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Factors associated with high levels of ICT capability among 14-16 year olds in English schools

Factors associated with high levels of ICT capability among 14-16 year olds in English schools

Roger Crawford

Submitted in fulfilment of the requirements for the degree of Doctor of Education (EdD)

The University of Leeds, School of Education

September 2001

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

Abstract

Factors associated with high levels of ICT capability among 14-16 year olds in English schools

Roger Crawford, EdD thesis, September 2001

There has been concern for more than a decade that pupils do not have sufficient knowledge, skills and understanding of Information and Communication Technology (ICT) at the end of compulsory schooling. This research investigates approaches to the organisation of the ICT curriculum, teaching and learning, management, staffing and resources that are associated with high levels of ICT capability among 14-16 year olds in four secondary schools, each of which organised the delivery of the ICT curriculum in different ways. These were discrete or 'centralised' ICT, cross curricular ICT; and hybrids of these, the 'skills core' and 'kick start' models (NCET, 1996, p7). There are detailed case studies of each school, and a comparative analysis, which includes an assessment of the relative ICT capability of their pupils. The more and less successful schools are characterised, and there is discussion of the issues arising and those areas requiring further research.

Features associated with high levels of ICT capability included:

- ICT was taught as a discrete subject throughout key stages 3 and 4, and pupils were entered for GCSE ICT at the end of key stage 4
- There were well planned programmes of study for discrete ICT but the use of ICT across the curriculum was not planned in detail
- ICT teachers were more aware of the differences between teaching ICT and other subjects
- There was strong leadership by senior management; the HoD ICT was enthusiastic and approachable; and there were opportunities for all teachers to be involved in decision making
- There was a management committee that included senior managers, the HoD ICT and ICT teachers; and a user group with representatives from other subject departments
- Teachers of other subjects could not avoid using ICT in the classroom and for aspects of school administration
- Schools valued their investment in ICT resources
- There were significantly more specialist ICT teachers employed by the school
- There was an adequate quantity of modern ICT resources
- Higher levels of bid based funding were acquired

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Many thanks also to the teachers and pupils who participated, especially those in the schools in which I piloted the research methodology and carried out the research. During the interviews, teachers shared their thoughts and feelings with me openly and frankly. This sometimes required considerable trust on their part for which I thank them. For my part, I have preserved their anonymity as I promised.

My employers, the University of Huddersfield, supported me throughout, both financially and by allowing me the flexibility to carry out the research, attend tutorials, etc. as required. My colleagues and students at the University supported me in many different ways, often unknowingly, through challenging discussions in seminars and more informally.

My wife, Jennie, and my family, also showed considerable tolerance of the long hours spent on research and writing, and as usual supported me throughout.

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Chapter 1: Introduction

There has been concern for more than a decade that pupils do not have sufficient knowledge, skills and understanding of Information and Communication Technology (ICT) at the end of key stage 4, after eleven years of compulsory education (Goldstein, 1988 and 1997; HMI, 1989; Ofsted, 1995). This is despite a continuous and increasing emphasis by government on the importance of pupils reaching satisfactory standards in ICT; improvements in the status of ICT within the National Curriculum (NC) (DES, 1990a; DfE, 1995; DfEE and QCA, 1999); a plethora of initiatives to improve ICT facilities in schools, (DfEE, 1997); the widespread approval of specialist ICT teacher training courses in September 1996 (Crawford, 1997b; Selinger, 1997; QCA, 1997); training for all trainee teachers in the use of ICT in teaching and learning (DfEE,1998a); and training for in-service teachers in the use of ICT in the classroom from March 2000 paid for by the New Opportunities Fund (NOF).

The UK Government's Comprehensive Spending Review (July 2000) sets a target for pupils' attainment in ICT of 85% to achieve level 5 at the end of key stage 3 by 2007, a considerable improvement on the 58% reported in 1999. Smith (2000) considers this to be achievable if '...the new (curriculum) strategy for key stage 3 goes well, that all the resources come on-stream and that we can get good quality training in place.'. However, he is clearly doubtful that this will happen, and expresses scepticism regarding the accuracy of teachers' assessments that 58% of pupils are already achieving level 5 at the end of key stage 3 in 1999.

The purpose of the research described in this thesis is to identify some of the factors associated with high levels of ICT capability among 14-16 year olds in English schools. It is important for schools and teacher trainers to know as much as possible about the pre-conditions for pupils to achieve high standards of ICT capability so that they might improve their effectiveness.

The author's personal commitment to improving pupils' ICT capability is a consequence of his work as an ICT teacher in secondary schools for 12 years; as a teacher trainer specialising in ICT for 10 years, having initiated and developed PGCE and BEd courses in ICT; as an Ofsted

inspector specialising in ICT for 7 years; and as a Chief Examiner for the General Certificate of Secondary Education (GCSE) in ICT related subjects for 14 years.

The author's involvement with ICT in education began in the late 1970's when computers were being introduced into English secondary schools. The author had previously been awarded a BSc in mathematics, and had worked as a computer programmer and a systems analyst in several large commercial companies in the UK and New Zealand, before training as a secondary school teacher. Subsequently, the author taught mathematics in New Zealand and Western Australia before returning to the UK. This level of experience of both computing and teaching was rare in English schools at the time, and the author was invited to assist with the development of ICT teaching and curricula in the school in which he was employed. Almost inevitably, this led to further study, and by 1984 the author had been awarded an MSc in Education and an MSc in Computing. Four years later, the author was appointed to the post of Head of Mathematics and Computing, and TVEI coordinator in another secondary school. Involvement in GCSE examining and work as an Ofsted inspector provided different viewpoints on approaches to the teaching and learning of ICT.

The author is currently a Senior Lecture in Education at the University of Huddersfield, and subject coordinator for the specialisms of ICT and mathematics. Having taken a leading role in designing PGCE and BEd courses in ICT, and in teaching the students enrolled on these courses, the author wished to revisit understandings rooted in over 20 years of professional practice. Hence the author enrolled for a Doctorate of Education (EdD) at Leeds University, and this thesis has been written to meet assessment requirements. Even so, the author's motivation in carrying out this research is grounded in his own requirements to understand and improve professional practice.

Consideration of the factors associated with high levels of ICT capability among 14-16 year olds in English schools raises three implicit questions. These are:

- What is ICT capability?
- How are levels of ICT capability to be investigated?
- What are the factors associated with high levels of ICT capability?

To understand what is meant by ICT capability, the author carried out an extensive historical study (Crawford, 1998). Analysis of the research projects and other materials investigated indicated that notions of what constitutes ICT capability had changed considerably over 20 years. Rather than being based on widely shared, stable and clearly defined knowledge and skills, understandings had evolved, and tended to reflect current beliefs and technological capability.

Currently, pupils would be considered to have high levels of ICT capability if they were able to:

A. Use ICT to support their learning in all subjects
B. Use common ICT tools
C. Take responsibility for their own learning, developing strategies to help them learn how to use unfamiliar ICT tools, and work collaboratively
D. Use current ICT hardware and software and understand its potential and limitations
E. Understand that using ICT affects social processes

Pupils' ICT capability was investigated using a questionnaire (Appendix 5) given to pupils at the end of year 11 in four secondary schools. These schools were chosen according to the ways in which they delivered the ICT curriculum. School D taught only discrete or 'centralised' ICT (NCET, 1996, p7); school S adopted the 'skills core' approach (NCET, 1996, p7); school K used the 'kick start' (NCET, 1996, p7) curriculum model; and school C delivered ICT entirely across the curriculum. The pupil questionnaire was designed to ensure that pupils had the opportunity to report their ICT expertise in relation to the different elements of ICT capability described above. This was achieved by mapping each question in the pupil questionnaire (Appendix 6) to the different elements ICT capability (A to E above).

Several themes have been used to provide useful standpoints from which to describe and evaluate the factors associated with high levels of ICT capability (Chapters 4 to 7). These were identified prior to the research as being likely to have some influence on pupils' ICT capability. They are described more fully in Chapter 2 and, in summary, are:

- the organisation of the curriculum
- approaches to teaching and learning
- the ways in which ICT is managed
- ICT resources and staffing, including arrangements for the acquisition and renewal of ICT resources and staff training

A consistent research methodology was developed (Chapter 3), using questionnaires, interviews and lesson observations. The approach taken facilitated the writing of separate and detailed case studies of the delivery of ICT in the four secondary schools (Chapter 4) and comparative analysis of the characteristics of each school and the levels of ICT capability of their pupils (Chapter 5). The more and less successful schools are characterised in Chapter 6, and there is further discussion of the issues associated with the four themes and others that were identified during the research. Completed questionnaires, interview transcriptions and observation records are available for inspection, and in addition, summaries and intermediate analyses not fully reported in this thesis. The research data collected is summarised in Table 1.1 – for more details see Appendix 7.

Type of data collected	School			
	D	S	K	C
Staff questionnaire	1	1	1	1
Interviews of teachers	3	2	3	4
Lesson observations in key stage 3	0	2	2	0
Lesson observations in key stage 4	3	1	1	0
Pupil questionnaire	54	43	47	48

Table 1.1: A summary of the research data collected, showing the type of data collected and the number of each type collected by school.

Constraints

The studies that underpin this thesis were commenced in September 1995. There has been rapid technological and curricular change in ICT throughout this period, so that as this thesis has been written, there has been a sense of continually re-commencing it.

During the last decade, ICT hardware and software have developed rapidly. For example, user interfaces for operating systems for desk top computers have developed from text based command lines to graphical user interfaces, and now facilitate 'point and click' access to extensive networks including the Web. The range of hardware available and its functionality has increased significantly. Scanners and digital cameras were not available at the start of the decade, and hard disk capacity has increased from approximately 5 Megabytes to in excess of 50 Gigabytes. ICT hardware and software is now much less expensive, easier to use and more accessible to more people with a wider range of diverse interests and abilities.

There have also been general changes affecting state education in the UK, and these have been extensive in relation to ICT. For example, the NC subject that is now ICT has changed its name and content frequently. Over the last decade, ICT related GCSE syllabuses have been entitled Computer Studies (1989-1995), Information Systems (1995-1997), Information Technology (1997-2001), and Information and Communications Technology (2001 on). Similarly, the status of ICT within the secondary school curriculum has changed from that of an optional subject studied by a small number of pupils, to part of the NC entitlement for all pupils (DfEE and QCA, 1999).

Such rapid development is likely to continue, and as a result, it is probable that aspects of this thesis will be out-of-date as soon as it has been completed due to the time taken to produce it. The volatile nature of developments in ICT and in education produce a constantly shifting reference framework within the research domain. This research can only be a snapshot of a rapidly evolving and complex social and technological process, and this affects the clarity, stability and generalisability of the outcomes. This volatility should be taken into account when reading this thesis.

Chapter 2: Literature review

Justification for the focus of the research

There is a general conviction that ICT has significant potential for improving the quality and standards of pupils' education (DfEE,1998a, p17). In addition, for many years there has been '...a broad consensus that...(ICT)...should be delivered across the curriculum.' (Passey and Ridgeway, 1991, p2) and uncertainty whether ICT should be taught as a separate subject (Harris, 1994, p20; Yeomans et al., 1995, p331). Ridgeway and Passey (1991, p5) state a personal ambition that ICT will be '...embedded seamlessly into all areas of the curriculum.', and the National Council for Educational Technology (NCET) (1995, p8) describe a 'transformation model' showing the highest level of development as full integration. Such sentiments do not necessarily preclude the direct teaching of ICT but strongly imply that this will take place in other subjects if at all. Wellington (in Yeoman et al., 1995, p331) describes a developmental model where the progressive decline of ICT as a separate subject results in the full integration of ICT into the whole curriculum and classroom practice. Zanker (2000, p49) unequivocally states that 'ICT is not a subject to be taught in its own right.'

Perhaps as a result, research and theorising has tended to focus on the impact of ICT on the quality of teaching and learning in subjects other than ICT (Davis et al, 1992, pp5-22; NCET, 1994, pp1-25; Somekh, B., 1997), or factors influencing the successful integration of ICT into schools and classrooms (Lawson and Comber, 1999; SCET, 1999), rather than the development of pupils' ICT capability. Even relatively comprehensive descriptions of the implementation of ICT in secondary schools have omitted consideration of the effects of this on pupils' ICT capability (Lawson and Comber, 1999; NCET, 1995a).

The research described in this thesis differs in that it attempts to identify factors that lead to high levels of ICT capability in pupils aged 14-16, and insofar as it considers improvements in the quality of teaching and learning, does so only as a contributing factor. This approach is long overdue. There has been concern for more than a decade that pupils do not have sufficient knowledge, skills and understanding of ICT at the end of key stage 4, after eleven years of compulsory education (Goldstein, 1988 and 1997; HMI, 1989; Ofsted, 1995). There have been very few attempts to measure pupils' ICT capability and identify the factors which encourage its development.

The factors – inputs

Schools are complex organisations and there are many factors that may influence the development of pupils ICT capability. Some factors are general and affect all aspects of schooling, and on the whole, these have been ignored (see Chapter 5: Background factors). Reading of the relevant literature and professional experience (discussed below), suggest that some factors might specifically influence the development of pupils' ICT capability, and these have been included in the research. What follows is a description of the included factors, in brief and at length, with justification for their inclusion. Later chapters indicate which of these factors were found to be important influences, and where there was insufficient evidence to make firm judgements.

The factors included in the research were organised into themes that provide useful standpoints from which to describe and analyse the delivery of ICT in English secondary schools. Briefly, these are:

- Organisation of the curriculum, that is, the arrangements for teaching ICT as a discrete subject, across the curriculum or as a hybrid of these, and the associated expectations and consequences
- Approaches to teaching and learning, for example, the adoption by teachers of didactic, teacher-centred, behaviourist approaches, or facilitatory, pupil-centred, constructivist strategies, or hybrids
- The ways in which ICT is managed, including management organisation; the effectiveness of communication between managers and users; how ICT coordinators influence other teachers to use ICT; and the value that the school places on its investment in ICT
- The adequacy of ICT resources and staffing, including the quantity, quality and organisation of hardware and software; financial arrangements for their acquisition and renewal; staff qualifications and experience; and arrangements for staff training

Curriculum organisation

The statutory NC orders for ICT define what must be taught (DfEE and QCA, 1999). These include separate programmes of study for key stages 3 and 4, and level descriptions so that teachers can assess pupils' ICT capability. External syllabuses, such as GCSE ICT, provide more detail of what may be taught in key stage 4.

Whilst secondary schools must cover the statutory programmes of study, the way in which they organise the ICT curriculum is not prescribed, and they have chosen a variety of different approaches. However, four distinct models can be identified. These are:

- discrete ICT
- cross curricular ICT
- hybrid models:
  - skills core
  - kick start

These different approaches to organising the ICT curriculum are reviewed below.

Discrete ICT

Discrete ICT, or 'centralised' (NCET, 1996, p7), is the teaching of ICT as a separate specialist subject. Time is allocated on the school timetable for ICT in the same way that it is allocated for other subjects, for example, mathematics, science, etc.

Before the NC was introduced, many schools taught ICT, or a related subject such as Computer Studies, as a discrete subject. This appeared as a named subject on the school's timetable and time was specifically allocated for it. Consequently, some schools implemented the NC by carrying forward the existing organisation, management, resources and staffing with few changes. The content of ICT courses changed slightly with the introduction of the NC but the means of organising their delivery did not. Later revisions of the NC (DfE, 1995; DfE, 2000) had separate orders which implied that ICT should be taught as a separate subject.

Teaching ICT as a discrete subject can ensure coherent coverage of the ICT NC programmes of study, '...coverage of the programmes of study is more rigorous...' (Ofsted, 1995, p4), and it may not be possible for pupils to achieve the higher levels of the ICT NC without discrete ICT lessons (Yeomans et al, 1995, p338). However, few schools have sufficient ICT resources to teach ICT as a discrete subject and most have difficulty allocating sufficient time in a crowded timetable. As a result, either all pupils have a relatively insubstantial curriculum or only some pupils are offered a substantial course in key stage 4. In addition, teaching ICT as a discrete subject may lead to '...thorough but sterile coverage...' (NCET, 1995b, p7) and the teaching of ICT in irrelevant and meaningless contexts (NCET, 1995b; Robertson, 1997, p 170). When ICT is taught as a subject '...there are insufficient opportunities to apply the ICT skills so acquired to work in other subjects. Absence of such opportunities deprives pupils of the benefits of rigorous training.' (Ofsted, 1995, p4).

ICT resources are often centralised in a small number of ICT rooms when ICT is taught as a discrete subject. Pupils may have adequate access to computers during ICT lessons but very limited access at other times.

Cross curricular ICT

Schools which organise the delivery of ICT across the curriculum teach ICT only in other NC subjects, for example, mathematics. There is no time allocated on the timetable specifically for lessons in ICT. It is assumed that the teaching of ICT will take place entirely in other NC subjects. When the NC was introduced, ICT was subsumed within the technology orders (DES, 1990a), and the non-statutory guidance (DES, 1990b) recommended delivering ICT across the curriculum. As a result, many schools adopted this approach.

Ensuring that ICT is delivered effectively across the curriculum requires detailed mapping onto the whole school curriculum. This can be done in a variety of ways. For example, by mapping sub-themes of the ICT programmes of study to several other NC subjects. The sub-themes represent coherent groupings of the subject content. The responsibility for teaching one or more entire sub-themes can be given to a particular subject. One possible arrangement is: the Communicating Information sub-theme is given to English; the Handling Information sub-theme is given to geography; the Controlling sub-theme is given to design technology; the Measuring sub-theme is given to science; and the Modelling sub-theme is given to mathematics. This arrangement can help ensure coherence, continuity and progression in the ICT curriculum, and simplicity of the associated planning and administration. Unfortunately, the subjects given responsibility for delivering ICT may find that the extra work is too great a burden in addition to their own subject teaching, and other subjects may feel excluded. An alternative is to change some of the nominated subjects at the end of a key stage.

Another way of organising the delivery of ICT across the curriculum is to design a number of coursework tasks that, taken together, cover the ICT NC programmes of study (Crawford, 1994). Detailed mapping of the ICT NC onto the coursework tasks is necessary but this is more limited in scope than mapping onto the whole school curriculum.

Team teaching, with teachers of other subjects and ICT specialists delivering the curriculum together, is another approach. The ICT specialist identifies a coherent programme of opportunities to study ICT derived from the whole curriculum. This approach is very expensive,

and as a result, it is not unusual to find that too little ICT support is provided. There is also an assumption that detail forward planning is possible across a range of subjects which may be difficult in practice.

The teaching of ICT across the curriculum can lead to excessively complex organisation, and in extreme cases the ICT curriculum may disintegrate (Goldstein, 1997). Teachers of other subjects may not have sufficient skills to teach ICT, may lack confidence (Brown, 1997, p6; DfEE, 2000a, Table 11), and may not wish to teach ICT (Andrews, 1997, p254; Moss, 1992, p290; Roper, 2001; Williams and Moss, 1993, p79). Delivering ICT entirely across the curriculum may result in incomplete coverage of the ICT NC programmes of study, or '...not making any progress beyond learning rudimentary skills.' (NCET; 1995, p7). Coherence and progression can be problematic (Robertson, 1997, p171), and it is unlikely that pupils could be adequately prepared for GCSE or other external assessment if the school teaches ICT entirely across the curriculum. Pupils are required to do GCSE ICT coursework, and must be prepared for terminal written examinations. As there is no timetabled time for ICT, this must happen in other subjects, and may be neglected. The cross curricular approach is rarely entirely successful, and '...works only where subject teachers are also confident in ICT, pupils' progress is monitored, and structures are in place for motivating and effectively coordinating delivery.' (Ofsted, 1995, p3).

