of the school's headteacher to IT is an important factor in determining the extent to which IT is used within the school.

Whilst Goulding (1994) witnessed different uses of computers by experienced and student teachers, Becker (1994) suggests that within school structures such as ongoing staff development and mutual support amongst computer-using teachers are contributory factors in helping teachers to become exemplary in their use of ICT.

Research evidence suggests that the innovation of IT in the classroom has not necessarily led to innovative pedagogy, indeed, teachers tend to adapt the use of IT into their established pedagogy (see Veen, 1993a; Van den Akker *et al.*, 1992; and Somekh and Davies, 1991).

An important issue to be addressed is whether or not it is acceptable for there to be considerable variation in utilisation of IT in schools, as a consequence of differences in teachers' confidence and competence in using IT. When there is variation, this suggests that opportunities for students are not equal, and vary from school to school.

Another important issue is that of the gender balance in computer use. Much research has identified greater numbers of male teachers than female teachers using computers (e.g. Andrews, 1997; Culley, 1993) and of fewer females having the role of IT coordinator (Reinen and Plomp, 1993b). In addition, female teachers seem to rate their competence in IT lower than do males (e.g. Andrews, 1997; Robertson *et al.*, 1995). However, is this indicative of a real difference in capability or merely of female teachers' modesty? In terms of impact on female students, schools need to consider whether organisational factors (such as mathematics ability being used as a selection criterion for computer courses) as well as a lack of female role models deter female students from selecting IT options.

4. IMPLEMENTATION IN SCHOOLS

4.1 Low level of implementation to date

As noted in Chapter 1, a number of initiatives over time, together with extensive INSET provision, have sought to encourage teachers to make use of IT in their teaching. However, evidence suggests that, to date, the impact on classroom practice has been relatively limited. Bell (1997) states: 'Although some teachers have adopted the new technologies and changed the way they work, no one can claim this approach has permeated the whole profession' (p. 6).

Statistics compiled by the Department for Education and Employment (and previously the Department for Education and the Department of Education and Science) have shown different levels of use in primary schools compared with secondary schools. Data show that despite the increase in levels of resourcing in computers over the last ten years, the percentage of teachers within secondary schools making regular use of computers (defined as twice a week or more on average) has remained constant at about 32 per cent, whilst the situation in primary schools seems more positive, with a consistent majority of teachers making regular use of computers (GB. DfEE, 1997a; GB. DFE, 1995; GB. DFE, 1993; GB. DES, 1991). However, frequency of computer-based work does not necessarily mean that primary school pupils are getting a wide variety of experiences (see Section 4.4.1).

Importantly, this comparative underuse of IT resources is set in the context of schools in Britain being particularly well equipped compared with their counterparts in other European countries (Mediawise Communications US Inc, 1997). The Mediawise survey showed that, at the time the research was carried out, schools in Britain had the most favourable ratios of computers to students at both primary and secondary school level:

- an average of 85 computers per secondary school and ten computers per primary school in Britain
- average computer:student ratios of 1:8.5 in secondary schools and 1:18 in primary schools.

This information is consistent with the findings of a recent government statistical survey (GB. DfEE, 1997a), and suggests that one of the most costly resources purchased by schools is underused. In addition, it is questionable whether or not Britain will maintain the 'major advantage' that Mediawise deemed it to have if greater numbers of teachers do not use the resources available to them due to inadequate training and/or lack of confidence in using them, together with a reluctance to amend their established pedagogy.

Ellis (1996) suggests that lack of expertise in IT is one of the reasons why 'despite the range of software available, science teachers have been slow to use computer simulations as an aid to teaching...' (p. 20)

OFSTED (1995), in their review of findings from school inspections carried out during 1993–4, note:

> *By the middle of the Key Stage* [3] *boys and girls are generally confident and competent in operating equipment in lessons... Unfortunately, in most schools pupils have few opportunities to employ these skills and insights in the course of studying more than a couple of subjects at most* (p. 7, para 10).

Both Russell (1995) and Govier (1991) point to shortcomings in the cascade model of training as a contributory factor to the relatively low numbers of teachers making use of IT in their teaching (see Chapter 2, section 2.2).

In essence, therefore, despite more than a decade of efforts in INSET, research evidence suggests that only a minority of teachers in secondary schools are using IT in their classrooms. In primary schools, there has been an increase in the percentages of teachers making use of IT.

4.2 Rationale for using IT in schools

If teachers are to be encouraged to use computers in their classrooms, on what basis is this to be justified, or, put another way, what is the rationale for their use to support teaching and learning (rather than administration) in schools? More than ten years ago, some researchers, such as Burghes (1987) and Jacobsen (1987) suggested that computers were of educational value since they provided opportunities for pupils to develop higher-order skills. In the context of mathematics, Burghes identified skills such as:

- *understanding problems*
- *implementing strategies for solution*
- *interpreting data*
- *transferring skills to new problems*
- *tackling unseen problems*
- *critical judgement*
- *working positively in a group* (p. 12).