ICT resources are often distributed throughout the school when ICT is taught across the curriculum. There may be one or two computers in some classrooms and a few small clusters so that pupils can use them when they are required. This distribution may preclude the teaching of ICT skills to whole classes.

Hybrid ICT

The hybrid approach, which combines features of discrete and cross curricular ICT, is the most common in schools (Yeomans et al., 1995; Fox and Selwood, 1992). For example, in year 11, 21% of secondary schools delivered ICT as a discrete subject, 31% entirely across the curriculum; and 48% as a hybrid (DfEE, 1998b).

NCET (1996, p7) identified two common variants of the hybrid model: the 'kick start' approach and the 'skills core' approach. The kick start approach includes discrete ICT only at the start of key stage 3, with all further development being through cross curricular use. The 'skills core' approach has a limited central core of discrete ICT each year, complemented by cross curricular

ICT. These approaches attempt to combine the advantages of both discrete ICT and cross curricular ICT, and minimise the disadvantages.

In the 'kick start' approach, pupils have discrete ICT lessons at the start of key stage 3, and for the remainder of key stages 3 and 4 are taught ICT across the curriculum. This strategy is thought to remove the need for teachers of other subjects to teach ICT as pupils have been taught the skills they will need at the start of secondary schooling. However, it is unlikely that pupils will remember everything they have been taught, and the technology will change while pupils progress through key stages 3 and 4. Consequently, further ICT teaching may be necessary, and this would have to be done by teachers of other subjects. Consequently, problems with skill deficiencies, lack of confidence and resentment among teachers of other subjects are likely to persist. In addition, detailed mapping of the ICT NC programmes of study across the curriculum is still required.

In the 'skills core' approach, throughout key stages 3 and 4, pupils are taught by ICT specialists in discrete ICT lessons and use ICT across the curriculum. The ICT NC can be covered in discrete ICT, however, the use of ICT across the curriculum will still need to be mapped. Teachers of other subjects will not need to teach pupils ICT as this can be done in discrete ICT. Pupils will need a minimum of support when they use ICT across the curriculum, and teachers of other subjects can give due priority to their own subjects, allowing pupils to use ICT when appropriate.

Why it was thought that the organisation of the ICT curriculum may affect the development of pupils' ICT capability

The above models of the ICT curriculum appear to have features which may affect the development of pupils' ICT capability. These are:

- Whether the ICT NC is thoroughly covered in relevant and meaningful contexts, with planned progression
- Whether pupils are taught ICT by specialist ICT teachers or non-specialist teachers of other subjects
- Whether teachers of other subjects have sufficient ICT skills, and are willing to teach ICT
- Whether pupils have access to sufficient ICT resources when required

This justifies the inclusion of this factor in the research.

Teaching and learning

Approaches to teaching and learning are characterised in this thesis as 'behaviourist' and 'constructivist'. The traditional and most common approach in secondary schools is 'behaviourist', however, there are general characteristics of ICT (Inge, 1996) and features of teaching and learning ICT in English secondary schools that make a 'constructivist' approach the only workable methodology. These two approaches are distinct and sometimes in conflict but teachers must find a pragmatic balance between them (Crawford, 1999a). How teachers resolve this conflict may affect how pupils learn ICT, and consequently, the development of their ICT capability.

Behaviourist

Traditional approaches to teaching and learning in English secondary schools, in subjects such as mathematics, are often teacher centred and didactic. Teachers attempt to control all aspects of the learning process and expect pupils to overtly demonstrate what they have learnt. Such approaches can be characterised as 'behaviourist'.

Behaviourist descriptions of the learning process consider only those outcomes which are overt, observable or otherwise measurable, disregarding descriptions of the development of individuals' cognitive and meta-cognitive strategies and other internal processes as unreliable (Burns, 1980, p4; Gergen, 1997; Skinner, 1953). Learning is considered to have taken place only if there is an observable change in behaviour; learners are encouraged by rewards and inhibited by punishments.

Skinner (1953) and Crowder (1955, in Child, 1973, p114) developed programmed learning teaching systems based on behaviourist principles. Typically, these were highly structured with tightly specified behavioural objectives; and incorporated provision for incremental learning gains; immediate feedback and regular reinforcement. The design of such learning programmes is highly teacher or designer centred. Recognised learning outcomes are restricted, and learners are given little if any opportunity to develop perspectives or undertake tasks not built into the programme. The characteristics of individual learners and the context in which learning will take place are often ignored (Brown, 1995; Moshell, 1997; Wilson, 1997).

This approach to programmed learning is not unlike that taken by teachers who are 'gods of knowledge' (Phillips, 1997), and expect to have total mastery of the subject content they teach,

and design and control all the learning that takes place within their classrooms. ‘The dominant educational paradigm is didactic instruction where learning is viewed as an information transmission process.’ (Soloway, 1997). Teaching is viewed as the transfer of knowledge from teacher to pupil, and teachers develop tightly structured, highly focused learning materials, and assess pupils’ learning only in relation to the specific learning outcomes built into them (Fosnot, 1996, p9).

The success of the transfer of knowledge from teacher to pupils is usually judged by the extent to which pupils can recall this in tests and examinations as ‘...politicians insist on ...methods which encourage students to regurgitate their received knowledge’ (Martin, 1997, quoted in Haigh, 1998, p15). No distinction is made between learning produced by rote memorisation or as a result of deeper understanding (Julyan et al, 1996, p55), and as a result, the separation of content from context is prevalent (Brown, 1997).

The influence of behaviourism in English secondary schools is extensive. State schools have very similar curricula, and what teachers teach is prescribed by the government in considerable detail. Teachers are driven by ‘...targets, benchmarks, inspections and action plans...’, including ‘...pupil learning targets, school performance tables and other quantitative indicators that are used to measure the success or failure of schools...’ (Wilce, 1998, p32). There is considerable pressure on schools to conform. This is encouraged by ‘unrelenting pressure from the centre’ (Skidelsky, 1997, p2), and reinforced by the School Standards and Framework Bill which gives ‘...unprecedented powers to the secretary of state to intervene across the board in the British school system.’ (Dorrell, S. quoted in Ward, 1997, p8). There is increasing conformity and central control (Mortimore et al, 1997) and non-conformist schools, such as Summerhill, are threatened with closure by Ofsted (Clutterbuck, 1997). There are parallels here with the emphasis in the behaviourist model of learning on observable outcomes, encouraged by rewards and inhibited by punishments.

Constructivist

Constructivists believe that knowledge ‘...does not exist outside a person’s mind.’ (von Glaserfeld, 1996, p5) and that learning is the self organisation of an individual’s cognition and experiences, not the discovery of an external, objective reality. Learning is seen as the process of ‘...assimilation, augmentation and self reorganisation of incomplete mental structures.’ (Soloway, 1997), and is considered to be most effective when learners are pro-active in and

control the construction of their own explanations (Davidson, 1995; Gergen, 1997; Strommen & Lincoln, 1992, p2).

From the constructivist perspective, the role of the teacher and the purpose of learning materials is to facilitate active learning, during which learners construct their own understandings, rather than design tightly specified, linear teaching programmes that impose given knowledge structures on the learner (Strommen & Lincoln, 1992). Teachers do not attempt to transfer knowledge direct to passive learners but only orientate their conceptual construction process (von Glaserfeld, 1996, p7). Learners are expected to have ownership of the learning process, experience with construction of their own knowledge, and self-awareness of the knowledge construction process (Boyle, 1997, p76; Wilson, 1997). There is an emphasis on process rather than specific outcomes and, as a result, learning outcomes are less predictable and may vary from learner to learner.

Gergen (1997) distinguishes between several types of constructivism, identifying radical and social constructivism as significantly different strands. Radical constructivists give less credence to shared understandings in assessing the validity of knowledge than social constructivists who believe consensus is the ultimate validity test (Heylighen, 1993). The development of shared cultural knowledge constructed through collaborative social discourse is an essential part of social constructivism and is valued by radical constructivists as a means of testing the products of individual cognition. Consequently, some form of collaborative learning can also be expected to be a part of the constructivist experience of teaching and learning.

There are general characteristics of ICT that facilitate a constructivist approach (Inge, 1996) and features of ICT that make a behaviourist approach impractical. One reason for this is that are a wide range of ICT resources available, which are often operated in different ways, and develop rapidly and often unpredictably. In addition, pupils may have access to more modern ICT resources at home (Cuthell, 1999). As a result, ICT teachers have great difficulty in maintaining a thorough and comprehensive understanding of the content domain, and must constantly relearn what they know. Consequently, they are unlikely to have the depth and detail of understanding needed to design and construct comprehensive programmed learning materials, or similar resources for the classroom, except where the focus of these is very narrow. They must be prepared to encounter in the classroom areas of ICT subject content that they do not know or fully understand (McKenzie, 1997), so that they must expect to learn at the same time as pupils and to take the lead in learning with them.

ICT teachers may have more difficulty maintaining the focus of pupils' work than other teachers, and those who adopt didactic, whole class, teacher centred approaches to teaching ICT may struggle to retain pupils' attention. Even though pupils may be highly motivated, they can be disinclined to sit and listen to the teacher or to wait for other pupils to complete their work as the teacher takes the whole class step-by-step through precise operational procedures. When learning materials based on traditional systematic instructional design are used, learners tend to deviate from the given sequence or abandon it entirely, preferring to try and make sense of the situation rather than following a series of rigid steps (Boyle, 1997, p13). Learners apparently prefer to attempt to construct their own understandings and seem to want 'meaningful interaction with real tasks rather than formal drill and instruction' (Boyle, 1997, p13).

In addition, ICT teachers may be less able to restrict pupils' access to only those learning resources and activities that are particularly relevant to the set task, as pupils using ICT may have access to the full range of software available and the wide range of features within each piece of software. As a result, pupils may inadvertently or deliberately use different pieces of software or features of the software that are not relevant to their work, and become distracted or irretrievably stuck.

ICT almost always involves an element of collaborative learning. As there is often insufficient hardware for each pupil to have the sole use of a computer (Goldstein, 1997), pupils are likely to work in small groups of two or three, and will almost always help each other. In such circumstances, pupils are likely to investigate and develop not only their own ideas but the ideas of other group members (Phillips, 1997). ICT teachers must expect to learn at the same time as pupils and to take the lead in learning with them.

Why it was thought that approaches to teaching and learning may affect the development of pupils' ICT capability

Behaviourist and constructivist approaches to teaching and learning are evidently distinct and sometimes in conflict. Even so, teachers must find a pragmatic balance between the behaviourist approach common in the English school system and the constructivist approach that may be more suited to teaching and learning ICT. The particular ways in which this is done may influence aspects of classroom practice. Some considerations are:

- Whether teachers have a thorough and comprehensive knowledge of the subject domain
- Whether teachers can fully update their ICT knowledge, skills and understanding as the technology develops

- Whether teachers seek to design and control all aspects of teaching and learning
- Whether teachers set actual tasks using real ICT tools in relevant and authentic contexts and recognise learning that they did not anticipate in lesson planning, or provide pupils with step-by-step worksheets and recognise only a narrow set of planned learning outcomes
- Whether teachers adopt a didactic teacher centred approach or promote pupil centred strategies and, autonomous and collaborative learning

Resolution is likely to lead to very different classroom practice, and may affect the development of pupils' ICT capability. This justifies the inclusion of this factor in the research.

Management

Different approaches to educational management are likely to have some impact on levels of provision for ICT and the ways in which it is implemented even between apparently similar secondary schools (DfEE, 1998b; Goldstein, 1997). The way ICT is managed is likely to affect all aspects of provision across the whole school, including curriculum organisation and teachers' willingness to use different approaches to teaching and learning. In addition, arrangements for the provision of ICT resources; the range of ICT skills and support available to the school; and the extent teachers use ICT in the classroom may be affected. These impact on pupils' overall experiences of ICT in school, and as a result, the development of their ICT capability.

The effectiveness of the ways in which ICT is delivered may be influenced by different approaches to educational management. Traditional departmental management roles and organisational structures may not be effective as these are too restrictive (Owen, 1992, p36). In most English secondary schools, teachers are responsible to HoD(s) (middle management) who are answerable to senior managers for the activities of their departments (Bush, 1995, p 29). It is generally the case that, for example, the HoD mathematics will have stable expectations regarding the time allocated to teaching mathematics; will produce schemes of work that cover the statutory curriculum or external examination syllabuses; will be consistently allocated modest funds each year for resources for teaching and learning; will allocate mathematics teachers to teach particular classes; and will generally, though not entirely, ignore such matters in other subject departments. Can an effective HoD ICT have such a narrow range of middle management responsibilities, or should senior management and teachers of other subjects be more involved?

The management of ICT may extend across traditional departmental boundaries. 96% of secondary schools have ICT middle managers who are expected to implement ICT policies, plans and schemes of work across the whole school; provide technical support and train colleagues; advise on ICT products, including whole school networks; and take responsibility for teaching discrete ICT (DfEE, 1998b). Hybrid and cross curricular models of the ICT curriculum anticipate that all teaching staff, whatever their subject, will use ICT in the classroom. Substantial usage of ICT is reported in most business studies lessons; some usage in most design technology, English and mathematics lessons; and limited use in RE and Physical Education (PE) lessons. ICT is used on average between 13 lessons per week in year 7 and 22 lessons per week in year 12 (DfEE, 1998b). In addition, ICT resources may be deployed throughout the whole school rather than only within the ICT department.

Throughout this thesis the titles ‘ HoD ICT’ and ‘ICT coordinator’ are used to refer to the middle manager responsible for ICT. These posts are likely to have similar and overlapping roles. Where a school believes that ICT should be managed in the same way that traditional secondary school departments are managed, then the middle manager for ICT is likely to be referred to as the HoD ICT. Such schools are more likely to teach discrete ICT, and the responsibilities of the HoD ICT will be those of a traditional departmental management role. Even so, the HoD ICT is likely to acquire responsibilities far broader than those of HoD(s) of other subjects. These may require the coordination of ICT throughout the school and cut across departmental boundaries. For example, the HoD ICT is likely to help colleagues develop their ICT skills and advise them on the use of ICT in their subjects, in effect coordinating ICT across the curriculum. In contrast, schools which emphasise the delivery of ICT across the curriculum, are likely to appoint an ICT coordinator whose first priority will be the delivery of ICT in ways that cut across departmental boundaries. Even so, if discrete ICT is taught, it is likely to be the ICT coordinator who will be responsible for its delivery, in effect taking on the departmental management role of the HoD ICT.

All teachers are required to use ICT in the classroom but many have not been trained to use it. The Government is providing NOF training (DfEE, 1997) for all serving teachers in the use of ICT in subjects, and requires that all trainee teachers develop adequate ICT skills (DfEE, 1998a). Even so, many teachers have not yet received adequate ICT training and lack skills at an appropriate level. Any ICT department with the capability to provide this training would inevitably be required to make decisions more properly determined at the level of senior management (Owen, 1992, p37).

The effective implementation of ICT in secondary schools is beyond the capability of middle management. Schools that assume that ICT can be implemented through traditional models of departmental management will not make the best use of ICT (Owen, 1992, p36). Crawford (1999c) analysed the formal, collegial, political, subjective, ambiguity and cultural models of educational management identified by Bush (1995), and identified possible management strategies that might help secondary schools deliver ICT more effectively. A summary of this analysis follows.

The most effective arrangement for implementing ICT may be a formal, that is an hierarchical, management structure led by a Headteacher with ICT expertise. 'If professional expertise is concentrated near the base of the bureaucratic pyramid the rules themselves must be largely a product of the consent of those to whom they apply.' (Williams et al, 1983, p94, quoted in Bush, 1995, p37). This generalised observation is a feature of all hierarchical organisational structures, and can be re-contextualised as: if expertise and enthusiasm for ICT are concentrated near the base of the formal management hierarchy, then its application throughout the school depends on the extent of its acceptance by individuals at this level. An ICT coordinator below senior management level in a formal, hierarchically organised school will lack sufficient authority and power to manage ICT effectively across the institution as whole whatever is achieved within a delimited departmental arena (Owen, 1992, p36). Poor liaison and a lack of support from senior management can affect ICT coordinators' effectiveness (Ofsted, 2001a, p15; Passey et al, 1991, p3). The headteacher is the most important influence on attitudes towards computers and ICT. If computers are ignored or merely accepted by the Headteacher, they will be marginalised within the school (NCET, 1994, p26).

Collegial management organisation provides opportunities for teachers to participate more fully, and '...the quality of decision making is likely to be better.' (Bush, 1995, p58). Collegial models are characterised by: collective decision making through consensus where differences are overcome through rational argument; individual autonomy grounded in the '...authority of expertise...' that arises directly from the exercise of professional knowledge and skills; shared values; and small decision making groups (Bush, 1995, p53).

Managing the delivery of ICT in its entirety requires considerable technical expertise. If senior managers do not have sufficient ICT expertise, then the formal model is likely to be much less effective. A flatter, collegial management structure where power and decision making are more widely shared may well be more effective than a hierarchical formal model. Professional

experience supports this view: '...schools with open and flat-topped management structures are the ones most likely to have a good quality of well planned ICT resources. ICT invites collaboration and communication and so Headteachers who like to control everything directly don't, in the main, like ICT.' (Seviour, 1998).

However, there is some doubt whether collegial approaches to educational management are possible in practice (Bush, 1995, p70). It is implicit in collegial management models that members of an organisation ultimately agree on its goals or find non-conflicting solutions that satisfy a multiplicity of different needs. Such conflicts are likely to be more difficult and take longer to resolve where participants have equal status than in formal organisations where the needs of one person or group are likely to be subservient to those of others. Collegial management is likely to involve more elaborate systems of committees, and consequently, decision making can be ponderous and unwieldy. It is more likely that some of those involved will not understand the technical issues, so that the quality of decision making may be eroded. Moreover, where decisions emerge from a complex committee system, it may not be clear who is responsible for implementation. These features of collegial organisations may affect their ability to implement effectively new and rapidly developing technologies. It may well be that the appointment of a senior manager with overall responsibility for ICT is desirable even in an ostensibly collegial organisation. This senior manager would have oversight of all decision making but the flatter management structure more typical of collegial models would ensure that the different needs of ICT specialists and the whole staff are taken into account.

Formal and collegial models of the management of educational institutions assume that organisational structure is explicit and stable. In contrast, in a political model the organisational structure is understood as emerging from political manoeuvring and negotiation between competing groups as they pursue their own independent sectional interests. The provision of an adequate ICT curriculum, resources and staffing is one of many competing aims the achievement of which will conflict with the realisation of others' goals, and it is probable that this will be prioritised more highly and pursued more vigorously by ICT teachers.

The political model of educational management provides useful insights that are relevant to understanding how ICT can be promoted within schools. ICT coordinators may seek to enhance their legitimate, positional authority and power through the development of their personal charisma, and the possession of superior technical expertise. At an operational level, ICT coordinators often have considerable power over the allocation of ICT resources to other teachers, and the availability of technical support. Without sufficient access and adequate technical support, users may not be able to make effective use of ICT. ICT coordinators are able

to reward those who are likely to be supportive by allocating more or better ICT resources to them; repairing hardware and maintaining software more promptly, and rationing training. Even though it is likely that some of these strategies would be considered unethical, there is limited research evidence that ICT coordinators employ such political strategies (Yeomans et al, 1995, p335-7),

Teachers with responsibility for ICT may well use political strategies to ensure that it is given sufficient prominence, however, this is unlikely to be effective in the long term. 'Political models assume that the goals of organisations are unstable, ambiguous and contested.' (Bush, 1995, p76). Consequently, the outcomes of the political process cannot be relied on to be consistent over time. For example, on one occasion adequate finance for ICT resources may be ensured by political bargaining but this does not guarantee sufficient, consistent annual funding.

Subjective models of educational management, that is, phenomenological, social interactionist and constructivist explanations of social reality (Mead, 1974; Richardson, 1997), can provide insights into individuals' perceptions of organisations (Bush, 1995, p104, p107). The rate and extent of individuals' adoption of ICT relate to factors, such as, psychological predisposition to accept change, capacity to learn, and personal evaluation of its usefulness. Management strategies that do not take into account the different ways in which individuals value ICT and their motivations, may not lead to enthusiastic and effective implementation. Changing individuals' values and standpoints is likely to be a slow process and these may not always be adjusted in the ways intended (Bush, 1995, p103).

Ambiguity models (Bush, 1995, pp112-27) of educational management may provide partial explanations of the difficulties inherent in delivering ICT in secondary schools. These assume that there is lack of agreement regarding institutional goals and purposes; that organisational processes, rules and structures are not entirely explicit or well understood; that organisations are characterised by fragmentation and loose coupling of decentralised subgroups; that individuals' powers and responsibilities are not clearly defined; that participation in decision making is inconsistent; and that the process of identifying problems and their solutions, and implementing, monitoring and evaluating these is not a linear, rational process (Bush, 1995, pp112-5).

Cultural models (Bush, 1995, pp130-40) of educational management acknowledge shared values and meanings grounded in the professional experience of secondary school teachers. These common understandings find expression as tradition and ritual, not only in the conduct of ceremonies, such as assemblies, but also in expected role behaviours. Cultural symbolism is expressed through, for example, language, patterns of social interaction, and uniforms, and the

values, philosophy and ideology of the school are embodied in its heroes and heroines. For ICT to be adopted across the whole school it must become part of the dominant school culture. It must be seen to be an important part of organisational processes and procedures, and this must be reflected in its usage by senior management. The organisation must value its investment in ICT, and demonstrate pride in its achievements and long term commitment. In practice, as secondary schools begin to make effective use of ICT, symbolic gestures, such as putting a computer on the Headteacher's desk, and routinely showing visitors the new ICT resources, are common. These overtly demonstrate that the school values and takes a pride in its financial and intellectual investment in ICT.

From the above, possible management strategies that might help secondary schools deliver ICT more effectively are:

- A Headteacher or a senior manager with positive attitudes towards ICT takes overall responsibility for the management of ICT throughout the school. This emphasises that successful implementation is important for the whole school.
- The senior manager in charge of the delivery of ICT has good ICT skills, and an understanding of technical issues. This makes it more likely that the different needs of ICT specialist teachers and the whole staff are taken into account.
- The management structure is formal and hierarchically organised but relatively flat-topped. Consultation is genuine and senior managers are open to change. This ensures that it is clear who has overall responsibility; decisions can be made rapidly; and those teachers with expertise and interest are consulted.
- ICT coordinators enhance their formal power through their personal charisma and technical expertise; by providing information; and by supporting colleagues' use of ICT. They build coalitions among groups with similar interests in order to provide support for policy proposals, and encourage colleagues to use ICT more widely.
- The different ways in which individual teachers value ICT and their motivations, are taken into account, and there is an awareness that changing these is likely to be a slow process which can be supported by the provision of up-to-date ICT resources.
- ICT is a part of the traditions and rituals of the dominant school culture. It is overtly demonstrated that the school values and takes a pride in its financial and intellectual investment in ICT.

These management strategies subsume those described in the non-statutory guidance (DES, 1990b) accompanying the Technology NC orders (DES, 1990a), and advisory literature and research related to this (Hackett and Kennedy, 1996; Owen, 1992).

Why it was thought that approaches to the management of ICT may affect the development of pupils' ICT capability

The way ICT is managed is likely to affect all aspects of provision across the whole school and pupils' overall experiences of ICT in school, and as a result, the development of their ICT capability. In particular, the management strategies suggested may affect the development of pupils' ICT capability because:

- Teachers' perception of the importance of developing their own and pupils' ICT capability may be affected by the ICT skills, attitude and status of the teacher who has responsibility for the management of ICT throughout the school.
- The level of ICT skills of the teacher who has responsibility for the management of ICT throughout the school may affect the appropriateness of ICT provision.
- Responsive yet decisive management organisation, and encouragement to participate in the formulation of policy, may encourage teachers' involvement in delivering ICT, and hence broaden pupils' experiences.
- ICT coordinators who extend their own influence and expertise may help more teachers develop their use of ICT in the classroom.
- ICT coordinators who are sensitive to the different ways individual teachers value ICT and their motivations may help them remain engaged in developing their ICT skills even if this is a slow process.
- When ICT is a part of the traditions and rituals of the dominant school culture, it is overtly demonstrated that the school values and takes a pride in its financial and intellectual investment in ICT. This is likely to include: showing visitors the ICT facilities; a perception that ICT is essential for school administration; prizes for achievement in ICT; and the headteacher demonstrating the value of ICT by having a computer in his/her office and using it. Such evidence of the school's appreciation of its investment in ICT may encourage more teachers and pupils to value their own ICT skills.

This justifies the inclusion of this factor in the research.

Staffing and resources

It would seem to be common sense that it is more likely pupils will develop higher levels of ICT capability in schools that have more specialist ICT teachers who are better trained and more highly qualified, and have more practical experience of ICT. Such teachers may be more likely to teach their pupils more effectively. Similarly, pupils who attend schools with a greater

quantity of more modern ICT resources that are regularly renewed are likely to have easier and more frequent access to ICT and develop their ICT capability more rapidly. Perhaps because these viewpoints are so widely accepted there has been very little research to confirm them. However, in general, 'There is emerging evidence of a link between high standards across the curriculum and good ICT provision.' (Ofsted, 2001b, p2). Becta (2001) found evidence that standards in mathematics and English were better in primary schools with higher numbers of modern computers. Other related evidence is reviewed below.

Most ICT teachers employed in English secondary schools lack qualifications and training in ICT, and very few have been specifically trained to teach ICT. ICT teachers need more training as the technology develops and provision of this is generally lacking. The Teacher Training Agency (TTA) only gave widespread approval for PGCE and BEd courses in the subject of ICT beginning in September 1996 (Selinger, 1997; QCA, 1997, p8). Prior to this there were general requirements that all teachers should have basic ICT skills, and courses at a very few universities, for example, Leeds University. Teachers of ICT must regularly learn new concepts, and re-learn old skills in new contexts, as the technology changes. In general, staff development is far too limited and most teachers have to teach themselves how to use ICT (Goldstein, 1997, p11). Teachers' ICT skills may be out of date in comparison with their pupils as they generally use older equipment at school whereas pupils may have access to more modern computer equipment at home (Cuthell et al, 1997). Perhaps it is not surprising that 'Teachers command of the subject was weak and appeared to weaken in comparison with previous years.' (Goldstein, 1997, p11).

Where there is regular and adequate annual funding for ICT, there may be a greater variety of modern ICT resources for pupils to use, so that their experience of ICT is broader and more up-to-date. Regular and adequate funding is necessary because of the rate of technological development. ICT hardware and software is generally considered obsolete after three to five years, and it has been calculated that around £30,000 per annum is needed by a secondary school with 850 pupils to ensure that its ICT resources continue to provide a satisfactory experience of ICT for pupils at the school (Crawford, 1997, p65). In 1998, the average expenditure per school on ICT resources for teaching and learning was £33,259 (DfEE, 1998b). This average includes very large exceptional payments to a small number of schools under schemes such as the Technology Schools Initiative (TSI). Schools that have successfully bid for TSI funds often have exceptional pupil:computer ratios while other schools are poorly resourced. Schools rarely budget for this level of spending on ICT resources each year, and often have insufficiently developed plans to replace out-of-date hardware (Ofsted, 2001b, p5). A reliance on bid based funding is unlikely to be a satisfactory strategy for consistent replacement

and renewal of hardware and software. This is more likely to be ensured by long term developmental planning, supported by the allocation of sufficient annual funding.

Why it was thought that staffing and resources may affect the development of pupils' ICT capability

ICT staffing and resources are likely to affect all aspects of ICT provision, and as a result, the development of pupils' ICT capability because:

- Specialist ICT teachers who are better trained and more highly qualified are more likely to teach pupils more effectively
- When there are more ICT resources, pupils may have easier and more frequent access, and more opportunities to develop their ICT knowledge, skills and understanding
- Where there is adequate annual funding for ICT, there may be a greater variety of modern ICT resources for pupils to use, so that their experience of ICT is broader and more up-to-date

This justifies the inclusion of this factor in the research.

ICT capability – outputs

In order to judge the impact of the factors affecting pupils' ICT capability, it would be useful to have a description of what is meant by ICT capability and a measure of pupils' development in relation to this. Summaries of pupils' achievements in ICT at the end of key stage 3 and in GCSE or General National Vocational Qualifications (GNVQ) in ICT might be expected to be useful measures of pupils' ICT capability as their purpose is its development and assessment. However, this information lacks sufficient specificity, does not provide detailed descriptions of pupils' strengths and weaknesses, and is not available for all schools. Consequently, a questionnaire was developed to measure pupils' ICT capability (Chapter 3). The design of this pupil questionnaire was based on a description of pupils' ICT capability derived from a historical study of the development of notions of ICT capability (Crawford, 1998). The trends discernable in this study, the research projects and other materials investigated, and what is currently considered to constitute ICT capability are summarised below.

Understandings of what constitutes ICT capability are not uncontentious and are not always explicitly stated. Rather than being based on widely shared, stable and clearly defined knowledge, skills and understanding, these have evolved, and reflect current beliefs and technological capability. Different groups are likely to approach ICT capability from different

perspectives '...strongly influenced by their biographies and prior experience of computer use.' (Somekh, 1996, p119). Some common trends are evident. These are:

- Within the educational community, the perceived purposes of developing ICT capability are both vocational and educational. However, there is currently much more emphasis on using ICT skills to support teaching and learning than on the need for these for employment (Yeomans, 1995, p330).
- Perceptions of the ICT skills pupils require have moved from technical skills to those needed by users. Technical skills become obsolete more quickly and have narrower application than the more flexible and transferable skills that users may develop (Benzie, 1997).
- Approaches to teaching and learning have become more emphatically constructivist (discussed earlier in this chapter). This affects the ways in which the curriculum is elaborated and the construction of training materials. For example, instead of writing detailed worksheets that instruct pupils in the technical operation of specific software, teachers encourage learners to develop strategies that enable them to select and use appropriate ICT resources whether or not they are initially familiar with their use (Benzie, 1997; Carroll, 1990).
- There is a tendency to be technologically conservative and deal predominantly with what is, not with what might be. Pupils are more likely to learn about the technologies currently available in school, rather than unusual, state-of-the-art or potential future technologies.
- Technological determinism, that is, the notion that the development of technology is independent of outside influences, is more prevalent than understandings of the relationship between technology and society in terms of social shaping that is interactive and recursive. In describing ICT capability, technological determinists might emphasise an understanding of the technology itself detached from social processes.

The research projects and other materials covered in the historical study (Crawford, 1998) were: the introduction of computers into schools during the late 1970s and early 1980s; the Microelectronics Education Programme (1980-86); the Pupil Autonomy in learning with Microcomputers (PALM) project (1988-1991); the 1990 Technology NC (DES, 1990a); the 1995 IT NC (DfE, 1995); the Initial Teacher Education and New Technology project (INTENT) set up in response to the Trotter Report (DES, 1989); a small research study by the author in March 1998 at the Universities of Huddersfield and Leeds, investigating student teachers' understandings of ICT capability; and the Initial Teacher Training (ITT) NC for the use of ICT in subject teaching (DfEE, 1998a).

Analysis of the research projects and other materials indicated that notions of what constitutes ICT capability had changed considerably over 20 years. Pupils would currently be considered to have high levels of ICT capability if they were able to:

A. Use ICT to support their learning in all subjects
B. Use common ICT tools
C. Take responsibility for their own learning, developing strategies to help them learn how to use unfamiliar ICT tools, and work collaboratively
D. Use current ICT hardware and software and understand its potential and limitations
E. Understand that using ICT affects social processes

This description is not unlike that given in the NC orders for Information Technology (IT) and elsewhere (Benzie, 1997; DfE, 1995), and is the operational definition of ICT capability used in this research.

Chapter 3: Research methodology

Introduction

This research study attempts to identify the factors associated with high levels of ICT capability among 14-16 year olds in English schools. The development of the research programme began with a detailed analysis of the four input factors, that is: curriculum organisation, teaching and learning, management, and staffing and resources (Chapter 2), and this was used to produce sub-questions (Appendix 1). The derivation and expression of the sub-questions was moderated through professional experience and prior research so that the answers to them would collectively provide a comprehensive description of the actualisation of the four input factors in English schools. Similarly, pupils' ICT capability was analysed and broken down into sub-questions. However, this was not initially successful and was redone following the pilot study (discussed below). The sub-questions were expressed at a level where they could be mapped to the proposed research instruments (Appendix 1). This mapping indicated that there would be opportunities to collect the same or similar evidence on multiple occasions so that this could be triangulated.

Next, a staff questionnaire (Appendix 2), an interview agenda (Appendix 3), a lesson observation schedule (Appendix 4), and a checklist of information to be extracted from an analysis of school documentation (not included) were developed. A pilot study was carried out to evaluate the effectiveness of these research instruments as methods of collecting information that could be used to compile meaningful case studies. As a result, modifications were made to the research instruments; a pupil questionnaire was developed that could be used to assess pupils' ICT capability; and the organisation of the full research programme was adjusted to improve the potential variety of perspectives investigated. The full research programme was then carried out. For reasons of economy, the research programme was based on case studies of four schools, and its scope was further restricted to key stage 4 to improve consistency and hence comparability between schools; to provide a sharper focus; and to maximise the clarity of the resulting insights. This research process is described below.

The pilot study

The pilot study was conducted during 1998/9, and consisted of what it was supposed would constitute the full research programme for one case study school. Prior to the pilot study, it was thought that in the full research programme a staff questionnaire would be distributed to two teachers in each of several hundred schools, and three schools would be identified that were suitable and willing to participate in further research. To model this in the pilot study, the staff questionnaire was sent to the ICT coordinator and the member of the Senior Management Team (SMT) responsible for ICT in each of five schools. When these questionnaires were returned, one school (school X) was chosen for more in depth study. School X, an 11-16 comprehensive school, was particularly suitable for the pilot study as the school had recently changed to the discrete approach having previously delivered ICT across the curriculum. The researcher visited school X and interviewed the ICT coordinator and the member of the SMT responsible for ICT, and observed lessons taught by these teachers the lesson observation schedule (Appendix 4). School documentation was collected and a checklist (not included) was used to extract information from it. A detailed description of some of the issues that arose in the pilot study follows.

Teachers' attitudes

'Teachers by and large do not know about research and do not wish to know about it' (Nisbet and Broadfoot, 1980). Saunders and Rudd (1999) (quoted in the TES, 17/9/99, p 28) found that teachers were '...hostile, despite my assurances that I was engaged in a small, independent empirical study, not an inspection...'. These attitudes may lead to a lack of mutual understanding between theorists and practitioners (Threadgold, 1985, p251). As a precaution, during the pilot study, the researcher repeatedly emphasised the confidential, non-threatening nature of the research; and explained the purposes of the research and of particular research activities, and clearly differentiated these from inspection or similar activities.

Staff questionnaire

The staff questionnaire was designed to maximise returns, facilitate the identification of schools that might usefully be investigated in greater detail, and provide relatively objective information across a wide range of schools. Prior to the pilot study, the staff questionnaire was modified to facilitate accuracy and ease of response, for example, by providing tick boxes. More detailed

descriptions of the development of the staff questionnaire, and the various versions of it, are included in Crawford (1999b). Staff questionnaires (an earlier version of Appendix 2) returned during the pilot study showed a lack of clarity in answers to question 2, that is, 'In which years is ICT timetabled as a discrete subject, and how is this organised?'. For example, although all pupils were timetabled for 1 hour per week throughout the year at school X, both teachers ticked '1 hr. per week' but neither ticked 'For 3 terms'. The layout of question 2 was altered to encourage more precise answers but no further modification was necessary. The version of the staff questionnaire used in the full research programme is included in Appendix 2.

Interviews

The interview agenda was initially designed according to the hierarchical focusing methodology for conducting interviews (Tomlinson, 1989). Hierarchical focusing is a structured methodology that enables interviewers to cover the interview topics in detail while accepting interviewees' spontaneous responses. Rogerian counselling techniques (Nelson-Jones, 1982; Rogers, 1945) are used to encourage interviewees to respond spontaneously. Interviewees' responses are coded as prompted or spontaneous, and as having fully or partially covered a sub-topic on the interview agenda. As a data collection methodology, hierarchical focusing shares the advantages and disadvantages of interviews, in general, and structured interviews, in particular, but more accurately tracks situations where interviewees respond spontaneously. However, conducting an hierarchically focused interview can be complex and demanding. Interviewers are required to track coverage of the interview agenda in detail by completing an hierarchical recording structure using a coding system. In order to simplify the interviewer's task, the hierarchical recording structure was modified so that coverage could be tracked but the requirement to code prompting was removed. Several versions of the interview agenda were produced, and a more detailed description of its development is included in Crawford (1999b). Only the final version is included in this thesis (Appendix 3).

The member of the SMT responsible for ICT and the HoD ICT were interviewed. They appeared less at ease and less inclined to talk at length at the start of the interview. To encourage them to relax and to answer spontaneously, the interviews did not adhere to the order of the planned interview agenda. The order of the questions was varied to accommodate their focus of interest, and potentially sensitive questions were asked later in the interview when they were more at ease. The wording of the questions was also adjusted during the interview to reflect the style and content of the language they used. This approach was continued in the full research programme, and in addition, a question asking interviewees to describe a typical ICT

lesson was added to help interviewees relax and provide an introduction to more detailed questioning.

The interviews were a rich source of a wide range of information. It was clear throughout that the issues raised in the interview agenda were not only relevant to interviewees but were at times sensitive. The teachers interviewed were more at ease answering questions where their professional practice was sound and their methods evidently ethical. For example, the HoD ICT at school X exhibited considerable uncertainty and discomfort when asked 'How do ICT coordinators get other staff to support them?'. As a result, it was necessary to revisit some topics on more than one occasion.