Jacobsen advocated the use of simulation software in science, especially for activities

> *... too difficult, costly, or dangerous for the laboratory, or those which occurred too fast or too slow for observation — the same reason computer simulations are still used in 'real' science. Students, usually working in small groups, decide on values for the parameters and then observe the output of the simulation, often in graphic form* (p. 409).

Empirical work, (e.g. Stradling *et al.*, 1994; Watson, 1993) has provided evidence of pupils being able to spend more time and effort attending to higher-order skills, such as analysing data, rather than routine skills such as recording and presenting data. Cox (1997) and Watson (op. cit.) found that the use of computers increased pupils' motivation, a feature which may indirectly contribute to higher levels of attainment. However, the real issue of whether or not the use of computers actually helps to raise pupils' achievement remains largely unresolved. The Impact study (Watson, op. cit.), which set out to determine the extent to which IT enhanced the performance of pupils in schools that make extensive use of IT, proved to be inconclusive, partly due to problems in maintaining the original study design of comparing the results of students in classes where teachers made extensive/little use of IT.

On the other hand, some, such as Cohen (1993), have expressed the view that as IT becomes increasingly sophisticated, students (and ultimately adults) have little incentive to develop basic numeracy and literacy skills and, as a consequence, are being 'deskilled'.

Some commentators, such as Anderson and Collis (1993), have pointed to the 'functionality' perspective as a rationale for using computers in schools, i.e. the relevance to the world of work and the desire to prepare students for this, together with employers' requirements for employees who are IT-literate. Selwyn (1997) refers to the 'functional' and the 'ideological' approaches to defining computer literacy. The first favours defining specific skills whereas the second acknowledges a sociological interaction and recognises the impact that computers and society have on each other.

Russell (1995) cites a hypothesis which he suggests might have been common in the 1980s:

> *If learners (at any level, any age, any gender, any grade, any IQ, etc.) are taught [some computer application] (for any length of time, using any method, by any teacher, etc.), they will improve more in [some cognitive or performance variable] than an experimental group who are taught traditionally [whatever that is]* (p. 2).

Clearly, we have moved on from a time when the use of IT was unquestioningly held to be 'a good thing'. Evaluations of new technologies such as integrated learning systems (ILS) have been commissioned (see Chapter 5), but one of the current paradoxes in education is identified by Russell (op. cit.):

> *To rely on empirical evidence suggesting that it is a worthwhile act to put computers into schools would not be economically viable since the technology suggesting this would be out of date by the time it was put into place* (p. 2).

We have, therefore, a situation in which the pace of technological change is so great that it is impossible to wait until the educational benefits have been confirmed by empirical research. Teachers, as a result, are under pressure to implement technology (for example, because of the high political profile

given to ICT) that not only appears to be unproved, but about which they may have personal reservations, not least because its implementation requires them to adapt their pedagogy. Yet arguably we cannot afford to ignore a resource which does motivate pupils and may yet prove to raise educational attainment. In this context, Russell argues that future educational research should move away from its focus on *how* computers are used in schools and concentrate instead on learning processes and educational benefits (if any). In his view, by doing this: 'We may eventually be able to suggest positive gains to be made from new technology, instead of simply guessing that they are a good thing' (p. 4).

4.3 Whole-school organisation/Schemes and policies

While the use of computers within classrooms may to some extent reflect the interests of individual teachers, since ICT is part of the National curriculum, schools should have a policy which provides guidance on what it is intended to cover throughout the school. Heinrich (1997a) differentiates between the school policy (a statement of what is intended) and the scheme of work (an indication of what is to be taught, in what contexts, and, one might add, in which year groups).

In an analysis of primary and secondary schools' IT policies, Harris (1994) identifies a number of main areas which were common to both the primary and secondary schools' policies. These included the curriculum, pupils' experiences, responsibilities/management and INSET. Within the responsibilities/management category, some policies described the role of the IT coordinator, obviously a key person with regard to ensuring the effective use of IT throughout the school. However, in addition,

> *Roughly one third of secondary schools evidently had cross- or inter-departmental strategies for promoting the use of IT across the curriculum, since this number of policies referred to the role of an IT working party or team within the school, or the role of IT link teachers in different departments. Details within the policies showed that link teachers were a means of improving communication between specific departments and the IT department, so that there was a recognised way of conveying information regarding, for example, new equipment, in-service training available and departmental software requirements* (p. 17).

Birch (1995) found that skills concerned with setting up equipment and the ability to solve technical problems were important to teachers. At a more general level, he considers that teachers who lack in-depth knowledge of IT will not be helped by the structure of the National Curriculum Order and the non-statutory guidance, and will find it easier to consider IT not as a subject in its own right, but as an area which can be delivered through, and used to support, other areas of the curriculum.