During the interviews, it emerged that all the ICT teachers involved in the pilot study had previously been teachers of Design Technology (DT). This common subject background appeared to lead to rather more uniformity than might have been expected otherwise. For example, the HoD ICT stated that a task-focused approach was common in DT, and this was observed in all the ICT lessons. Consequently, a question on subject background was added to the interview agenda. In addition, in order to include a greater variety of perspectives and approaches in the research, it was decided to increase the number of interviews per school to three. These were to be: the member of the SMT responsible for ICT, the HoD ICT and the HoD mathematics, or reasonable substitutes.

Other problems were organisational and technical. Finding a quiet room where teachers could be interviewed without interruption was problematic. All the teachers interviewed were in constant demand by colleagues throughout the working day, and interviews were frequently interrupted, disrupting their continuity and depth. This emphasised the need to insist that interviews take place in a quiet room where interviewees could not be interrupted. Even so, the interview agenda was covered in the hour set aside for each interview.

The teachers interviewed were later observed teaching. Observing some teachers before the interview, and some after it, was considered in order to evaluate the impact of the order of these research activities, however, this was not possible in practice. No evidence was found that the order might influence the results.

Lesson observations

The lesson observation schedule was designed to assist investigation of approaches to teaching and learning. It was structured to record features of the lesson with time weightings to indicate predominance. During the pilot study, the researcher attempted to record observations at ten minute intervals but this was sometimes too frequent as there was no change of activity and the researcher was distracted from in-depth observation. In contrast, when transitions between different activities were rapid, recording observations at ten minute intervals was too infrequent. Changes were made to the lesson observation schedule so that both the time and the type of activity could be recorded as required. The version of the lesson observation schedule used in the full research programme is included in Appendix 4, with more detailed descriptions of its development in Crawford (1999b).

Four discrete ICT lessons were observed against a target of two but the additional observations did not yield significantly more information. In an attempt to observe a greater variety of approaches to teaching and learning in the research, it was decided to observe three lessons not all of which would be discrete ICT. These were to be of: the member of the SMT responsible for ICT, the HoD ICT and the HoD mathematics, or reasonable substitutes.

There were apparent weaknesses in the selection and timing of the lessons observed during the pilot study. The school arranged for the researcher to observe classes with well behaved pupils of above average ability, and timetabled the research programme over a two day period. A more effective research programme might have included observations of classes of a wider range of abilities, spread over a longer period of time. This approach was taken during the full research programme.

Analysis of the documentation

A checklist of information to be extracted from an analysis of school documentation (not included) was produced. The purpose of this checklist was to ensure that all the required information was consistently collected from the documentation provided by schools so that information obtained using other research instruments could be systematically cross checked. The school documentation required included the staff handbook; school prospectus; school timetable; ICT policy or development plan; end of key stage 3 assessment results; end of key stage 4 external assessment results; and Ofsted reports.

The checklist itself proved satisfactory in use but school documentation was sometimes unavailable or inconsistent between schools. Ofsted reports could be downloaded from the Internet, but some difficulties were encountered obtaining other school documentation. In addition, some of the information obtained from the school documentation that was available was inconsistent with that derived from other sources including interviews and lesson observations. Such inconsistencies were usually due to inaccuracies in the documentation, for example, it was out of date. In addition, analysis of the documentation available from several schools indicated that the information provided by different schools was not sufficiently consistent to facilitate useful comparisons. Such inaccuracy and inconsistency limited the usefulness of school documentation for systematic research. Consequently, the checklist was not used in the full research programme, although opportunistic reference was made to Ofsted reports and other school documentation where this was relevant and available.

Pupils' ICT capability

Prior to the pilot study, it had been expected that summaries of the number of pupils achieving each National Curriculum level at the end of key stage 3 and each GCSE grade would provide adequate information regarding pupils' ICT capability and attainment. However, this information did not provide detailed descriptions of pupils' strengths and weaknesses, and was not available for all schools. The lack of a satisfactory measure of pupils' ICT capability was a major weakness of the research programme tested in the pilot study, and to address this the pupil questionnaire (Appendix 5) was developed.

The design of the pupil questionnaire was based on a description of pupils' ICT capability (p26) derived from a historical study of the development of notions of ICT capability (Crawford, 1998). More details are given in Chapter 2. Each question in the pupil questionnaire was mapped to the description of pupils' ICT capability, and translates this description into language and concepts meaningful to year 11 pupils. It was revised several times during its construction, and a limited pre-test carried out.

The mapping relies on the author's professional experience and judgement, so that whether the pupil questionnaire is a comprehensive and balanced measure of pupils' ICT capability is problematic. In addition, the questionnaire collects information about pupils' self assessment of their own ICT capability and is consequently not entirely reliable. However, it evidently measures some aspects of pupils' ICT capability, and facilitated useful insights during analysis

of the outcomes of the full research programme, although these cannot be expected to relate to schools in general.

In order to increase the likelihood that year 11 pupils of a range of opinions and abilities would be sampled, it was decided that each school would be asked to ensure that at least 40 pupils from more than one class completed the questionnaires.

The full research programme

The full research programme was carried out from April to July 2000. Around 210 staff questionnaires were sent to 70 schools. Three questionnaires were sent to each school, addressed to the member of the SMT responsible for ICT, the ICT coordinator; and the HoD mathematics. These teachers were chosen because they could be expected to have an overview of how ICT was delivered in the school from different perspectives. Questionnaires were returned from 25 schools. It was unusual for more than one questionnaire to be returned from a school despite three having been posted separately to individual teachers, and several schools indicated that the recipients had collaborated in filling in one questionnaire. As a result, the information collected by the staff questionnaires was primarily used to select the case study schools.

In the staff questionnaire, eight schools indicated a willingness to participate in the full research programme, and the four case study schools were selected from these. The research evidence collected at these schools is described in Appendix 7.

Four schools were chosen to participate in the full research programme as this was sufficient to cover the range of approaches to delivering the ICT curriculum. The schools selected delivered ICT as a discrete subject (school D), and using the skills core (school S), kick start (school K), and cross curricular (school C) approaches. The approach taken to the delivery of the ICT curriculum had been consistent for at least five years in all the schools selected. This ensured that pupils' ICT capability was an outcome of the current or a very similar approach to the ICT curriculum.

In order to include a sufficient variety of perspectives, three teachers were to be interviewed and three lessons were to be observed in each school (discussed in Chapter 3: Interviews). It was intended to interview the member of the SMT responsible for ICT, the HoD ICT; and the HoD mathematics, and observe each of them teaching either an ICT lesson, or a lesson in which ICT

was used to support teaching and learning. The interviews were easily arranged except for the HoD mathematics at school S, where due to domestic circumstances it was not possible to arrange a formal interview, and a substitute was not available when the research was carried out.

At times there seemed to be a tension in interviews between how teachers felt they should respond and what they believed to be the reality of the situation they were describing. As a result, in the record of research evidence in Appendix 7, there is an indication whether interviewees were thought to be reliable or otherwise. For example, for the interview with the deputy headteacher responsible for ICT throughout school K, it is noted that 'Evidence is unrealistic and favours the school.' (IKCB – for a description of this reference, see Appendix 7). In reading the interview transcripts and weighing the evidence from other sources about school K, this subjective assessment of the interviewee's credibility was taken into account.

Some interviewees made it clear that they dissented from views that they anticipated other interviewees would ascribe to them and sought to clarify what they believed to be the real situation. For example, there were differing opinions about the universality of teachers' enthusiasm to use ICT in other subjects (IDPR); the adequacy of access to ICT resources to support teaching and learning in other subjects; and the extent to which arrangements for managing ICT resources and curriculum enabled all teachers' views to be heard and their needs to be considered.

Arranging the intended lesson observations was problematic. One reason for this was that the member of the SMT responsible for ICT and the HoD mathematics did not always teach ICT or make use of it in the classroom. As a result, guidelines were developed for selecting the teachers who would teach the lessons to be observed. Briefly, if the member of the SMT responsible for ICT could not be observed, then a basic scale ICT teacher was substituted. This provided insights into classroom practice from a knowledgeable but much more classroom focused perspective. Similarly, if the HoD mathematics could not be observed teaching then any basic scale teacher of a subject other than ICT was substituted. Again, this provided insights into classroom teachers' perspectives.

It was intended that lesson observations would be of classes with pupils in key stage 4 as the research focus was on 14-16 year olds, and considerable efforts were made to observe these. Unfortunately, this was not always possible. For example, school K adopted the 'kick start' approach which was only well mapped in key stage 3. Hence, opportunities to observe ICT being used in the classroom could only be planned in key stage 3. However, as the lesson observations focused on issues such as styles of teaching and learning, the particular year group

observed was not critically important. In school C, it was not possible to observe any lessons where ICT was used in the classroom. School C delivers ICT across the curriculum and the ICT programmes of study were not planned to the extent that it was possible to arrange for the researcher to visit the school and observe lessons where ICT was to be used to support teaching and learning in other subjects.

Concurrent with the programme of interviews and lesson observations, the pupil questionnaires were distributed to schools. Teachers were asked to give these to pupils near to the end of year 11, so that their ICT Capability could be measured at the end of key stage 4. Teachers were asked not to explain what the questions meant to pupils but to ask them to do their best. This was to avoid teachers giving inconsistent explanations, and to avoid pupils' answers being influenced by what teachers told them. The lesson in which the questionnaires were to be filled in was not specified, and discrete ICT classes were allowed. Perhaps as a result, in schools with a heavy emphasis on discrete ICT, the pupil questionnaires were filled in ICT lessons; and in schools with more emphasis on cross curricular ICT, the questionnaires were filled in lessons in other subjects.

Chapter 4: The case study schools

In this section, the four case study schools are described separately. The descriptions are based on the interviews, lessons observations and documentary evidence collected.

School D – discrete

Brief characterisation of the school

School D was an 11-18 coeducational Technology College where pupils followed a discrete ICT curriculum in key stages 3 and 4, leading to GCSE or GNVQ ICT. Senior managers believed the school was effective at delivering discrete ICT but that cross curricular ICT was a weakness. Even so, pupils reported more use of ICT across the curriculum in more subjects than in the other case study schools.

Management organisation and a consultative approach to decision making encouraged good communications. The headteacher provided clear leadership in promoting ICT in the school and chaired the ICT management committee which planned its development. This committee included the headteacher, two deputy headteachers, two senior ICT teachers and the ICT technical manager. There was an ICT user group comprising representatives from all subject departments. Teachers could not avoid using ICT as registration was computer based. The school highly valued its investment in ICT.

The specialist ICT teachers who taught discrete ICT were experienced and knowledgeable but teachers of other subjects lacked confidence in using ICT, and seemed overwhelmed by the effectiveness of the ICT department. There was a whole school network of over 300 modern PCs permanently connected to the Internet, a PC in every classroom, and a pupil:computer ratio well above the national average.

The ICT development plan was an integral part of the whole school development plan but there had been almost complete reliance on bid based funding. The school had been granted such funding in recent years but not in the current year. The HoD ICT did not know of plans to fund ICT provision from capitation but even so the school was developing two more ICT rooms.

Curriculum organisation

School D was a coeducational 11-18 comprehensive school designated as a Technology College. 1377 pupils attended the school and 31 had statements of Special Educational Need (SEN) (DfEE, 2000b). GCSE results were above the national average and improving. Pupil absenteeism was 7.6% (DfEE, 2000b; Ofsted, 1996a, p10). It was a good and improving school, standards of behaviour and discipline were very good, the school was an orderly community and the quality of teaching was 92.9% satisfactory or better (Ofsted, 1996a, p1, p9 and p18).

The NC ICT Programmes of Study were covered in discrete ICT, and pupils' attainment was '...sound with good standards being achieved.' (Ofsted, 1996a, p95). In key stage 3, pupils had one 70 minute ICT lesson for three weeks, then one drama lesson for three weeks, then one ICT lesson for three weeks, and so on, which was around 19 discrete ICT lessons in a year. In key stage 4, pupils were expected to study for GCSE ICT full course or short course, or foundation or intermediate GNVQ. Exceptionally, a group of around 24 disaffected pupils followed a vocational course which did not lead to external accreditation. GNVQ ICT and A-level computing were available post-16 (IDAI).

Pupils learnt to use ICT in discrete ICT lessons, and it was assumed that they would make use of it in lessons in other subjects. The HoD ICT believed the use of ICT across the curriculum was only an enhancement for the discrete ICT curriculum. The headteacher expected that when ICT teachers were teaching discrete ICT they would '...link into other curriculum areas...' (IDHL) and teach pupils the ICT skills they needed so that teachers of other subjects would not need to teach ICT skills. For example, in an English lesson, the teacher did not need to show pupils how to use the Internet as they had been taught this in discrete ICT lessons (IDHL). However, given that pupils are unlikely to remember everything they learn in ICT lessons, it is possible that teachers of other subjects would have to teach ICT skills to some pupils if they are stuck and would not otherwise make progress.

The school was satisfied with the discrete ICT curriculum and was developing cross curricular ICT. This was not yet well planned or coordinated, and very little progress had been made developing this over several years in contrast with the discrete ICT curriculum which had been continuously improved. The school made more extensive use of ICT across the curriculum 10 years ago but the HoD ICT found it too difficult to monitor (IDAI; Ofsted, 1996a, p98). The curriculum for discrete ICT was the responsibility of the HoD ICT but the use of ICT in other subjects was the responsibility of the HoD for the subject (IDHL). The HoD ICT knew that in key stage 3 ICT was used in English, mathematics, science, DT and Modern Foreign Languages

(MFL) but was not fully aware of how it was used or the extent of its use. The HoD mathematics said that the department had '...very much neglected...' the use of ICT in mathematics (IDPR). Even so, a teacher had recently been released from other commitments to become familiar with mathematics software, and plan its integration into the school's mathematics curriculum. However, the HoD mathematics was not convinced that this software helped pupils learn mathematics (IDPR).

The school had a homework timetable including traditional subjects such as English, mathematics, science, history, geography, RE, DT and art, and this was well organised and comprehensive. However, ICT was not on it, and before being interviewed the headteacher had not considered whether it should be included. ICT homework was set infrequently in key stage 3, because of difficulties with the timetabled carousel with drama, and usually consisted of research or completing a worksheet so that a computer was not needed to do it (IDAI). The headteacher assumed ICT homework would be set in key stage 4 when pupils studied GCSE or GNVQ ICT but there was little evidence of this.

Teaching and learning

None of the teachers gave a formal written lesson plan to the researcher prior to the lesson observations, and there was no evidence that teachers planned lessons in order to achieve particular learning objectives. Even so there was evidence of forward planning in the preparation of worksheets, etc. In key stage 4, year 10 pupils were doing GCSE coursework set by the examination board which involved working through an extended series of tasks using a variety of software within a unifying context. Following this, pupils would do another coursework task where they worked more autonomously, designing, creating and evaluating an ICT system for others to use.

The HoD ICT was observed teaching a mixed ability year 10 GCSE ICT lesson. The lesson started with didactic whole class teaching on the topic of security. Various contexts familiar to pupils were used to illustrate this topic. For example: using passwords to access the school's computer system; the swipe cards pupils use to access school facilities; and using bank cards to withdraw cash at an automated teller machine or cashpoint. Pupils were told to write about the advantages and disadvantages of different security precautions for ICT systems. As the lesson progressed, it became clear that some pupils were still doing tasks set in the previous lesson and were not yet ready to attempt the topic of security. Whole class teaching was not appropriate at

this time for this class as many pupils did not immediately benefit from it because they had not made sufficient progress previously (LDAI).

The ICT curriculum manager was observed teaching a year 10 GCSE ICT lesson to a mixed ability class of seven pupils (LDRB). There was no whole class teaching. At the start of the lesson, the teacher asked pupils to continue with a worksheet he had prepared to help them meet GCSE coursework requirements. This worksheet covered the topic of control set in multiple contexts, sometimes involving pupil choices, and set pupils realistic tasks using actual ICT tools in authentic contexts. For example, pupils were to design and develop a system for others to use, choosing one from automatic doors; a lift; a timing device; a heating control; and a car park barrier. The class organised themselves into two small groups and several individuals, and the teacher circulated helping them. When the teacher was occupied elsewhere, pupils helped each other. The teacher put very little pressure on pupils to make progress but most pupils remained more-or-less on task throughout the lesson, showing confidence and good understanding of the set tasks. However, the pace and concentration shown by individual pupils varied considerably throughout the lesson (LDRB).

Using a worksheet to underpin a substantial task that will need many lessons for pupils to complete can help them sustain their efforts. However, if the teacher does not also monitor and direct pupils lesson by lesson they may not remain on task. In addition, pupils may have very different rates of progress, due to absence, ability or motivation. In contrast, if the teacher attempts to motivate the class by teaching the whole class, this teaching may not be at an appropriate time for many pupils as they may not have made sufficient progress or may have already completed the topic taught (LDRB; LDAI).

The HoD mathematics believed that when mathematics teachers at school D wanted to use ICT to support teaching and learning, they taught the topic in their timetabled mathematics classroom where there was no access to ICT resources, then booked the class into an ICT room and revisited the topic using the software available. There were no opportunities to use ICT in mathematics classrooms when it was required (IDPR). A mathematics teacher was observed teaching a year 10 GCSE class in an ICT room. At the start of the lesson, the teacher talked briefly to the whole class, and directed pupils to mathematics software on the school network and on the Web. One of the Web sites the teacher mentioned had not been accessible for several weeks. Pupils used the online ICT resources as they chose, and most pupils browsed a wide range of mathematics software searching for entertainment. The teacher ensured only that pupils were using mathematics software. Some of the software did develop pupils' understanding but this usually did not give feedback other than as a mark out of a total. Often, the software did not

indicate what had been misunderstood or which questions were wrong. During this lesson, there was little development of pupils' ICT capability and there were many missed opportunities to use the mathematics software more effectively. Mathematically, the lesson was incoherent (LDMS).

Mathematics teachers preferred to plan lesson content in detail, and did not like the unexpected events that could happen when ICT was used. Sometimes pupils knew more about ICT than mathematics teachers and this discouraged these teachers from using ICT (IDPR). The HoD ICT, an ex-mathematics teacher, believed that pupils did not expect teachers to know how to operate all software facilities even though they expected mathematics teachers to have complete knowledge of mathematics. She had changed from being a mathematics teacher '...who knows all the answers to the questions and can solve all the problems.', and believed that in ICT it was important to know the strategies to use and to work with pupils to find solutions. Similarly, whereas teachers expected pupils to produce almost identical answers in mathematics they were less likely to do so in ICT (IDAI).

The headteacher believed that using ICT changed ways of teaching and learning in the classroom, and that this was one reason why some teachers found it difficult to cope with ICT '...because it changes the whole dynamic...'. She believed that a teacher became a '...supporter and encourager...' (IDHL) of learning and that teachers who taught in a traditional teacher centred, didactic manner would find using ICT in the classroom more difficult than teachers who used pupil centred strategies. For this reason, she believed that English teachers adapted to using ICT more easily than mathematics teachers.

Management

'The leadership of the school is very good. The management structure is effective and provides both a clear lead and support for staff and pupils...' (Ofsted, 1996a, p10). There is a clear committee structure, regular contacts and meetings, and the planning process is consultative and involves staff.

The previous headteacher was proactive in obtaining funds for ICT resources and consequently often directed how they were spent. The new headteacher intended to continue to provide strong leadership in developing ICT in the school. There was an ICT management committee chaired by the headteacher which included two deputy headteachers, the ICT technical manager, the HoD ICT, the ICT curriculum manager and the HoD Technology. The ICT management

committee made decisions about development and spending priorities, and all its members had good ICT skills.