The issue of how to deliver the IT curriculum raises different priorities and considerations in primary schools as compared with secondary schools. Govier (1991) suggests that the integrated curriculum which characterises primary education (together with the lack of syllabus-bound specificity found in secondary schools) provides opportunities for developing the potential of IT. In considering the issue of covering IT through specific subject timetabling or through cross-curricular implementation in secondary schools, Donnelly (1994) remarks:

> *There is no doubt that having a timetabled slot at Key Stages 3 and 4 is the easiest way of ensuring that pupils learn the content of the IT part of the National Curriculum ... However, if you put an extra subject on the timetable, you have to make room by removing another one (usually impractical), by reducing the time given to other subjects, or by extending the school day. The inherent difficulties in adopting any of these measures means that many schools have persevered with delivering and assessing IT only* ***across*** *the curriculum, usually in at least three subject areas; few deliver or assess IT in* ***all*** *National Curriculum subjects* (p. 19).

Arguably, IT should be used to support and enhance subjects across the curriculum, and teachers with particular subject specialisms should be able to identify which IT resources to use, and how best to utilise them to support children's learning and provide guidance regarding this to their colleagues. However, this is not always the case, as Brown (1997) notes: '... the reality is that subject coordinators or heads of department are not confident in determining how IT can be used at all, let alone where it is most appropriate' (p. 6).

Ultimately, the ongoing weakness in teachers' competence and confidence in using IT suggests that schools should heed the advice given by Heinrich (1997a; 1997b) that provision for staff training should be one of the areas for which funding from the school IT budget is allocated.

4.4 Patterns of implementation

Teachers who use IT in their classrooms will have different priorities and methods of using the resources. In the context of supporting/enhancing different areas of the curriculum, teachers will select appropriate software; with the needs of pupils of different abilities in mind, teachers will set different tasks using the same programs; for some pupils, a course of work using an integrated learning system (ILS) may be suitable; on some occasions, the teacher may use IT to demonstrate or reinforce a particular concept. Clearly, there are a number of different ways of utilising IT resources to support learning in schools.

Scott *et al.* (1992) suggest there are three main ways of using computers in classrooms:

- as part of the curriculum
- as a substitute for the teacher
- as a tool to achieve traditional pedagogical goals.

These methods of use are not independent of national decisions about the content of the curriculum and ways in which it should be taught in schools. In England and Wales, the National Curriculum prescribes the content of the curriculum in different subjects, including IT, for pupils aged 5–16 years, but teachers retain the freedom to decide how to implement it and what resources to use. Apart from being a subject in its own right, IT can be used to support and enhance other subjects across the curriculum. From the early focus on drill and practice programs concentrating on improving pupils' basic skills (e.g. spelling and arithmetical games), the idea of the computer as a substitute for the teacher has moved on to a more sophisticated format: integrated learning systems (ILS), in which the system prepares a structured learning programme, reacts to the responses made by pupils and provides assessment information for the teacher at the end of the session. In utilising computers as one of a range of resources that they draw upon, teachers may use content-free software, including word processors, Logo and spreadsheets, or they may use software which is relevant to specific subjects, such as simulations set in an historical context, multimedia material for modern foreign languages and geographical databases.

With regard to these types of use, Anderson and Collis (1993) differentiate between the practice where pupils are taught IT skills through the medium of other subjects and the use of computers to support other curriculum areas. In the first case, the emphasis is on computer literacy, whereas in the second, the emphasis is on the subject; Anderson and Collis identify these as 'integration' and 'infusion' respectively.

Clements *et al.* (1993) contrast the limited benefits of drill and practice programs and ILS with the wider educational benefits of more open-ended programs, such as Logo. This accords with the view expressed by Ernest (1989), who argues that computer programming activities best utilise the potential of the computer to support learning in mathematics.

At primary school level, Senior (1990) suggests that there are two approaches to the inclusion of software in school work:

- using the software as the starting point, and relating that to the curriculum
- using a topic as a starting point, and drawing on relevant software as appropriate.

In contrast, Clements *et al.* (op. cit.) identify three 'paths' that teachers may take when using computers in the classroom:

> *Those travelling on the first path use simple games for 'rewards' or occasionally use drill software but do not integrate it into their wider educational program* [sic]. *Those travelling on the second*

> *path integrate drill and other structured software activities into their programs. Those travelling on the third path use problem-solving software and tools such as word-processors, Logo, and drawing programs to extend and enrich their children's education.*
>
> *Research suggests that the first path leads nowhere; teachers might better invest efforts and resources elsewhere.*
>
> *The second path is educationally plausible. Well-planned, integrated activities can increase achievement in cost-effective ways. This is a safe and easy path ...*
>
> *The third path is more challenging — in time, in effort, in commitment, and in vision. This path alone, however, offers the potential for substantive educational innovation...* (p. 63).

Finally, empirical work carried out by Veen (1993a) led him to identify seven different ways of using computers in classrooms. On the basis of two years' case study work in a Dutch secondary school, he classified the types of organisation as either:

- **the electronic blackboard**: the teacher uses the computer to demonstrate or illustrate points to the class
- **working apart together**: some students are working independently with computer(s) whilst the teacher instructs the rest of the class
- **rotating groupworking**: students work on the same task in groups and take turns to use the computer
- **artificial classroom reduction**: students work individually or in groups on a variety of tasks; computer(s) and other resources are used as appropriate by different groups
- **volunteer working**: students volunteer to work on computer outside class time
- **computerlab without support**: the whole class is in a computerlab, working at machines individually or in pairs
- **computerlab with technical support**: the class is split in two, with half working in the computerlab with a technical assistant supervising, and the rest working with the teacher in the classroom; the teacher sometimes visits the computerlab to monitor work/help.

Whilst Veen acknowledges that the 'electronic blackboard' approach is not very stimulating, he suggests that it may be more prudent, in the long term, to allow teachers to use IT in a simplistic way so that they gain confidence, in the hope that they may subsequently start to become more innovative in their uses of IT.

4.4.1 Implementation in primary schools

With the research evidence noted above in mind, it is, therefore, appropriate to ask how computers are currently used in primary and secondary schools in England and Wales. Evidence from the government surveys carried out in the 1990s (GB. DfEE, 1997a; GB. DFE, 1995; GB. DFE, 1993; GB.

DES, 1991) indicates that word processing is the most frequently used application in both primary and secondary schools. Survey evidence (GB. DfEE,1997a) also found that this application is the one most frequently used in all year groups in secondary schools and in Years 2 – 6 in primary schools; only in Reception and Year 1 classes are practice exercises and puzzles used more frequently than word processors.

Whilst much research relies on teachers' own reports on their use of computers (i.e. self-ratings on a scale to indicate the level of usage of computers/different types of software), there is an inherent weakness in this type of data collection in that, unless teachers are given very clear and unambiguous guidance about what each response option represents (e.g. how many times per week/per month represents regular/frequent/occasional use), responses can be very subjective. In addition, some teachers, perhaps with an awareness of their own need to increase their use of ICT in the classroom, may (consciously or unconsciously) enhance or inflate their responses beyond what is actually representative of their classroom practice. Results may, therefore, be somewhat unreliable if respondents have had different criteria in mind.

In contrast, the research carried out by Chalkey and Nicholas (1997) collected data by means of classroom observations[1] rather than teachers' self-reported accounts of their work. On the basis of observations carried out in three inner-city London primary schools, and having calculated the maximum periods of time for which computers could potentially be used (i.e. excluding storytime, games lessons, breaks, etc.), Chalkey and Nicholas found that:

- for 56 per cent of the time the computers were not turned on
- of the time when computers were turned on, they were in use for only approximately half of that time; the rest of the time they were turned on but not in use.

Chalkey and Nicholas comment: 'Overall computers were in use for only 20 per cent of the available time' (p. 102). This finding is consistent with that reported in an earlier DfEE survey (GB. DfEE, 1995), although not with the most contemporaneous (GB. DfEE, 1997a), which suggested that computers were used for 43 per cent of the total lesson time per week. In this context, it is worth noting that there seems no obvious explanation for the apparent doubling in the use made of computers between the two DfEE surveys. Also, some inaccuracies may be due to survey responses being made by one person on behalf of the whole school.

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[1] *Chalkey and Nicholas did not disclose to headteachers and teachers involved the nature of their research. They state that they outlined the reasons for their observations in 'unspecific terms', with an intention 'to observe how children share information in the classroom' (p. 100).*

The people involved in the observations did not give their informed consent to participate, which has a bearing on the quality of the research. Since the teachers believed that 'sharing information' was the focus of the research, they may well have emphasised activities involving discussions/conversations between children, especially since many of the children were from ethnic minorities and used English as an additional language.

Referring to the relatively low level of computer use that they witnessed, Chalkey and Nicholas (op. cit.) suggest:

> *Since computers are just one of many educational tools that a teacher has at his/her disposal it could be that teachers are actually confident and skilled in using computers but simply don't choose to use them very much. A low level of use might result from a number of different factors; for example from a lack of hardware... Alternatively teachers may deliberately choose other methods of teaching and learning to those offered by computers and the available software* (p. 99).

They also note that:

> *Where the introduction of computers challenges the conventional view or demands a different style of teaching it is likely to be rejected. Likewise where the technology supports the existing view it is more likely to be incorporated (although other factors such as the number of computers available may influence the degree of use)* (p. 99).

However, in some primary schools, teachers are exploring a range of strategies to ensure that children benefit from the expertise of teachers who are confident and competent with regard to IT. Cooke (1997) provides an account of one school's approach:

> *The four classes in year 5 and 6 would rotate between four subject areas in one day, with one of the subjects being IT. It was believed that this might provide a better opportunity for children to develop IT skills and understanding which they could use to enhance and extent* [sic] *the learning process throughout the whole curriculum (p. 7).*

In Cooke's school, children in each class were split into five groups and worked on five different activities which used different hardware/software and covered different parts of the programme of study for ICT. The five activities and associated resources were as follows:

- designing a questionnaire and using a database to collect information (junior Pinpoint)
- using an adventure program (Crystal Rainforest)
- using a word processor to write about Victorian schools (laptops)
- using a floor robot to solve problems (Roamer)
- writing a play for a radio programme (tape recorder).

Importantly, this was part of a whole approach to the curriculum, but it shows how the expertise of the IT coordinator can be utilised.