There was also an ICT user group which consisted of a representative from each subject department, and the LRC (IDAI; IDHL). The HoD mathematics was a member of this group but felt that the needs of the mathematics department had been neglected and that the ICT department had driven the development of ICT resources. He reported that other departments had expressed similar views at recent ICT user group meetings (IDPR).

The HoD ICT recognised that she needed support from other teachers because of the plethora of initiatives. She tried to develop cross curricular ICT by working alongside individual teachers in the classroom, supporting them one to one and showing them what to do by example. However, increased demands on her time reduced her ability to provide this type of support. As a result, either subject teachers developed the use of ICT in the classroom themselves or no development took place. This was unsatisfactory as most teachers were not confident ICT users (IDAI). Even so, the HoD ICT believed that most teachers were ICT enthusiasts and wanted to develop the use of ICT in the classroom. She respected the viewpoint of those teachers who were reluctant to use ICT, and accepted that they could be effective teachers without using ICT. In contrast, the HoD mathematics believed that a majority of teachers wanted to teach their own specialist subject and did not want to use ICT to do it. Even so, most teachers could not avoid using ICT as there was a computer in every classroom which was used for pupil registration.

School D valued its investment in ICT. The headteacher believed that visitors '...like to see the kit...' and that '...parents expect to see computers...' (IDHL), and visitors to the school would be shown the main areas where there were computers, including the LRC, the ICT rooms and ICT resources in other subject departments. In contrast, the HoD mathematics believed it unlikely that visitors to the school would be shown a typical mathematics classroom. The school had presentation evenings for year 11 and sixth form pupils. There were two subject prizes for ICT at GCSE but there were no subject prizes for other year groups, however, this was being considered. Both the headteacher and the HoD ICT believed ICT was essential for school administration, and the headteacher had a laptop computer and used it. The school made extensive use of the Schools Information Management System (SIMS), and was entirely dependent on ICT for many other aspects of school administration (IDAI; IDHL).

Staffing and resources

ICT specialist staffing consisted of the ICT technical manager who was not a teacher, the HoD ICT, the ICT curriculum manager, three other specialist ICT teachers and a full time ICT technician. The ICT technical manager was not qualified in ICT when appointed and developed his ICT skills with some help from the HoD ICT. The school does not send the ICT technical manager or the ICT technician on technical training courses as these are too expensive. The HoD ICT was a qualified mathematics teacher but trained herself to teach ICT and had no formal ICT qualifications. The ICT curriculum manager had an MSc in computer communications and networks and a PGCE mathematics. Two of the specialist ICT teachers were NQTs and had met the teacher training requirements of 4/98 Annex B, the use of ICT in subjects.

In contrast, all the mathematics teachers had been trained as specialist mathematics teachers. Ofsted had criticised the school because at the time of the previous inspection some mathematics teachers did not have appropriate qualifications and training. The HoD mathematics believed that all teachers should be appropriately qualified in the subjects they taught and made no exception for ICT teachers. He believed that most of the ICT specialist teachers at the school did not have satisfactory qualifications.

Several of the specialist ICT teachers at school D had previously been mathematics teachers, but now taught only ICT and preferred this arrangement. However, the HoD mathematics was unhappy that his department could no longer expect these teachers to support the use of ICT in mathematics. He believed his department was split into those teachers who '...were the ones that loved maths and that was the end of the story and there were the others that managed to love both (mathematics and ICT) and they were the ones that went that way and actually developed the ICT'. These teachers were the ones who were more proactive in developing the use of ICT in mathematics and would have supported colleagues who were less confident and enthusiastic (IDPR).

The pupil:computer ratio was much better than the national average at 4:1, and there was whole school network of more than 300 PCs permanently connected to the Internet. There were several ICT rooms mainly used by the ICT department, and these contained around 20 PCs each with networked laser and colour ink jet printers. There were large clusters of computers for specific departments, for example, the multimedia ICT room which was mainly used by MFL and mathematics. The majority of these computers had been purchased in the previous three years. There were a small number of older Apple computers in DT and a few Archimedes computers

in science and music but these were not connected to the school network. Every classroom had a PC connected to the school network on the teacher's desk which was used to register pupils' attendance. This PC could also be used for Web access, email and to support teaching and other professional activities, including writing worksheets, preparing reports and accessing pupils' personal records. There were also a small number of computers in the staff room. The school had its own Web site and used this as an information kiosk and to provide access to learning resources.

Despite this apparent wealth of ICT resources, the HoD mathematics believed that the use of ICT in mathematics lessons was underdeveloped because of a lack of access to ICT resources during these lessons (IDPR). Interestingly, what he described as a lack of access would be considered to be a good level of access in many other schools, with the mathematics department sharing access to an ICT room with the MFL department, in addition to access to the other ICT rooms. On average, mathematics classes had access to an ICT room on one occasion each week.

Many teachers who were not specialist ICT teachers were acquiring basic ICT skills through NOF training which was being delivered in the school. However, the same teachers of discrete ICT, who had previously been unsuccessful in encouraging and training teachers of other subjects to use ICT in the classroom, were delivering the training. This arrangement seems unlikely to be effective.

The HoD ICT recognised that when teachers had developed personal ICT skills, getting them to use ICT in the classroom was more problematic. However, given the level of ICT resources in the school, the HoD ICT expected that many more teachers would use ICT. The HoD mathematics believed this would happen but not to the extent anticipated, and that this required further training. However, there was an attitude that 'Everybody should be able to develop themselves...' and that '...if you're a maths teacher you definitely ought to be able to teach ICT or you're a bit of a failure...' (IDAI; IDHL; IDPR). This negative attitude did not encourage development.

The ICT development plan was an integral part of the school development plan but it was not funded was from the school's annual budget (IDAI). In recent years, the school had been very successful in bidding for funds, and Technology College funding had purchased most of the ICT resources. In the current year, the school had not been allocated Technology College funding but it still intended to build two more ICT rooms. The headteacher knew that hardware and software became obsolete quickly, and replacement and renewal would be very expensive because of the high level of ICT resources in the school. She recognised that the school had

been fortunate in attracting generous bid based funding, and acknowledged the difficulties in relying on this approach, but did not believe there are realistic alternatives. She anticipated that there could be problems: 'You don't know for certain how much money is going to be available for the following year and I could see it could come to a hard decision between computers or books.' (IDHL). The HoD mathematics was already concerned that a considerable amount of money had been spent on the school's ICT resources but very little additional funding had been available for mathematics (IDPR).

School S – skills core

Brief characterisation of the school

School S was an 11-16 comprehensive school which organised the ICT curriculum using the skills core approach. Pupils followed a reduced discrete ICT curriculum and relied on this to cover the ICT NC. The use of ICT across the curriculum was extensive and involved several subjects but it was not as well organised as discrete ICT. Even so, the ICT coordinator knew what was happening if not when.

The headteacher did not use ICT and delegated responsibility to a management committee consisting of two deputy heads, the ICT coordinator and the network manager. The ICT user group was chaired by the ICT coordinator and included representatives from each subject department. Day-to-day management of ICT was firmly directed by the ICT coordinator, perhaps too firmly, but there was no evidence of resentment from other staff. Teachers could not avoid using ICT, and were at least obliged to teach the NC requirements for their subjects, but the persistence, enthusiasm and openness of the ICT coordinator were more effective in involving others and providing appropriate support. The school valued its investment in ICT which was considered to be a '...very, very important tool.' (ISPS).

There was a knowledgeable ICT department and several teachers of other subjects were confident users. The school invested more than the other case study schools in developing staff ICT skills through external and in-school courses. There were a good range of ICT resources but the pupil:computer ratio was slightly below the national average. Funding for ICT was built into the school's annual budget but this was not sufficient and there was some reliance on opportunistic bid based funding.

Curriculum organisation

School S was an coeducational 11-16 comprehensive school of 1100 pupils. 35 pupils had statements of SEN (DfEE, 2000b). Overall it was 'a very good school' (Ofsted, 1997, p1); 60% of pupils were awarded 5 or more GCSE grades A*-C (DfEE, 2000b), and the quality of teaching was 90% satisfactory or better. Standards of attainment in ICT were '...generally well above average...' and pupils developed '...very good skills allied to exceptionally full understanding of ICT systems and their uses.' (Ofsted, 1997, p177). Pupil absenteeism was 4.9% (DfEE, 2000b).

School S used the skills core approach to organising the ICT curriculum. In years 7 to 10, pupils were timetabled for one hour per week discrete ICT, and also used ICT throughout the curriculum in most subjects. It was intended that these arrangements would carry forward into year 11, where ICT was currently optional (ISBG; ISPS). In key stage 4, most pupils were entered for the GCSE ICT full course, but those that found this too demanding were entered for GCSE ICT short course or Northern Partnership Record of Achievement (NPRA) units.

The use of ICT was widespread throughout the curriculum. For example: in English, pupils had '...good ICT skills and use them appropriately.'(Ofsted, 1997, p123); in mathematics, ICT was used to '...reinforce and extend learning...' (Ofsted report, 1997, p134); in history pupils made good use of ICT to organise and present their work (Ofsted report, 1997, p165); and in music good use of ICT was made for composing (Ofsted report, 1997, p191). ICT in science was used to 'reinforce a scientific principle ... and to get some ICT benefit as well.' (ISPS). Overall, the coverage of the ICT NC programmes of study were '...carefully planned and monitored.' (Ofsted report, 1997, p180); the teaching of ICT was '...consistently good and can occasionally be excellent.' (Ofsted report, 1997, p179); and there was '...good (ICT) expertise ... in all departments.' (Ofsted report, 1997, p179).

ICT homework was set in discrete ICT lessons and this was mainly tasks that did not require the use of a computer. Occasionally, pupils might be expected to use computers for their homework but they had access to the school's ICT resources to do it (ISBG). In science, pupils' homework might involve using ICT, for example, using the Internet for research (ISPS).

Teaching and learning

The ICT coordinator believed the style of teaching and learning that was appropriate depended on the topic, pupils' knowledge of the ICT being used, and their maturity. For example, control technology needed more step-by-step worksheets than Desk Top Publishing (DTP), and in year 7, pupils needed more prescription because they were using the software for the first time. In the more prescriptive tasks, teachers expected pupils to achieve specific outcomes but as the degree of prescription declined, they did not expect all pupils to produce the same outcomes (ISBG). As pupils progressed to year 9, the degree of prescription progressively declined. Pupils were given more open ended tasks, expected to select the appropriate software and decide how to use it. In the year 10 science lesson observed, the teacher used a prescriptive worksheet to introduce pupils to unfamiliar data logging software. However, the teacher wanted '...not answers but process...', and intended to discuss this in a later lesson '...when we talk in depth about what was happening...' (ISPS).

All the lessons observed were planned around the tasks pupils were to do. There was no evidence that teachers used formal written lesson plans with learning objectives. Pupils were usually expected to produce a required outcome though there was some latitude in the outcomes teachers regarded as acceptable. In discrete ICT, during the teacher's initial exposition, most pupils appeared more interested in using the computers than listening to the teacher. The worksheet used guided pupils through a series of progressive, well structured, closed tasks, giving them enough detail so that they knew what to do but did not tell them how to do it. Pupils who finished this worksheet were expected to do more open ended tasks (LSBG).

In the mathematics lesson observed, pupils were given a highly structured, step-by-step worksheet that described the tasks they were to do and the exact instructions to be input into the computer. Only the final task encouraged pupils to experiment. Most pupils quickly deviated from this worksheet, and experimented, producing unrelated outcomes. For example, pupils should have been using Logo to draw polygons on screen, but instead some changed the appearance of the cursor so that it resembled a giraffe. Pupils who deviated from the set tasks concealed this from the teacher and only attempted these when the teacher checked their progress. Many pupils attempted the set tasks by trial and error rather than by following instructions or prior calculation. For example, pupils drawing a regular octagon on screen knew that substituting for x in REPEAT 8 [FORWARD 200 RIGHT x] would lead to a solution, and they modified the value of x until this was achieved rather than calculating the value of x as

instructed. The teacher stated that boys were more likely to do nothing or stray from the set tasks, and that girls were more likely to do what was asked of them but no more (LSSB).

The ICT coordinator expected that ICT teachers would not have as comprehensive subject knowledge as teachers of other subjects. For example, she expected pupils to ask her questions in ICT lessons that she could not answer immediately, and had '...no problems with that at all.'. This was because it was not possible to '...keep up with all the new developments...' in ICT. In addition, because pupils used ICT throughout the curriculum, they used software and hardware that she did not use. However, when she taught mathematics, she would have been '...mortified...' if she had not had a comprehensive knowledge of the mathematics she was teaching (ISBG). Similarly, the science teacher was often asked questions about ICT that she could not answer immediately, but this happened '...very rarely in science.'. For example, in the science lesson observed, some pupils incorrectly set the software controls for a temperature probe, so that the graphs the computer produced were not the expected cooling curve. The teacher knew that these graphs were incorrect but could not explain to pupils why the software had produced them, and was unable to help pupils re-program the software (ISPS).

The ICT coordinator believed that ICT lessons were harder to control than lessons in other subjects. 'ICT is frenetic.' and lesson outcomes '...might not be achieved because of faulty equipment, because of a network crash, because of situations not within your control.'. In contrast, in mathematics '...you're in control ... it's your theory that would be lacking and your perception of the group...' if the lesson objectives were not achieved (ISBG). Experiments in science were also hard to control but in ICT this was even more pronounced: '...it's different in ICT ... so many things can go wrong...' (ISPS). Most teachers '...tend to want to be didactic...', and find it difficult to '...manage rather than control...' (ISPS). In all the ICT lessons observed, teachers spent more time facilitating pupils' progress than in didactic teaching, however, whether this was significant in comparison with other subjects was not investigated (LSBG; LSPS; LSSB).

In the discrete ICT lesson observed, the teacher established links between the tasks pupils were doing and realistic contexts from the wider community. The teacher described to the class relevant contexts from the manufacturing industry, and stated explicitly that industrial processes were being modelled. Pupils were set tasks that modelled the use of pseudo-robotic devices in industry, e.g. building a computer controlled conveyor belt (LSBG). However, in the science and mathematics lessons observed, teachers did not establish links between pupils' use of ICT in the classroom and realistic contexts from the wider community. In mathematics, no indication was given why pupils might need to know how to use Logo to explore the relationship between

the number of sides of a regular polygon and the size of its internal and external angles (LSSB). In science, the production of cooling curves provided the context for using ICT, but the reasons for producing these was not explained (LSPS). There was no overt attempt to relate mathematics and science to realistic contexts in the wider community that were beyond the learning of their theory and practice in school. In addition, the ICT tools used were not the actual software and hardware that would be used in the wider community but modelled these in a simplified form. For example, the control software used in the discrete ICT lesson was only adequate for the manufacturing task modelled; Logo is rarely used outside the classroom; and in science the software lacked sufficient capability and scope to be used in industry (LSBG; LSPS; LSSB).

The school had introduced discrete ICT lessons for all pupils to ensure they received their NC entitlement whatever the attitude of their teachers towards ICT. The majority of staff used ICT in the classroom, and the ICT coordinator believed that there were only a small number of teachers who were not keen on using it. She believed that their reluctance was due to not knowing how to use ICT; feeling that they would not be in control of their classes as a result; and because '...it's a different teaching strategy.' (ISBG). The ICT coordinator believed that those teachers who were not keen on using ICT ideally needed support in the classroom from another teacher who taught the same subject and was a competent ICT user. In contrast, the deputy headteacher thought that such teachers were '...sceptical of the process...' and tended to use excuses such as lack of access to the computer rooms to avoid using ICT in the classroom. She had some sympathy with this perspective and believed that '...you can be a perfectly good teacher without using ICT.' (ISPS).

Management

'The headteacher, senior management and the governing body work in a purposeful partnership to provide a very high quality of leadership...' (Ofsted, 1997, p33). '...management is a strength of the school. ... Leadership at middle management level is good and is increasing in effectiveness...' (Ofsted, 1997, p37).

The headteacher accepted the importance of ICT for school administration and in the curriculum even though he did not use ICT himself. He delegated responsibility for ICT to a senior management committee which consisted of the ICT coordinator, two deputy heads, and the network manager when his expertise was relevant to the decisions being made (ISBG; ISPS). Most of the senior management committee for ICT had good ICT skills but one deputy

headteacher believed her skills were only ‘OK’, however, this was not important as ‘...the decisions that are made, they’re often accounting decisions, they’re often about negotiating with departments and so on.’ (ISPS). The ICT coordinator had recently been promoted to four responsibility points on the pay scale, and was responsible for all curriculum aspects of ICT. This was understood to include government initiatives, such as, NOF funded training. A deputy headteacher was responsible for school administration, but the ICT aspects of school administration defaulted to the ICT coordinator, and these were substantial.

The ICT coordinator chaired the monthly meetings of the ICT user group which consisted of at least one representative from each subject department. Meetings were open to anyone who wished to attend. Members of the senior management committee for ICT attended occasionally, particularly when invited by the ICT coordinator. Meetings were used to disseminate information, and monitor the need for training and support. The ICT subject representatives reported to their subject departments through departmental meetings (ISBG; ISPS).

The ICT coordinator believed she was well supported by senior management: ‘...its as important as literacy and numeracy and ... the deputies and headteacher also feel that.’ (ISBG). She did not feel that her lack of seniority constrained her ability to implement ICT throughout the curriculum. She believed that she was effective because she was aggressive, ‘...people are scared...’ of her (ISBG), and she had the absolute support of the senior management team. Other teachers knew that if she asked them to do something they had to do it. ‘If a member of staff refused to do ICT and it was in their NC and it was part of their syllabus ...and they wouldn’t do it...’ (ISBG) disciplinary procedures would be followed. However, the ICT coordinator also provided substantial support for other teachers, including writing ICT worksheets for them, and running training programmes.

The school clearly valued its investment in ICT even though the headteacher did not use a computer and did not believe they were essential even for school administration. However, the deputy headteacher, believed computers were a ‘...very, very important tool.’ and were almost essential for school administration (ISPS). Visitors touring the school were almost always shown the ICT facilities. The school runs adult education classes in ICT and parents can join classes during the school day. Prizes are awarded to pupils for achievement in all subjects, including ICT.

Staffing and resources

There were four ICT specialist teachers who taught discrete ICT, including the ICT coordinator who had a full teaching timetable, and the network manager on a 50% timetable. There was a non-teaching technician. The network manager and the technician ran the school ICT network. An additional ICT teacher had been appointed recently, but even so, the school had enough only because 'We make the timetable fit with what we've got.' (ISBG). There were too few technicians to support departmental ICT resources adequately (ISPS), however, relative to other schools, technical support was very good (Ofsted, 1997, p108).

The ICT coordinator had a degree which included ICT, and she updated her skills regularly. For example, she had recently visited an airport to look at how ICT systems were used for air traffic control. The network manager had recently completed a HND in ICT with fees paid by the school and absence approved to attend lectures. The ICT technician had previously worked on a computer help line. A science teacher had trained to be an ICT teacher by distance learning with fees paid by the school. Several teachers had ICT qualifications at sub-degree level. The ICT coordinator and ICT manager ran training in school if requested. For example: training days had incorporated ICT training; and several non-teaching assistants had studied for GCSE ICT. ICT teachers encouraged others to use ICT. There was access to the ICT resources before school, at lunch time and after school (Ofsted report, 1997, p178). During the school day, other teachers and adults were present in ICT lessons with pupils.

The school's hardware for curriculum use was relatively modern as 75% of it had been purchased within the previous three years (ISBG). There were around 120 desktop computers, giving a pupil:computer ratio of 9.2:1 compared with a national average of 7.9:1 (DfEE, 2000a). These were located in four computer rooms, several clusters, and single computers in some classrooms. For example, in DT there was a small cluster and a computer in each classroom. Specialist hardware and software for particular activities was available in sufficient quantities in the lessons observed. For example, model robots and interfaces in ICT, and data logging equipment in science (LSBG; LSPS). Every teacher and every pupil had an email address and there was permanent Internet access from one computer room. Approximately 50% of the computers used for administration had been purchased in the last three years (ISPS), and around 10 computers were allocated for support for teachers' professional activities, and these were located throughout the school with one in the staff room. The curriculum and administration networks were physically separate due to fears that if they were connected pupils might hack into the administration network from the curriculum network.

The school and each department had an ICT development plan which was of '...a particularly high quality...' (Ofsted, 1997, p99) and 'Financial planning within subject teams is good with some very good practice in ... ICT.' (Ofsted, 1997, p115). The purchase of ICT resources was funded from capitation, by fund raising and through initiatives involving bid based funding, such as the National Grid for Learning (NGfL). Even so, there was insufficient financial provision for replacements and renewals in the annual budget, and funding in total was insufficient to meet the school's needs (ISBG; ISPS).

School K – kick start

Brief characterisation of the school

School K was a coeducational 11-18 comprehensive school which operated a 'kick start' model of the ICT curriculum. Form classes were timetabled for discrete ICT for one hour per week in year 7 only, and ICT was taught entirely across the curriculum in years 8 to 11. The delivery of cross curricular ICT involved only a small number of subjects, and some of these did not make the substantial contribution the ICT coordinator anticipated.

There were no ICT committees, and consequently no formal opportunities to develop communication between senior management, the ICT department and other departments. Senior management was defensive, there was a lack of open discussion, and contentious issues were not discussed and resolved. This lack of communication severely constrained the development of well planned programmes of study for cross curricular ICT. The school's investment in ICT was regarded as important, and was particularly attractive to pupils choosing the school for their post-16 education. However, most teachers' experience of school administration was intentionally paper based. The school encouraged but did not require teachers to use ICT in the classroom, and very few teachers used ICT confidently, other than the school's three ICT specialist teachers who were well qualified and experienced. Where pupils did use ICT in other subjects, they generally underachieved. Access to ICT resources was poor. The pupil:computer ration was 15.4:1, well below the national average. The whole school development plan was not adequately costed or prioritised, and though financing for ICT was built into the school's annual budget, this was minimal, and there was an over reliance on opportunistic bid based funding.

Curriculum organisation

School K was a coeducational 11-18 comprehensive school of 1388 pupils of whom 16 had statements of SEN (DfEE, 1996). It was '...a successful school with a strong sense of community ... which promotes positive attitudes, good behaviour and generally satisfactory standards of attainment...' (Ofsted report, 1996, p1). 41% of pupils were awarded 5 or more A*-C grades at GCSE (DfEE, 2000b), and the quality of teaching was 90% satisfactory or better. Pupils were not entered for external examinations in ICT at the end of key stage 4, however, A-level Computing was taught post 16. Pupil absenteeism was 11% including both authorised and unauthorised absences (DfEE, 2000b).

School K delivered the ICT curriculum using the kick start approach. In year 7, pupils were timetabled for discrete ICT for one hour per week throughout the year. It was intended that this lesson would be taught by the form tutor, but even though this arrangement had been in place for ten years, form tutors '...don't feel they've got the skills...' (IKST), and an ICT teacher taught the lesson. In years 8 and 9, the ICT coordinator timetabled the ICT rooms for English, mathematics, humanities, science and modern foreign languages. This was done on a short carousel, for example, science had three weeks, then English had three weeks, then science had three weeks, and so on. Within these three weeks, each department had to arrange which classes used the ICT room. The HoD mathematics complained that one ICT room had to be shared between several classes, and only half a class could use it because there were not enough computers. As a result, many pupils used ICT in mathematics for only 1 or 2 periods each year, and they did not have sufficient opportunities to use the wide range of mathematics software available (IKSD).

The deputy headteacher responsible for whole school ICT had no concerns about the delivery of the ICT NC in key stage 3 but believed that provision was '...much thinner...' in years 10 and 11 (IKCB). The ICT coordinator was not aware of any arrangements for teaching ICT in key stage 4: 'We don't have any provision for ICT in year 10.' (IKST). There were no discrete ICT lessons and no other timetabled access to ICT rooms. A small number of subject departments had ICT resources in departmental areas but where they did not have these, there was little opportunity for teachers to use ICT in their lessons. For example, in mathematics, there was no timetabled access to the ICT rooms in key stage 4, and the department did not have its own ICT resources. Despite a persistent and enthusiastic HoD, the use of ICT in the classroom in mathematics was '...non existent...' (IKSD). However, the ICT coordinator believed ICT was used in key stage 4 in technology, business studies and where '...it tends to happen as a part of

the subject anyway.' but he could not give details of this (IKST). Pupils who left school at the end of key stage 4 had no opportunity to acquire formal qualifications in ICT at school. A small number of pupils studied A-level computing post 16, but its popularity was diminishing.

ICT homework had not been set in the past, and ICT did not appear on the school's homework timetable for key stages 3 and 4. A trainee teacher on placement at the school had recently set one piece of homework in year 7, and the ICT coordinator was now considering introducing this in the future. However, he did not seem convinced of the need for this or committed to its introduction (IKST).

Teaching and learning

Opportunities for pupils to develop as independent and autonomous ICT users were negligible. A typical ICT lesson was '...driven by a worksheet...' (IKST). The ICT coordinator believed that these worksheets developed pupils' ICT capability in the context of the other subject being taught. It was intended that sufficient detail would be given in the worksheets so that pupils could use ICT without further support to complete the subject related tasks. In all the lessons observed, pupils followed worksheets that directed them to complete a series of tasks. For example, in geography and technology, pupils were expected to produce tightly specified outcomes by following the instructions given to them in a worksheet. These instructions described the subject related task and indicated in detail the instructions to be given to the ICT software to complete the task. There was no explanation of the generic ICT knowledge and skills pupils would need to make effective use of ICT (LKST1; LKSR). On completion of the worksheet, the outcomes were expected to be '...identical for every pupil.', and the only way to distinguish one pupil's work from another's was '...because they put a name on it.' (LKST1). In contrast, in business studies (LKST2), the worksheet used provided no support for pupils' use of ICT and did not indicate where pupils might use ICT effectively. Very recently, some teachers had begun to use the Internet in the classroom and wanted pupils to search for information themselves. The ICT coordinator believed that 'It often doesn't work that, it's a bad thing to choose.' because the outcomes could not be prescribed. (IKST).

Formal written lesson plans were not made available to the researcher, and there was no evidence that teachers used learning objectives to plan lessons. However, teachers set pupils authentic tasks in realistic contexts to be completed using real ICT tools or simulated software, though they did not always make pupils aware of this. For example, in a geography class, pupils compared the rainfall and temperature in the North and South of Italy based on realistic data,

using a spreadsheet widely used in commerce and industry (LKST1). However, there was no discussion of why someone might wish to make these comparisons or use ICT to do them. In a technology lesson, pupils were asked to build a robot, and write a program to control it, so that it would independently manoeuvre around an object in its path. This is a realistic task in an authentic if relatively narrow context, however, it was not explained to pupils why a robot might need to do this in an industrial context (LKSR).

When ICT was used in technology, there were conflicts between developing pupils' understanding of ICT and of design technology (LKSR). For example, in the lesson observed, pupils were expected to build a robot; control it by entering a simple computer program; and evaluate the design. Pupils had problems constructing the robots and they fell apart in use. In addition, the robots were dismantled at the end of a lesson, and re-assembled at the start of the next lesson. The HoD technology who also observed the lesson, felt that it was important that pupils learnt to assemble, dismantle and re-assemble the robots. However, the unstable construction of the robots impeded pupils' progress with their computer programs as they were constantly distracted by the need to rebuild the robots, and consequently, much less time was available to write and test the computer program. For this task to be effective in developing pupils' ICT skills, the robot would need to be permanently assembled.

The ICT coordinator had not thought about the differences between teaching ICT and other subjects before he was interviewed. However, he immediately responded that the need to use ICT equipment makes teaching ICT quite different from teaching mathematics which he taught previously. He stated that ICT made it much more difficult to control the focus of pupils' work in the classroom as the range of activities available to them was much less constrained than in a mathematics lesson.

Management

Ofsted, (1996b, p22) commented that overall leadership and management gave '...a clear sense of direction...'. However, there was no formal committee structure for managing ICT. The headteacher, the deputy headteacher responsible for ICT, and the ICT coordinator met informally to plan how to make best use of the school's ICT resources (IKCB), and the ICT coordinator was expected to have operational control of ICT throughout the school. He wondered whether '...the best way for the school is for me to be deciding everything...' and had considered setting up an ICT user group with a representative from each subject department. However, he had not done so because being ICT coordinator was a difficult job even when he

controlled all developments. He already had '...so many people asking for things that you can't give them...' and thought it might not be prudent to set up a user group which would then '...ask you for even more, and argue about it, then tell you what to do...' (IKST). Perhaps as a result, the strategic reasoning that underpinned decisions relating to the allocation of ICT resources was not always clear, and some teachers were puzzled and aggrieved that ICT resources had not been allocated to their departments (IKSD). For example, the HoD mathematics had been asking for ICT resources in departmental classrooms for over six years without success. He did not understand and it had not been explained to him why several other departments had been allocated ICT resources while the mathematics department had not. There was no evidence of a dialogue, no formal process for establishing a dialogue, nor a mutual understanding of alternative viewpoints.

Even so, some subject departments had nominated a teacher who was responsible ICT within the department, and this teacher usually taught most of the ICT lessons for the subject. The ICT coordinator believed that when there was a teacher in a subject department who was prepared to '...deliver what ICT wants, not just what the subject wants, then you can get a dialogue...' (IKST). Unfortunately, this precondition sometimes obstructed cooperation with subject departments. For example, the first priority of the HoD mathematics was teaching mathematics. As a result of the breadth of the mathematics NC curriculum and limited access to ICT resources, mandatory elements of the mathematics NC were not taught. Consequently, he was reluctant to teach ICT in mathematics lessons (IKSD). From the viewpoint of the ICT coordinator, who was attempting to deliver the ICT NC across the curriculum, a department's readiness to teach the ICT programmes of study was the most important precondition for cooperation. Whereas, the HoD mathematics perceived the readiness of his department in terms of preparedness to use ICT to support the teaching and learning of mathematics, not to teach the ICT NC. Perhaps as a result, informal liaison was not well established with all departments in the school, and in every department there were teachers who are not particularly interested in ICT (IKSD).

The school encouraged teachers to use ICT in the classroom but did not compel them, and all interviewees felt that it was possible to teach effectively without using ICT. The ICT coordinator recognised the contradiction between the mandatory requirements in the NC orders (DfEE, 1999) that teachers should use ICT to teach specific topics, and the schools' policy of encouraging but not requiring teachers to have appropriate ICT skills. The ICT coordinator believed that those teachers who were not keen on using ICT needed support in the classroom, and he would provide this if he had time. The deputy headteacher recognised a potential problem if a member of staff refused to use ICT but felt that encouragement and support was the

way to overcome this. The school was not yet at a point in the staff development process where it would invoke disciplinary procedures to ensure that ICT was used in the classroom as required.

The ICT coordinator believed that '...the management team or certain members of the management team regard ICT as being important.' but he could not immediately think of a way in which the school demonstrated that it valued its investment in ICT. The headteacher and the deputy headteachers had computers in their offices and used these for school administration, and both the ICT coordinator and the HoD mathematics believed that ICT was essential for school administration. However, because of the limited funding available, most teachers' experience of school administration was paper based (IKST). There was an awards evening when certificates for GCSE, A-level and other external examinations were presented. Pupils' achievements in ICT were recognised in the same way as in other subjects, but as they were not entered for GCSE ICT there were no prizes for this. The ICT coordinator was not aware of any other acknowledgement of pupils' achievements (IKST). In contrast, the HoD mathematics arranged independently for pupils to receive certificates that acknowledged their effort and achievement in mathematics at the end of each term. When visitors were shown round the school, they were usually shown the ICT facilities. In contrast, they were rarely shown taken to the mathematics department. The school's ICT resources were a particularly important factor in persuading pupils to choose the school for their post-16 education.

Staffing and resources

There were three ICT specialist teachers, including the ICT coordinator who taught ICT for part of the week, managed the ICT networks and supported the use of ICT in school administration. One teacher taught both ICT and DT; and a third was employed part time for three days each week. The deputy headteacher believed there were too few ICT specialist teachers. There was one ICT technician and the ICT coordinator believed that this was sufficient at present.

The ICT coordinator had studied computing as a second subject during teacher training, and another ICT teacher trained specifically as an ICT teacher after substantial experience in commerce and industry. These ICT teachers did not expect to be sent on training courses to update their specialist ICT skills. The deputy headteacher believed that when the ICT coordinator attended meetings at the school's ICT resources supplier that this was sufficient training but this view was not shared by the ICT technician who had no ICT related

qualifications and was paying for himself to study the Microsoft Certified Systems Engineer course.

The ICT coordinator had offered colleagues '...quite a lot of INSET over the years.' (IKST). The Internet, wordprocessing, spreadsheets, databases, etc. had been covered. The deputy headteacher believed that the majority of teachers were enthusiastic and many had volunteered for NOF funded training. Even so, the ICT coordinator felt frustrated because teachers had poor ICT skills even though the school had done '...everything it can to try to get staff to use ICT' (IKST). He believed that too few teachers consistently made use of ICT in the classroom, and that, in addition to the ICT specialist staff, only around four teachers could teach pupils how to use ICT rather than relying on pupils' prior knowledge and experience. These teachers had either trained themselves or had benefited from short training courses. For example, the HoD mathematics had acquired sufficient ICT skills by using his computer at home. However, he used ICT infrequently in the classroom not because of a lack of skills but because of a lack of access to sufficient ICT resources (IKSD).

There were '...probably 90 computers that work...' and around 50% of the curriculum computers had been purchased in the previous three years (IKST). There was an ICT room with 30 PCs; a technology room and a business studies room each with 10 PCs; and 22 PCs in the Learning Resource Centre (LRC). The pupil:computer ratio was 15.4:1 which was significantly worse than the national average of 7.9:1 (DfEE, 2000a), and pupils sometimes had to share computers. For example, there were usually 30 pupils in a mathematics class so that some pupils had to share (IKSD); and in the technology lesson observed, ten computers were shared by 18 pupils. Most computers were connected to a whole school network but this was not permanently connected to the Internet. All the Web sites accessible over the school's Intranet had been downloaded and cached on an internal file server. Consequently, teachers and pupils could not use email. Around seven computers were used for administration and these were located in the school office, and in the offices of the headteacher and the deputy headteachers. There was one computer in the staff room. This was connected to the Internet, and it was well used. However, staff who used ICT regularly were likely to have their own computer at home (IKSD).

A small proportion of the school's ICT resources were funded from capitation each year as the school leased some hardware and software. However, this did not cover all the ICT resources needed. The school was heavily reliant on opportunistic bid based funding, but had not been successful in acquiring this in recent years (IKST, IKCB). In addition, the annual funding allocated to subject departments was insufficient to enable them to purchase ICT resources (IKSD). The deputy headteacher believed that the school's difficulties in delivering the ICT NC

programmes of study were entirely due to under funding, and that the school could not afford to finance ICT adequately. He believed that there was no lack of desire or any philosophical objection only a severe lack of funds. This was because the financial allocation to the school from the LEA were less than the national average. This was so serious that when the LEA was inspected, it was found wanting in this respect (IKCB). In addition, around eight years ago, when the LEA integrated three schools to form the existing school, it did not fund the merger adequately with the result that the school has had a continuing deficit (IKCB).

School C – ICT across the curriculum

Brief characterisation of the school

School C was a coeducational 11-16 comprehensive school. Teachers were convinced that ICT should be taught across the curriculum, and had no doubts that this was the right approach. However, there was no mapping of the ICT NC across the curriculum, and it was not clear which subjects delivered the ICT NC, if any.

The headteacher did not use ICT and delegated responsibility for whole school ICT to a deputy headteacher. This deputy headteacher provided leadership, and organised and motivated teachers. There was a non-teaching ICT manager and a teacher in charge of ICT within each department. There was no management committee. An informal user group chaired by the deputy headteacher met irregularly but made little contribution towards the development of ICT. The school was equivocal about the value of ICT as it was not regarded as a subject but as a tool to be used when appropriate. Teachers were not obliged to use ICT, and very few teachers had sufficient ICT skills to make use of ICT in the classroom. In contrast, the non-teaching ICT manager was well qualified, and had organised the installation and networking of the school's computers. There was a new LRC, a new ICT room was being refurbished, and ICT resources were generally modern. Even so, the pupil:computer ratio was well below the national average.

In general, developmental and financial planning were effective. There was a very detailed school development plan which set whole school priorities and targets. However, the need for annual funding for the replacement and renewal of ICT resources had not been understood by the headteacher and governors. There had been a belief that no further investment in ICT would be needed once sufficient hardware and software had been purchased. The deputy headteacher had only recently persuaded the headteacher to budget for ICT each year. The school had been unsuccessful in competitive bidding for funds (ICDB).

Curriculum organisation

School C was a coeducational 11-16 comprehensive school of 949 pupils, including 44 with statements of SEN (DfEE, 2000b). 'A commitment to raising achievement permeates the whole work of the school.' (Ofsted report, 1998, p6). 37% of pupils were awarded 5 or more GCSE grades A*-C (DfEE, 2000b), and the quality of teaching was satisfactory or better in 97% of lessons. Unfortunately, 'Pupils do not receive a coherent experience in ICT because of weaknesses in the management of the subject and attainment is below expected levels.' (Ofsted, 1998, p6). Pupil absenteeism was above the national average at 12.2% (DfEE, 2000b).

It was intended that ICT would be taught across the curriculum throughout key stages 3 and 4, (ICDB; ICSW; ICVL). The deputy headteacher in charge of ICT throughout the school emphatically stated that 'We do not teach ICT as a discrete subject' (SC). She believed that cross curricular ICT was '...the ideal vision...' but had no practical experience of it: '...I don't know whether it works...' (ICDB).

The deputy headteacher indicated that cross curricular ICT was delivered through the majority of subjects in key stages 3 and 4 (SC), but this was more intention than fact. The ICT curriculum was not well planned, and there was no systematic mapping of the ICT NC to the whole school curriculum (Ofsted, 1998, p8; p47; p48). At key stage 3 the school had been '...working on trying to encourage departments to do an ICT experience, no matter how small...' (ICDB), and had, for example, asked the mathematics department to teach spreadsheets, though this was not yet happening (ICDB; ICSW; ICVL). At key stage 4, pupils' ICT curriculum was even more insubstantial. The deputy headteacher believed that '...we've got to get key stage 3 right first of all and then ... build on key stage 4.'. (ICDB). Despite emphatic commitment to cross curricular ICT, features of a hybrid approach were being introduced. Pupils in year 7 had a lesson to introduce them to the school's ICT resources, and optional GNVQ ICT and Computer Literacy and IT (CLAIT) courses were being introduced in key stage 4. Even so, most pupils were not entered for external examinations in ICT at the end of key stage 4 (ICDB; ICVL).