In addition to using computers to support the curriculum, schools also use them for administrative and managerial purposes. It is not intended within this report to explore this somewhat different aspect of computer use within schools. However, it should be noted that this type of use brings attendant IT issues, including appropriate training, access and security of information.

Howlett (1993) notes that when a management information system was introduced into one primary school, the two main users were the headteacher and the school secretary, although the intention was to increase the use of the system by other teaching and non-teaching staff.

4.4.2 Implementation in secondary schools

As noted above, research has shown that word processing is one of the most widely used applications in schools, including secondary schools (see, for example, GB. DfEE, 1997a; Cuthell *et al.*, 1997; Harris and Preston, 1993). One of the issues that secondary schools must contend with is the potentially wide range of experiences using IT that students entering the school (most notably upon intake in Y7) bring with them. Despite the theoretical uniformity of what is taught, using the National Curriculum Order as a basis, as we have already noted, there are considerable differences in teachers' knowledge of, and competence and confidence in teaching about/ using, IT. This is evident in both the primary and the secondary education phases, but the effects are exacerbated when secondary schools receive their intake of Y7 students from several different primary schools. Not surprisingly, therefore, Harris's (1994) analysis of schools' IT policies found that some secondary schools included specific guidance about the length and content of IT courses/modules for particular year groups. As well as indicating how IT should be approached as a subject in its own right, schools' policies also emphasised the importance of cross-curricular implementation of IT throughout the school, and, in some instances, gave examples of how specific applications could be used to support particular subjects, sometimes to the extent of providing sample lesson plans. The same research found evidence of secondary schools' attempting to promote IT across and within departments by means of an IT working party within the school. Some schools had identified 'IT link teachers' in different departments in an effort to improve communications regarding such issues as new equipment available, INSET and departmental software requirements.

Data collected by Harris and Preston (1993) revealed that:

> *Word processing was relatively widely used across departments; databases were also quite widely used, especially within science-based and humanities departments. Spreadsheets were most widely used in mathematics although adventures/simulations seemed to be used to some extent in most departments, especially SEN and humanities* (p. 39).

The results from a small-scale survey led Zanker (1992) to conclude that, whilst the majority of schools were covering communicating information/ handling information, fewer schools covered modelling and still fewer covered measurement and control. Zanker comments:

> *Two of the strands* [of IT capability] *proposed by the National Curriculum Council, modelling and control, are not prominent in the majority of schools. This is particularly surprising given that the former is considered to be a powerful tool for simulation ... (p. 20).*

Evidence to support Zanker's findings is presented in the results of two Government surveys of IT in schools (GB. DfEE, 1997a; GB. DFE, 1995), which show that, in a typical week, no more than six per cent of any year group in secondary schools used software for either measurement or control, or for modelling.

Kennewell (1996) reports on a survey sent to all secondary schools in the UK, which included questions about the models of IT implementation used in the curriculum. The questionnaire listed five different types of organisation and asked respondents to indicate which ones were used in different year groups. The approaches listed were:

1. subjects schedule IT when appropriate to their scheme of work
2. IT lessons timetabled but allocated to other subjects to teach IT
3. specialist IT lessons timetabled, with contexts provided by other subjects
4. specialist IT lessons timetabled, with context devised by IT teachers
5. other.

In Y7, the most frequently used approach was a combination of model 4 plus other(s), whilst the most frequently reported model for Ys 8–11 (60 per cent or more respondents) was a combination of model 1 plus other(s). However, in considering these data, it should be noted that the responses to the survey represented a response rate of only approximately ten per cent, so that it is impossible to draw any conclusions about the preferred models of IT implementation in the majority of secondary schools in England and Wales.

Looking at the use of IT to support particular areas of the curriculum, NCET (1995) produced a short guidance document outlining ways in which IT could enhance students' mathematics work in key stages 3 and 4. The document identified six different ways in which IT could support learning:

- learning from feedback
- observing patterns
- seeing connections
- working with dynamic images
- exploring data
- 'teaching' the computer.

However, despite these examples of potential ways in which to use IT, the actual ways in which teachers choose to utilise IT in mathematics lessons may be less varied. Andrews (1997) collected data about mathematics teachers' use of four different types of software:

- spreadsheets
- databases
- Logo
- Basic.

These four types of software were selected because they were either mentioned in the 1995 mathematics Order, or in a previous Order (i.e. 1991 or 1989). The responses to the survey suggested that, of the four types of software listed, the one type identified by the largest number of respondents (20 per cent) as being 'frequently' used was Logo. The percentages of respondents who indicated that Logo, databases and spreadsheets received 'average' use were similar: 44 per cent, 41 per cent and 42 per cent respectively. Work involving Basic was relatively rare: 81 per cent of respondents said they rarely used this in mathematics lessons. Andrews' survey also asked teachers to provide information about their competence in using these types of software, together with background details such as age, gender, length of service, etc. Andrews summarises his findings as follows:

> *In terms of competence and regularity of use, length of service was the most significant indicator, with shorter careers* [i.e. suggesting younger teachers] *being associated with competent regular use and longer ones with incompetent rare use* (p. 253).

Interestingly, these findings contrast with those of Griffiths and Alfrey (1989b) which are discussed in Chapter 2, section 2.1.

Ellis (1996) conducted action research into the effects of using computer simulations on students' ability to design investigations in science, specifically their ability to formulate hypotheses concerning the germination of seeds. The research design involved a control group and an experimental group of Y10 students. The total of 19 students were alternately allocated to either the control or the experimental group. After the lesson input, which seems to relate to one lesson only, Ellis noted that there were no substantive differences in the types of hypotheses produced by either group. Arguably, it might be over-optimistic to expect to see major differences in the work produced by the experimental group as compared with the control group after only one lesson, especially since we are not given any details about the previous computer experience of the two groups. However, it may be that this type of work could be a valuable subject for future, more large-scale research.

Finally, Higham and Morris (1993) describe a project within one LEA to develop a hypercard databank for use by students which was designed to satisfy both the IT and modern foreign language (MFL) requirements of the National Curriculum. The work focused on collating information about Leeds' French twin town Lille, but a major aim of the project, in which existing and student teachers collaborated with LEA and Leeds University staff, was that other schools/towns should be able to replicate the database for twin towns in different countries/regions. Higham and Morris note the beneficial effects on teachers' knowledge, skills and attitudes with regard to computers:

> *It seemed that the project members had gained a greater knowledge of the potential of the computer for use with classes, groups and pairs and become more proficient in their personal use. When asked how their attitude to the use of computers had changed since*

> *the beginning of the project, some commented that their confidence was greater and others that their previous positive attitude towards the use of computers in teaching had been reinforced. All said that their general awareness of information technology had increased and all but one felt very positive about the progress of the project* (p. 34).

Arguably, it may be the case that teachers who use computers successfully in their teaching find personal benefits as well as benefits for their students, which increase their likelihood of using them again in the future. As already noted in Chapter 3, this makes the most important hurdle to overcome that of encouraging teachers to use computers for the first time.

4.5 Summary

Despite considerable increases in the numbers of computers in schools over the last ten years, the percentage of secondary school teachers using computers twice a week or more has remained constant at about 32 per cent, whereas in primary schools the majority of teachers use computers this often.

Reasons for encouraging the use of IT in schools include preparation for the world of work and opportunities to develop higher order skills. However, a persistent paradox is that the pace of technological change is so rapid that if teachers were to wait until the educational benefits of ICT had been confirmed by empirical research, that technology would by then be outdated. Consequently teachers are under pressure to implement technology for which not only is the educational value unproved, but about which they themselves may have reservations.

Primary schools retain a degree of flexibility with regard to curriculum implementation, and class teachers are able to use IT to support different areas of the curriculum. In larger schools, organisational approaches such as team teaching where individual teachers' IT expertise can be exploited can benefit pupils. In contrast, in secondary schools there remain tensions between using IT to support and enhance subjects across the curriculum, and timetabling IT as a subject in its own right.

Researchers have identified different levels of teacher competence in incorporating ICT into classroom practice. Veen (1993a) suggests that it may prove beneficial in the long term to allow teachers to use IT in less innovative ways, in the hope that, ultimately, they may progress to more sophisticated modes of use.

Surveys have shown that the most widely used application in both primary and secondary schools throughout the 1990s to date has been word processing. In contrast very few students (no more than seven per cent) in either primary or secondary schools use software for modelling or for measurement and control (GB. DfEE, 1997a).

5. NEW TECHNOLOGIES AND BEYOND

5.1 Integrated Learning Systems (ILS)

The increase in the number of computers within schools to support learning (as opposed to those machines dedicated to administrative uses) over the last 15 years has raised a number of related issues. For example, the introduction of integrated learning systems (ILS) which devise and implement individual learning programs for students and monitor those students' progress has necessitated focused INSET for the teachers using the systems. However, effective use of such systems requires considerably more knowledge and understanding of their potential than can be acquired in one or two days of training.

Bagley (1996) argues that in order for students to benefit from using ILS, their work using ILS needs to be perceived by them as important. In practical terms, this means not being sent to another class or a computer laboratory (where another adult supervises their work) before they return to their own class with no follow-up to the ILS work. Bagley argues that teachers need to become familiar with ILS themselves so that not only can they supervise students using the systems, but they can also actively include the use of ILS in their own schemes of work and administer appropriate tests to students.

Clariana (1992) identifies five different categories of teachers using ILS:

- **novice non-participatory**: the class teacher is not involved in ILS use; Clariana suggests that this sends to students 'a non-ambiguous message that *this activity is not important*' (pp. 2–3).
- **novice**: teachers may lack expertise in maximising the potential of ILS because they themselves lack knowledge about the systems. Time can help increase familiarity with content, but teacher attitude is important.
- **practitioner**: these teachers use ILS, especially for low-ability learners, but teach material twice — once in class and once in the computer lab.
- **integrator**: uses ILS selectively so that it integrates more effectively with classroom instruction, but all students do the same activities, and so higher-ability students are held back.
- **extender**: these teachers have fully integrated ILS and their classroom curriculum so that some work is covered in ILS, some in other class work, and some in both.