Teaching and learning

The researcher did not observe lessons where ICT was used in other subjects at school C. The deputy headteacher was unable to arrange these despite being exceptionally well organised and

enthusiastic. On several occasions she asked the researcher if it would be acceptable to arrange observations of the very few discrete ICT lessons, such as GNVQ ICT. The researcher declined as the school was of interest because of its stated commitment to delivering ICT across the curriculum. As a result, no lessons were observed. This was further evidence that very little ICT was used in other subjects, and that it was not well mapped.

The HoD mathematics did not identify the contradiction in the school's policy of teaching ICT across the curriculum, which he agreed with, and his expectation that mathematics teachers should not need to teach pupils basic ICT skills (ICSW). He believed pupils should be taught these before they used ICT in mathematics. He complained that mathematics teachers had to teach pupils how to log on to the network and how to use a spreadsheet, whereas they should have been teaching pupils how to use ICT to in mathematics.

If ICT is taught across the curriculum and some teachers do not have sufficient ICT skills to contribute, then the alternatives are: all teachers improve their ICT skills; those teachers with adequate ICT skills teach the classes of those teachers who do not have these skills; or a mix of these. At school C, the mathematics teacher in charge of ICT within the department had sufficient ICT skills to teach pupils ICT and mathematics. However, she was concerned that she would be asked to teach ICT to all mathematics classes because this would reduce contact with her own classes and other mathematics teachers would not improve their ICT skills.

Teachers of other subjects did not consider that they taught ICT so they did not set ICT homework (ICDB; ICVL). In contrast, compulsory mathematics homework was set every week. Homework in other subjects did not require pupils to use ICT, though this was not forbidden. For example, if the deputy headteacher set a science homework to '...find out about Louis Pasteur ...what he's done.', then pupils could use an online encyclopaedia if they wished. When asked whether pupils were ever set ICT homework that did not involve using ICT resources, the deputy headteacher did not understand the question initially as she was not aware that this was possible (ICDB). Most teachers were '...not aware of methods of setting homework for ICT that don't actually involve pupils having access to a computer...' (ICVL).

During the interview, the deputy headteacher was asked how teaching ICT and teaching science were different. Her answer did not address the question, but described how she would structure a worksheet so that pupils could access information on a CD-ROM. What she described was a highly structured, step-by-step approach that would lead pupils to the required information by following detailed instructions rather than by learning generalisable ICT skills. Using such a worksheet, pupils would not develop their ability to use ICT resources autonomously. The

deputy headteacher also stated that she had actively promoted changes in styles of teaching and learning in lessons involving ICT. However, when she described these changes, it was clear that she did not fully understand the interviewer's questions which attempted to explore her understanding of teacher centred and pupil centred learning. She stated that in the beginning, teachers sat at the desk at the front of the ICT room while the children worked on the computers. '...a lot of members of staff saw it as a doddle ... it kept the children quiet...' (ICDB). She had encouraged teachers to be more involved and to circulate helping pupils.

The HoD mathematics believed that mathematics lessons were less predictable when ICT was used (ICSW). When ICT was not used, teachers had more control over the mathematical content, and could anticipate pupils' difficulties. Typically, there would be reviews towards the middle and the end of a lesson. However, when ICT was used, there were a wider range of difficulties which made this approach less effective. When ICT was used in mathematics, lessons were usually based on a worksheet and there were fewer whole class reviews. Teachers tended to circulate helping individual pupils. In addition, the mathematics done using ICT was far more open ended. For example, problems were more realistic and pupils were expected to use numbers of any value rather restricting these to whole numbers. Pupils found different but equally acceptable answers to problems, and '...they're certainly going to get them in different ways.' (ICVL). The HoD mathematics believed that using ICT in the classroom would not improve mathematics teaching, but would stimulate pupils' interest (ICSW).

When the deputy headteacher used ICT in science lessons, she expected to be able to answer questions pupils asked her about science, but not about ICT, and relied on the ICT manager to be present to answer questions about ICT. Similarly, the HoD mathematics expected to be able to answer questions about mathematics, and was confident using spreadsheets, but lacked expertise with other aspects of ICT. He believed that mathematics teachers were uncomfortable when pupils had better ICT skills and did not like lessons being interrupted because of problems using ICT which had no relevance to the mathematics being taught (ICSW). In contrast, the teacher in charge of ICT within the mathematics department did not expect to be asked questions about ICT that she could not answer, though she recognised that '...this is a huge worry for a lot of staff...' (ICVL).

The deputy headteacher believed that a weaknesses of the school's cross curricular approach was that '...there is no ... depth.' (ICDB), and that teachers did not concern themselves with pupils' progression in ICT. Pupils spent too much time using the basic ICT skills needed to use ICT in the other subject, and did not attempt work at the higher levels of the ICT NC. In

general, the teaching of ICT, and pupils' progress and attainment in key stages 3 and 4, were unsatisfactory and below national expectations (Ofsted, 1998, p25; p46; p48).

Management

The previous Ofsted report noted that the school benefited from strong leadership and good management practices. However, management of ICT was a weakness, and there was no whole school management structure for ICT (Ofsted, 1998, p29; p48). As a result, the deputy headteacher was appointed and given the responsibility for developing ICT throughout the school. In addition, a teacher was appointed as ICT coordinator, and the ICT technician promoted to network manager (ICDB). There was still no formal whole school management structure for ICT but departments were encouraged to have an ICT coordinator for the subject, and the deputy headteacher met with these informally and occasionally (ICDB; ICVL).

The deputy headteacher believed that as ICT was not used extensively throughout the school, this was a weaknesses in management because the ICT curriculum was not adequately planned. She believed that a headteacher who was very involved could ensure that the whole school ICT curriculum was mapped in detail, and that this would lead to widespread usage. This was one of her current responsibilities but she felt that she did not have sufficient time to devote to it. Delivering ICT across the curriculum was a substantial, complex undertaking. To do this effectively 'You need a very clear ICT plan...' (ICDB). A three year development plan had been drawn up, with targets to be completed each term, and this was being implemented.

In contrast, other teachers identified operational shortcomings that might not always be directly improved only by better leadership and management. The HoD mathematics believed that the main factor that constrained teachers' use of ICT in mathematics was teachers' lack of confidence in using ICT and lack of access to ICT resources with classes as required. In addition, pupils did not have sufficient ICT skills so mathematics teachers had to teach these; and small groups of pupils often shared a computer which disadvantaged less confident pupils (ICSW). The mathematics teacher in charge of ICT within the department believed teachers were discouraged by: hardware or software malfunction disrupting lessons; the excessive time needed to produce worksheets to help pupils use ICT in mathematics; and lack of projection facilities to demonstrate software to a class of 30 pupils (ICVL).

The deputy headteacher in charge of ICT acknowledged that teachers might be reluctant to learn ICT skills. She believed teachers would have to learn how to use ICT in the classroom because

this was required by the NC. ‘Whether they like it or not they will have to do it.’ (ICDB). She entirely rejected the argument that, for example, because a teacher had taught mathematics successfully for 15 years without using ICT then there was no reason to use it. The deputy headteacher acquired her own ICT skills because she needed them to do administrative tasks at a previous school. However, at school C, very few teachers used ICT for administration as the school office did this (ICDB; ICVL). Consequently, teachers did not become skilled at using ICT because ‘...they’re not made to develop ... if you’re given a task and you have to use ICT, that’s how you learn...’ (ICDB).

The deputy headteacher was unsure whether the school valued ICT. ‘...I don’t know whether the school values it. I think they realised that they had to do it.’ (ICDB). The headteacher had a computer in his office ‘...but he asked for it to be taken away ... because he just doesn’t use it.’ (ICDB). The mathematics teacher in charge of ICT believed that putting the ICT resources in a separate ICT room made them seem special but she wondered if the cross curricular approach might lead to a perception of ICT not as a special technology but as equipment which is used routinely (ICVL). The school awarded subject prizes for academic effort, for example, pupils received rosettes in mathematics and English. However, there was no similar award for ICT, as ICT was taught across the curriculum and was not regarded as a discrete subject. The few pupils studying the new GNVQ ICT course might be considered for an ICT achievement prize. Even so, visitors to the school were shown the computers in the LRC and the new ICT room.

Staffing and resources

There were few teachers with satisfactory ICT skills at school C (ICDB; ICSW; ICVL). There were no specialist ICT teachers, and only approximately five teachers had sufficient ICT skills to teach it. None of these had teacher training in ICT or specialist ICT qualifications (IBDC). The deputy headteacher had taught herself ICT skills because she needed these to do her work, and the mathematics teacher in charge of ICT within the department had no teacher training or qualifications in ICT but was enthusiastic and had trained herself. She had organised training sessions for other mathematics teachers but these were infrequent. The HoD mathematics had a low level of ICT skills but he was being taught how to use timetabling software by the deputy headteacher, and had attended a one day training session. However, NQTs had some training in ICT because the teacher training standards now included this (DfEE, 1998). The deputy headteacher believed that teachers who were beginning to use ICT in the classroom needed support from an experienced colleague, and she made arrangements for this.

School C had a full time non-teaching ICT manager who set up and maintained the school's ICT resources. He had a degree in computing and a post graduate certificate in networking, and updated his skills by attending training courses provided by suppliers when new equipment was purchased. In addition, the school had sent him on a part time Further Education (FE) teacher training course, so that he could set up ICT training courses for teachers and other adults. Technical support was effective, and hardware and software were well maintained (Ofsted, 1998, p47), but the ICT manager believed this was insufficient to meet demand. In contrast, the deputy headteacher in charge of ICT believed that technical support was currently adequate (ICDB; ICVL; ICPE; Ofsted, 1998, p47).

The deputy headteacher was not sure how the school would ensure that teachers developed ICT skills and made use of ICT in the classroom. Her current strategy was to timetable classes into the ICT room and hope that when teachers were there with their pupils they would use the ICT. However, the appropriate subject specific software might not be available. When teachers had been on courses and had trained to use software the school did not have, it was unlikely that this would become available immediately in school. Acquiring software could be a long term process, and needed to be built into departmental budgets. Consequently, when the software arrived, teachers had forgotten how to use it and were less enthusiastic. In addition, teachers were often trained how to use software but not how to use it in the classroom in their own subject.

Ofsted (1998, p32) reported that the pupil:computer ratio was 6:1, but this was not consistent with provision at the time of the research visits which was around 19:1 (SC), well below the national average of 7.9:1 (DfEE, 2000a). Over 60% of the curriculum computers had been purchased within the previous 3 years, and the school had '...swapped a lot of not very good computers for fewer better computers...' (ICVL). Around 25 computers were located in a newly equipped LRC; five classrooms had one or two computers; and a new ICT room was being built which would have 20 computers when complete (ICVL; ICPE). The ICT manager installed the whole school network which had spasmodic Internet access. The software used throughout the school was MS Office (ICDB; SC).

There was a detailed school development plan which set whole school priorities and targets, and 'Planning at all levels is strong, leading to a clear educational direction ... supported by very effective financial planning.' (Ofsted, 1998, p6). However, the headteacher and governors apparently believed that once sufficient ICT resources had been purchased no further investment would be needed, and the need for annual funding for the replacement and renewal of ICT resources had not been understood. The school received no assistance from bid based funding as

bids had been entirely unsuccessful (ICDB), and the deputy headteacher had only recently persuaded the headteacher to budget £15,000 per annum.

Chapter 5:

Comparison of the case study schools

The characteristics of the case study schools

The four case study schools were chosen to represent the different ways the delivery of the ICT curriculum can be organised, that is, the 'discrete', 'skills core', 'kick start' and 'cross curricular' approaches (NCET, 1996, p7). Other factors, such as approaches to teaching and learning, management organisation, and staffing and resource levels, were not known when the schools were selected.

Curriculum organisation

School D represented the discrete approach to delivering the ICT curriculum. School D had substantial timetabled provision for teaching ICT as a discrete subject in every school year, and all pupils were entered for GCSE or GNVQ external examinations at the end of key stage 4. The HoD ICT believed that ICT was used to support teaching and learning in some other subjects but this was not well developed. This supposed lack of cross curricular ICT was regarded as a weakness, yet paradoxically pupils reported more use of ICT across the curriculum than pupils in all the other case study schools (Table 5.3).

School S used a skills core approach but the timetabled time available for discrete ICT in key stage 4 was around half of that in school D. There was extensive usage of ICT in other curriculum subjects, and the HoD ICT knew broadly what ICT was being taught in these subjects, if not when it was taught. The NC ICT entitlement was delivered in discrete lessons and it was expected that the use of ICT in other subjects would supplement this. Most pupils were entered for external examinations, mainly GCSE ICT, at the end of key stage 4 (ISBG).

School K used the kick start model of the ICT curriculum. This involved teaching ICT as a discrete subject in year 7 for one hour per week, and across the curriculum for the remainder of key stages 3 and 4. In years 8 and 9, opportunities to use ICT were timetabled for several subjects but this might amount to no more than one or two hours per pupil per subject per year. The ICT coordinator believed that the ICT NC was covered in key stage 3 but insubstantially. In

key stage 4, ICT was not timetabled and not mapped, so that ICT was taught only in those subjects where '...it tends to happen anyway...' (IKSD). For example, business studies where there were departmental ICT resources. However, not all departments had these, for example, the mathematics departments had no modern ICT hardware. There was no provision for pupils to be entered for external assessment at the end of key stage 4.

Teachers at school C emphatically stated that they delivered ICT across the curriculum. They believed that 'ICT is not a subject' (ICDB), and there were almost no timetabled discrete ICT lessons. They intended to deliver ICT entirely through other timetabled subjects, such as, English and mathematics. However, there was no systematic mapping of the ICT NC across the whole school curriculum. The ICT curriculum was at best work in progress in key stage 3 and there had been very little planning for key stage 4. There was thought to be some teaching of ICT in some subjects but this was minimal and poorly coordinated. Paradoxically, the HoD mathematics expected pupils to know how to use ICT when they arrived at mathematics lessons but believed ICT should be taught across the curriculum. He was not clear where he expected the ICT to be taught. Most pupils were not entered for external examinations at the end of key stage 4. However, despite emphatically declaring that the school used the cross curricular model to deliver ICT, discrete ICT was being introduced for a small number of pupils in key stage 4 following GNVQ or CLAIT specifications. Interestingly, the school was unable to arrange for the researcher to observe ICT being taught through other subjects but on several occasions offered to make arrangements for these discrete ICT lessons to be observed.

It is likely that the quality of teachers' schemes of work for teaching the ICT subject content will affect the development of pupils' ICT capability, and that there will be differences between schools. However, detailed analysis and comparison of these could not be carried out. Only the schools which taught discrete ICT in key stages 3 and 4 had detailed schemes of work for ICT and these were only for discrete ICT. None of the case study schools had schemes of work for cross curricular ICT, and at best, there was only informed speculation as to what would be taught and when.

Teaching and learning

The variation in approaches to teaching used by teachers did not appear to be related to the curriculum model adopted, with many common features across the case study schools. In all the case study schools except school C, teaching had been assessed as satisfactory or better in 90% to 93% of lessons across all subjects during previous Ofsted inspections, with school C

recording 97% of lessons satisfactory or better. Even so, none of the teachers gave the researcher a written lesson plan for any of the lessons observed though it was clear that there had been some forward planning. Homework was not set except in discrete ICT lessons in school S, and did not appear on any of the schools' homework timetables.

All the teachers observed were attempting to find ways to direct and control pupils' learning. Teachers tended to prefer a didactic, teacher centred approach when they taught the whole class but if this was more than directing pupils to the set tasks, it was at times inappropriate for some pupils. Pupils were usually keen to use the computers and disinclined to listen to the teacher. Typically, teachers had anticipated this and responded by setting pupils a task or series of tasks using a worksheet to direct their efforts.

Teachers attempted to control the focus of pupils' attention using carefully structured worksheets but they were not always successful. Worksheets had more step-by-step, operational instructions at the start than towards the end where more demanding, open-ended tasks were set. A common approach was to structure the initial tasks very carefully, perhaps with the expectation of identical outcomes that would vary only because pupils had different names and made different mistakes. Where there were step-by-step instructions, so that pupils could attempt the ICT element of the tasks without support from the teacher, there was usually no explanation of why ICT was being used. While pupils could complete the set tasks they were not encouraged to understand what they were doing.

It was not uncommon for only those pupils who made very rapid progress to attempt the open ended tasks. These open ended tasks almost always required pupils to attempt a realistic task set in an authentic context using software identical to or that simulated the software used in commerce and industry. In schools D and S, where ICT was predominantly taught as a discrete subject, key stage 4 pupils doing GCSE ICT coursework attempted a greater variety of open ended tasks. These required them to design and build ICT systems for others to use taking an approach similar to those used in producing commercial software. Pupils in schools C and K did no more than use ICT to support teaching and learning in other subjects, and this rarely required advanced ICT knowledge, skills and understanding.

When pupils were given worksheets that provided step-by-step support for the ICT content, many deviated from the set tasks and explored other features of the software. Some pupils seemed content to work steadily at the set tasks, but many deviated from these from time to time, returning to them only when the teacher monitored their work. Some pupils apparently preferred to learn how to use the software by trial and error, setting their own tasks relevant to

their own needs, rather than following those set by the teacher. This is congruent with the findings of Boyle (1997) who found that learners using computer based learning materials based on traditional systematic instructional design deviated from or abandoned the given instructional sequence, preferring to construct their own understandings by trial and error. Perhaps as a result, ICT teachers tended to manage the learning process rather than always expecting to control all aspects and outcomes of it. For the teachers observed at school D, pupils' autonomous exploration of the software was a part of the set tasks. Such teachers expect to be facilitators and encouragers rather than 'gods of knowledge' (Phillips, 1995).

The real world relevance of the ICT related tasks teachers set for pupils was more overtly referred to by teachers in discrete ICT lessons than in lessons in other subjects. Whereas ICT teachers went to considerable lengths to show pupils how the set tasks modelled ICT systems and processes in commerce and industry, teachers of other subjects were generally content to help pupils use ICT to support their learning of the other subject. Teachers of other subjects did not make overt connections between their subject and the aspects of the real world being modelled, and consequently, the relevance of the ICT tools used was established only for the activities taking place within the lesson.

Where ICT was taught through another subject, there was usually a good balance between the ICT subject content and the other subject, however, where there was a lack of balance it was the ICT that was neglected. For example, in school K, in a business studies lesson, pupils worked through a worksheet that did not direct them to the possibility of using ICT. As a result, most pupils used a wordprocessor to present their work but made little use of a spreadsheet to analyse data and generate graphs which would have been helpful to them (LKST2).