In essence, these categories represent increasing levels of competence in using ILS, and theoretically one might assume that it would be best to aim for all teachers using ILS to work as 'extender' types. However, the use of ILS then impacts on other aspects of pedagogy, as Clariana notes:

> *As teachers reach higher levels of ILS use, they will be forced by necessity to make their teaching groups smaller and smaller. To increase instructional efficiency, eventually, each student may need an individual education program (IEP) ... This level of use is often difficult to achieve in mainstream classes [due] to the teacher time commitment* (pp. 6–7).

Clariana goes on to suggest that other factors pertaining to the learning environment may impose restrictions:

> *To maximise learning with an ILS, very complex questions about the type of learning environment must be answered. It would be naïve to assume that an extender type environment is best for all conditions. In an ideal world, it may be possible to create individual programs for every student, and then be able to implement every program. But schools are faced with constraints involving time, teacher training and education, teacher and student abilities, class size, and student mix to name a few* (p. 10).

Within the UK, over the period 1993–1997, major evaluations of ILS were carried out by a number of research institutions and managed by NCET. The work was scheduled in three phases. The first phase involved both primary and secondary schools. The second phase involved primary, secondary and special schools; in addition to continuing the evaluative work in the 12 schools that had been involved in the first phase, the second phase involved a further 11 schools. The third phase involved greater numbers of students and teachers (see Wood, 1998) in attempts to measure the difference in achievement between students in ILS schools and non-ILS control schools, together with other evaluations, including one focusing on one specific ILS and another focusing on classroom interaction. The effects of using ILS on students' achievement, motivation and attitudes are reported elsewhere (see, for example, Underwood *et al.*, 1998a; 1998b; Burghes with Riall, 1998; Hulme *et al.*, 1998; Sizmur *et al.*, 1998). However, the introduction and use of ILS impinges on teachers as well as students.

Underwood (1997) presents findings from the national evaluation of ILS. Like Clariana, she notes the effects of using ILS on pedagogy:

> *Schools developed models of practice to integrate ILS fully into their working day. The more innovative and advanced thinking, of necessity, came from those teachers who had been working with the system for two years. This is to be expected as it takes time to gain any real understanding of such a complex product.*
>
> *The impact on classroom practice did not follow a simple pattern within or across the schools. For some teachers it was a refocusing of work in the classroom to support or complement the ILS* (p. 5).

Underwood observes:

> *In Phase 2, we saw constructive moves by teachers to use the ILS effectively. The first stage of this was to understand the system, and the second stage was actively to use that knowledge to integrate the ILS experience into a whole curriculum* (p. 5).

Hence, the importance of the teacher should not be underestimated. Underwood goes on to stress that 'the teacher is a key component if the ILS is to be effective' (p. 5).

5.2 Changing roles for teachers

In reviewing the reactions of teachers to using ILS, Underwood's evidence suggests that teachers regard ILS as a resource to supplement other work/ resources rather than to replace these. This is important, since some commentators have suggested that the use of a computer within a classroom has the potential to change the balance of power.

Van den Akker *et al.* (1992) note that the way in which computers are used within classrooms may lead to changed roles for teachers. They go on to observe that some teachers feel uneasy about changes in their established role and try to minimise these changes.

Somekh and Davies (1991) also focus on the relationships found in classrooms, where traditionally students are dependent on the teacher as a source of knowledge and information. They note that:

> *... the configuration of teacher, student and computer changes the traditional structure of teaching and learning in the classroom. The computer, by providing an additional source of knowledge and information, reduces the dependency of students upon the teacher. They can use software to control and pace their own learning, taking the active role of constructing knowledge rather than the more passive role of receiving it. Their constructions of knowledge can then be tested against those of other members of the class, including the teacher.*
>
> *Having choices and making independent and/or collaboratively negotiated decisions are features of autonomous learning. The new technology extends the range of choices for the learner both in itself and through the options programmed into the software* (pp. 159–160).

Within the context of primary mathematics, Ernest (1989) differentiates between two sources of control:

1. **control by the teacher**, as in the case of giving demonstrations using a computer
2. **control by pupils**, for example when they have 'hands-on' experience, when they make choices within a program.

It is apparent, therefore, that there are wider issues to be addressed than mere technical competence in using ICT. Furthermore, just as some teachers are more willing than others to adopt new technologies in their teaching, others may feel reluctant to reconsider their established pedagogy and uneasy about allowing students to take a more active role in determining the pace and extent of their own learning.

5.3 National Grid for Learning (NGfL)

The government is committed to connecting every school in Great Britain to the information superhighway by 2002. The NGfL is envisaged as a mechanism enabling schools to interact with each other and to access other institutions, such as libraries, universities, museums and art galleries. In terms of impact on schools, this means that teachers and students will no longer be restricted to using only those resources which are physically located within their school.

As Goldsbury (1998) notes:

> *The Internet is the only medium which enables a student to look at worldwide information from their desk; data that is constantly updated and can be compared to that on another site seconds later* (p. 22).

In addition to providing resources for students, the Grid has the potential to provide on-line support to teachers, assisting in their professional development (see GB. DfEE, 1997b). Broadfield (1998) comments that:

> *Pilot 'Virtual Teacher Centres' on the Web are proving to be effective at providing professional development. Here, teachers can pick up examples of best practice and resources for lessons, as well as follow links to other resources and even complete lesson plans* (p. 39).

As a mechanism for delivering INSET, the Grid has considerable advantages over more conventional methods in terms of flexibility: users can decide when and from where to access the Grid, and they can control the length of the session to suit their own circumstances. Potential physical isolation may be overcome by using the Grid for discussions with teachers (and others) in the same/other schools, in other areas/countries.

However, two main issues that need addressing are:

- **the cost to schools of being on-line**: if this is seen by schools as being over-expensive, the extent to which the NGfL is utilised will be constrained by this cost
- **quality control of material on the Grid**: the responsibility for this falls to BECTa, as does the screening out of unsuitable/inappropriate material for student access. In the initial stages of development of the Grid, this task is undoubtedly manageable (although there may be a

tension between the desire to provide resources quickly, so as to promote interest and strict quality control), but as the amount of material submitted mushrooms, it remains to be seen whether this task becomes impossible.

The NGfL is still under development, and the contribution it will make to teachers' ongoing professional development can not yet be quantified. It is an ambitious project and has the potential to make a considerable impact on both teachers and students, yet at the same time it increases the need for more training. The pace of technological development involves teachers in a spiral of ongoing INSET in order to use new technologies. If the Grid can provide teachers with the necessary INSET to use constantly changing technology it will undoubtedly be worth the investment.

5.4 A final word

Ten years ago, Jones (1988) suggested that teachers are potentially both the greatest barriers and the greatest assets to students in relation to the latter's opportunity to gain from new technology, '... for once staff become technologically literate, i.e. can overcome their initial fear/scepticism, they can more readily integrate the use of the technologies within their professional range of skills as teachers' (p. 39).

One way of encouraging practising teachers to utilise computers in their lessons is not only to provide good quality software together with training for teachers, but also to offer support materials for class work which, even if not suitable for a particular class in their original form, could suggest to an experienced teacher possible activities to extend and develop work. Van den Akker *et al.* (1992) term such support materials 'lessonware' and suggest that the provision of appropriate lessonware contributes to the successful implementation of computers within classes as it increases teachers' own confidence in the use of the resource and they become more convinced of the value of computers in helping them to teach their students.

The plans for the National Grid for Learning undoubtedly have been drawn up with the intention of helping teachers to make the best use of ICT in their classes. It remains to be seen whether this latest resource will be of benefit to all, or will be accessed only by the already converted. If the latter proves to be the case, it may be that the National Grid for Learning will become the most recent evidence of what Jones (1988) termed 'the widening gulf between the technologically literate and the illiterate' (p. 39).

5.5 Summary

New technologies such as ILS raise additional organisational and training issues. Although the structure of ILS determines the curriculum content presented to individual students using the system, the teacher is not marginalised. Indeed, Underwood (1997) regards the teacher as a key component in determining the effectiveness of an ILS.

The Government has stated that all schools in Great Britain will be connected to the information superhighway by 2002, and as a result will be able to use the NGfL. As well as enhancing and extending the range of resources for learning which students can access, the Grid will also act as a mechanism for effecting INSET for teachers.

Some commentators (e.g. Broadfield, 1998; Van den Akker *et al.*, 1992; Somekh and Davies, 1991) argue that the use of computers within a classroom may lead to changed roles for teachers, as students take a more active role in determining the pace and content of their own learning. Is it reluctance on the part of some teachers to confront a scenario in which their role is changed that appears to make some teachers unwilling to include ICT in their pedagogy?

Despite the introduction of new resources including ILS and the NGfL, large numbers of teachers still lack confidence and competence in basic ICT skills. The consequence of this is less than equal opportunities for students: those that are fortunate in having teachers with well-developed ICT skills have good role models and opportunities to develop their own skills, whereas students who do not encounter such teachers will enter the 21st century relatively ill-prepared.

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INSET for IT

a review of the literature relating to preparation for and use of IT in schools

Computers have been widespread as resources for learning in schools since the 1980s, and information technology (IT) has been part of the National Curriculum since 1990. Hardware and software have become easier to use and yet research evidence suggests that some of the most costly resources currently in schools are under-used.

We look towards the 21st century and the opportunities to be provided by the National Grid for Learning. Yet if teachers lack the necessary skills to utilise this latest resource, is it they or their pupils who will be disadvantaged?

This report reviews the literature relating to preparing teachers to use, and using, IT in primary and secondary schools. Main chapters focus on:

- in-service training for IT
- factors relating to the use of IT in the classroom
- implementation in schools
- new technologies and beyond.

The report identifies areas of concern and issues to be confronted. It will be of interest to school IT coordinators, headteachers, training providers and policy makers.

ISBN: 0 7005 1500 3
£5.00