Teachers in schools D and S were more aware of differences between teaching ICT and other subjects. Prior to being asked at interview, teachers in schools K and C had not considered the differences between teaching ICT and other subjects, perhaps because they teach much less discrete ICT (IKST; ICDB). Even so, their initial reflections during the interviews supported the views of teachers of discrete ICT. These teachers believed that the content of ICT lessons was less predictable and harder to control. This was because it was harder to control the focus of pupils' attention, and because there was more likelihood that teachers would be asked questions that they could not immediately answer. The open ended nature of the more advanced ICT tasks also made the content of the lesson less controllable as there could be different but equally valid approaches. Teachers knew that their ICT subject knowledge was not entirely comprehensive, and in contrast to subjects such as mathematics, they expected to be asked questions they could

not answer in a lesson. Teachers anticipated that some pupils knew more about ICT than they did but not all were comfortable with this.

Management

The case study schools that taught discrete ICT throughout key stage 4 had strong leadership with respect to the use of ICT within the school, well developed organisational structures for managing ICT, and effective arrangements for consulting and involving other staff. In school D, the headteacher believed that she led the implementation of ICT in the school. She valued ICT, had her own computer in her office, and was an enthusiastic user. The headteacher of school S did not use a computer, had poor ICT knowledge, skills and understanding, and did not use ICT. However, he accepted the importance of ICT and did not interfere with management processes, delegating these to the deputy headteachers who had good ICT skills. In both schools, there was a formal ICT management committee which directed the development of the ICT curriculum and resources within the school. This consisted of the majority of the school's senior management all of whom had good ICT knowledge, skills and understanding. In school D the ICT management committee consisted of the headteacher, two deputy headteachers, three senior teachers, the HoD ICT and a technical manager. The composition of this committee was similar in school S but omitted the headteacher and the three senior teachers.

Schools D and S also had ICT user groups chaired by the HoD ICT which included representatives from the other subject departments, such as mathematics and English, and the school's learning resources centre. These met regularly and were inclusive committees in that no one was excluded, even though each subject department had its own nominated representative. The purposes of these user groups were to improve communication between the management committee and users; generate enthusiasm and ideas; ensure that ICT resources were performing satisfactorily; facilitate pupils' access to ICT resources; and to generally ensure that every teacher could influence policy and procedures. In school D, the relationship between ICT management and users was so well developed that the school was considering negotiating internal service level agreements for users.

Leadership and management of ICT were less well developed in the schools that taught ICT entirely across the curriculum in key stage 4, and there was no formal management committee or user group to facilitate communications between ICT management and users in these schools. Consequently, teachers of other subjects could feel excluded and there were long standing issues that remained unresolved. For example, the headteacher of school C provided no leadership in

respect of the deployment of ICT in the school. The headteacher had a computer in his office but asked for it to be removed as he didn't use it (ICDB; ICVL). Perhaps not surprisingly, the previous Ofsted report had identified the management of provision for ICT at school C as a weakness (Ofsted, 1998).

In school K, the headteacher, two deputy headteachers and the ICT coordinator all had easy access to and made good use of ICT in school administration but for most teachers this was intentionally paper based. This small group of senior managers met annually to discuss the development plan for ICT but there were no formal ICT committees at any level. However, the deputy headteacher in charge of ICT throughout the school expected to consult the ICT coordinator, and the ICT coordinator expected to be consulted. The ICT coordinator considered himself to be the school's ICT expert and did not want other teachers telling him what to do. He already had '...so many people asking for things that you can't give them...' and felt it might not be prudent to set up a user group which would then '...ask you for even more, and argue about it, then tell you what to do...', perhaps leading to demands that could not be satisfied (IKST). As a result of this lack of formal opportunities for consultation, the HoD mathematics felt that he had no means of influencing policy on ICT related issues. One such issue was that his department had sufficient ICT skills to make greater use of ICT in teaching mathematics but he did not wish to be involved in teaching the ICT curriculum (IKSD). In contrast, the ICT coordinator believed that the mathematics department was not ready to make use of ICT in the classroom to support teaching and learning as they were unwilling to teach aspects of the ICT curriculum. It is an inescapable consequence of the cross curricular model for organising the ICT curriculum that teachers of other subjects should teach the ICT subject content. In school K, this issue was unrecognised, unresolved, and long standing. Had there been a formal ICT user group that met regularly to discuss such matters, this issue might have been identified and resolved quickly.

Across all the schools, the more effective HoD ICT were open, approachable, enthusiastic, encouraged and supported others, and had good ICT knowledge, skills and understanding. In schools D and S, the HoD ICT approached their work in this manner. The HoD ICT at school S encouraged individual teachers to use the ICT rooms even if these were in use by other teachers with their classes. She had helped others learn how to use ICT, including supporting non-teaching assistants and others to obtain qualifications in ICT, including GCSE ICT. The HoD ICT at school D tried to persuade other teachers to use ICT and respected their viewpoints, while the HoD ICT at school S would use compulsion if persuasion was not effective. Both believed that the use of ICT across the curriculum enhanced the ICT subject curriculum but neither had mapped this coherently (ISBG; IDAI). In contrast, the deputy headteacher at school

C, who was effectively the ICT coordinator, had very little background in ICT before being given responsibility for developing ICT in the school as a result of a poor Ofsted inspection report. She was very enthusiastic, but had only just begun to develop her subject knowledge, and had not thought through all the issues relating to the development of a whole school approach to the implementation of cross curricular ICT (ICDB). The ICT coordinator at school K had good ICT knowledge, skills and understanding but believed the involvement of others would lead to demands that could not be satisfied. Consequently, he had taken a defensive position, effectively discouraging others' contributions and participation.

Teachers of other subjects tended to use ICT more in the schools which taught discrete ICT throughout key stage 4. In these schools, teachers could not and were not permitted to avoid the use of ICT. School S would consider disciplinary procedures if a teacher declined to make appropriate use of ICT in the classroom, and whilst teachers at school D might avoid using ICT to support teaching and learning in the classroom they had to register pupils using the computer located in each classroom for this purpose. In both schools, there was a culture of support, openness and encouragement towards the use of ICT in the classroom. As a result, teachers of other subjects made use of ICT in the classroom or felt under pressure to do so. In contrast, in schools K and C, teachers could avoid using ICT in the classroom and many did so. School K felt that it was not yet appropriate to insist teachers made use of ICT in the classroom, and the involvement of most teachers with school administration was intentionally paper based. However, school C was moving towards a more hard line approach: 'Whether they like it or not they will have to do it' (ICDB). It is worth noting that when teachers of other subjects avoided the use of ICT in the classroom this did not always mean that pupils in their classes did not have opportunities to use ICT. Using some arrangement for rotating classes, ICT could be taught to all classes by a member of the subject department who had good ICT skills (IDPR; IKSD; ICVL). This strategy had been or was being used in all the case study schools except school S and may be a stage in the process of encouraging all teachers in a department to make appropriate use of ICT in the classroom where compulsion is not acceptable.

The schools that taught discrete ICT in key stage 4 tended to value it more highly (Chapter 4: School D: Management; Chapter 4: School S: Management). In contrast, the deputy headteacher of school C was unsure whether the school valued ICT. They did it because they had to (ICDB). ICT was believed to be a tool to support teaching and learning in other subjects, and hence ICT was merely equipment to be used routinely and not especially valued. In all the schools, visitors were always taken to see the ICT facilities and the LRC but they did not always visit classrooms where other subject departments were based. Pupils received prizes for academic achievement in ICT in the schools which taught discrete ICT throughout key stage 4.

In contrast, those schools that taught ICT across the curriculum in key stage 4 did not give prizes for achievement in ICT. For example, in school C, there were prizes for academic effort but not for ICT as these prizes were subject prizes, and ICT was not considered to be a subject as it was taught entirely across the curriculum. In school K, the school awarded prizes for achievement at GCSE and A-level but as pupils were not entered for GCSE ICT, there were no prizes for ICT. Some subject departments arranged for certificates for effort and achievement at end of each term but this was not done for ICT.

All the schools used ICT for school administration but this was more highly valued in school D where it was thought that school administration could not be done without ICT. On the whole, senior management in all the schools used ICT for school administration and had computers in their offices, except that the headteachers in schools S and C did not use computers and delegated the computer-based administration to their deputies. In schools K and C, there was a deliberate policy of restricting the extent that teachers in general used ICT for school administration as they did not have easy access to ICT resources.

Staffing and resources

Those schools which taught discrete ICT throughout key stage 4 tended to have a larger number of specialist ICT teachers deployed teaching ICT. School D had five full time specialist ICT teachers; school S, had four and had recently appointed another; school K, had three, but these did not teach ICT full time, and their aggregated ICT teaching was equivalent to one and a half full time teachers; and school C had no specialist ICT teachers as it was expected that ICT would be taught entirely across the curriculum, however, only about five teachers of other subjects had sufficient ICT skills to teach ICT (ICDB). Each of the schools had an ICT technician, and all the schools had a network manager, though arrangements differed. At school D there was a full time network manager who was not a teacher; at schools S and K, the network manager was a teacher on half a timetable; and at school C the technician was the network manager.

On the whole, teachers in the case study schools were not well qualified in ICT or a related subject, though there were exceptions. At school S, the HoD ICT had studied ICT as a part of her degree. The network manager had recently completed an HND ICT. A teacher at school K had completed teacher training as a specialist ICT teacher and had been awarded a PGCE ICT; and another had studied ICT as a minor subject during teacher training. The network manager at school C had a degree in computing, and the technician at school K was working towards an

industry standard Microsoft Certified Systems Engineer (MCSE) qualification in his own time and funded by himself.

None of the case study schools had provision for systematic, effective training based on a good understanding of training needs. In all the schools, several staff had attended one or two day courses run by the suppliers of the hardware or software systems used in school, and NQTs had completed teacher training courses that should have ensured that their ICT skills met the requirements of 4/98 Annex B (DfEE, 1998a). NOF funded training was becoming available for basic ICT training for all teachers. Other training requirements were met in different ways with only school S taking a positive, proactive approach. The network manager at school S had HND course fees paid for by the school and half a day per week study leave. School S also paid for a science teacher to do an ICT course by distance learning, and there had been externally accredited in-school training for several teachers and other staff, for example, for GCSE ICT. In stark contrast, teachers in the other schools were expected to train themselves. ICT teachers trained themselves in different ways but few attended lengthy courses or attempted to acquire formal qualifications.

Those schools which taught the most discrete ICT had much more advantageous pupil:computer ratios (school D, 4:1; S, 9.2:1, K, 15.4:1,C, 19:1) with school D being the only case study school with a better ratio that the national average of 7.9:1 (DfEE, 2000a). Despite school D having a ratio almost five time more advantageous that that of school C, when only modern computers are included, the difference is more exaggerated. School D had 300 modern PCs; school S had 120 computers and school K had 90 working computers, but in both schools only 50% of these were modern; and school C had 50 modern computers.

The distribution of computers throughout the schools followed similar patterns in all the schools. All the schools had one or more computer rooms, a cluster of computers in the LRC, several smaller clusters throughout the school, and a small number of computers in some classrooms. All claimed to have whole school ICT networks but only in school D was this pervasive with four ICT rooms, several large departmental clusters, and a networked computer in every classroom permanently connected to this network and the Internet. Teachers in all the schools except school D claimed that there was insufficient hardware and that this affected the curriculum.

The provision of sufficient modern ICT resources in schools is dependent on the allocation of adequate funding for the initial purchase of ICT hardware and software, replacements and renewals, and forward planning. Arrangements for funding were similar in all the case study

schools. Annual allocation from capitation was insufficient, so that all the schools were heavily reliant on bid based funding. School D had been very much more successful in its bids for funding than the other case study schools. In school C, the leasing of a small proportion of the ICT resources ensured a minimal amount of guaranteed funding from the annual budget. School K had recently allocated £15,000 per for ICT resources, and it was intended that this should be available annually.

Where the schools differed substantial was in the adequacy of their developmental forward planning. In school D, the ICT development plan was an integral part of the school development plan (Ofsted, 1996a), and in school S, the school and each department had an ICT development plan (Ofsted, 1997). However, forward planning was weaker in school K where the ICT development plan was a part of a school development plan which lacked detailed costing and did not make priorities clear (Ofsted, 1996b). In school C, despite clear whole-school planning, the school had acted as if ICT resources were a one-off purchase and had not made provision for on-going funding for replacement and renewal (Ofsted, 1998, p6).

Background factors

The development of pupils' ICT capability may be affected by the socio-economic background of the school's catchment area, and the characteristics of individual pupils, such as motivation. However, a comprehensive, detailed analysis of this was not a practical possibility, and such influences have not been considered. An illustration of some of the ways in which the case study schools differed is shown in Figure 5. Clearly, some of the background factors illustrated may well affect pupils' expected achievements in all subjects including ICT.

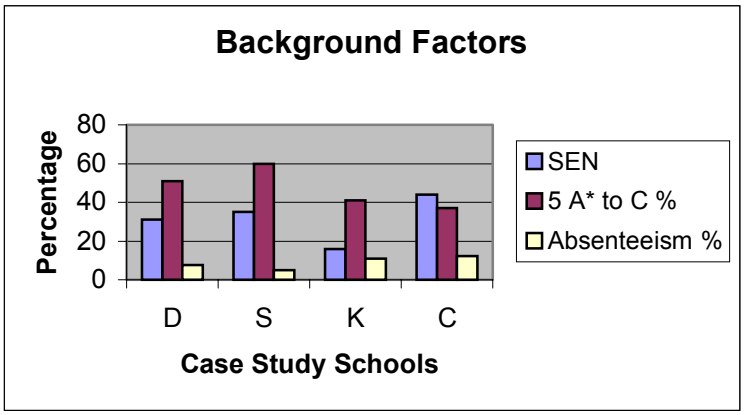

Figure 5: Some background factors of the case study schools

ICT capability among 14-16 year olds in the case study schools

Analysis of the questionnaires given to pupils

In this section, the ICT capability of 14-16 year old pupils in each of the four case schools is compared by analysing the outcomes from the questionnaires (Appendix 5) completed by pupils in each school at the end of key stage 4. The content of this pupil questionnaire was designed to measure pupils' ICT capability in relation to the conclusions of a study of what constitutes ICT capability (Crawford, 1998). Each question is mapped (Appendix 6) to the description of ICT capability (p26). The mapping relies on the author's professional judgement and experience, and more research is needed to investigate whether or not the pupil questionnaire is an adequate measure of pupils' ICT capability. The pupil questionnaires record pupils' self assessment of their own ICT capability, and consequently, the data collected using the questionnaire will not be entirely reliable. The data was collected in the four case study schools, and may not be representative of schools in general.

In all the case study schools, year 11 pupils at the end of key stage 4 filled in the questionnaires in class and returned them to their teachers. In school D, questionnaires were filled in by pupils in two year 11 GCSE ICT classes, one short course and one full course, and one year 11 GNVQ class. In school S, pupils in several year 11 GCSE ICT classes completed the questionnaires. In school K, the pupils in year 11 classes who completed the questionnaires were using ICT to support teaching and learning in other subjects as the school does not offer GCSE ICT or any other programme of studies in discrete ICT or a related discipline in key stage 4. In school C, pupils in year 11 mixed ability form classes completed the questionnaires as the school delivers ICT across the curriculum and there are no timetabled ICT lessons.

Question 1

The proportion of boys who filled in the questionnaire is greater than the number of girls (Table 5.1). As a result, if there are gender effects, this imbalance should be taken into account.

	School					
	D	**S**	**K**	**C**	**Mean**	**SD**
Boys	59 %	67%	62%	54%	60.5%	4.7%
Girls	41%	33%	38%	46%	39.5%	4.7%
Total Number	54	43	47	48	48	3.9

Table 5.1: Pupils who filled in the questionnaire.

Question 2

Pupils were asked to indicate in which NC subjects they used ICT and whether they used ICT at home. Table 5.2 shows the percentage of pupils who did not indicate that they used ICT in any subject at school or at home. In those schools where ICT is predominantly taught across the curriculum some pupils did not use ICT.

School D	School S	School K	School C
0%	0%	4.3%	10.4%

Table 5.2: The percentage of pupils who did not use ICT at school or at home.

The highest percentage of pupils that indicated that they used ICT in the most subjects was in those schools that taught the most discrete ICT. Paradoxically, it was those schools that relied most on teaching ICT across the curriculum in which pupils reported that they used it in the fewest subjects (Table 5.3). Moreover, this pattern is confirmed as the percentage of pupils reporting that they used ICT in a subject is increased. That is, more pupils made use of ICT in more subjects in schools that taught discrete ICT than in schools that taught ICT across the curriculum. This finding is contrary to reasonable expectations.

Percentage of pupils	School D	School S	School K	School C
over 10%	9	9	6	8
over 20%	7	8	3	5
over 30%	7	8	2	3
over 40%	6	6	2	2
over 50%	5	6	1	1
over 60%	5	3	0	1
over 70%	5	3	0	0

Table 5.3: The number of subjects in which more than the given percentage of pupils used ICT.

Similarly, pupils made more use of ICT at home in those schools that taught discrete ICT than those schools that taught ICT across the curriculum (Table 5.4). This effect appears to be more pronounced for girls. The difference between the percentage of girls and boys who used ICT at home is greatest in those schools that taught ICT across the curriculum.

	School			
	D	**S**	**K**	**C**
Female	86.4%	85.7%	50.0%	50.0%
Male	93.8%	93.1%	75.9%	61.5%
Difference Male/Female	7.4%	7.4%	25.9%	11.5%
All pupils	90.7%	90.7%	66.0%	56.3%

Table 5.4: The percentage of pupils that used ICT at home.

In the schools that taught discrete ICT, more pupils used ICT in the other subject which used ICT the most (Table 5.5). This again confirms the impact of teaching discrete ICT on pupils' use of ICT throughout the curriculum.

School D	**School S**	**School K**	**School C**
81.5% in DT	95.3% in English	59.6% in English	66.7% in DT

Table 5.5: The highest percentage of pupils who used ICT in another subject in each school.

To summarise, in those schools which taught discrete ICT throughout key stages 3 and 4, that is, schools D and S:

- More pupils used ICT in more subjects
- More pupils used ICT at home
- More boys used ICT at home than girls, but this tendency was less pronounced than in those schools which taught ICT across the curriculum; and considerably more girls used ICT at home
- More pupils used ICT in the subject which used ICT the most

Question 3

Pupils were asked to name four pieces of software that they had used in the previous week. Pupils in schools D and S where discrete ICT was taught in key stages 3 and 4 used a much narrower range of branded software than pupils in schools K and C (tables 5.6; 5.7). However, when the software pupils used is grouped into generic types, the variety of experience in schools K and C is less evident. This may be because pupils were taught to use particular software in schools D and S, and then they used this software in preference to software that they had not been taught to use. Pupils in schools K and C received very much less instruction in using software, and were therefore not predisposed to use, for example, Word rather than WordPerfect.

School	Total number of different pieces of branded software used	Mean number of pieces used per pupil
D	26	0.48
S	29	0.67
K	42	0.89
C	37	0.77

Table 5.6: The total number of different pieces of branded software that pupils had used in the previous week., and the mean number of pieces used per pupil.

School	Total number of different generic types of software used	Mean number of types per pupil
D	11	0.20
S	12	0.27
K	18	0.38
C	12	0.25

Table 5.7: The total number of different generic types of software that pupils had used in the previous week, and the mean number of types per pupil.

Significantly more pupils used the most popular generic type of software in schools D and S (Table 5.8). Pupils in school K reported their use of the Operating System or Graphic User Interface (OS/GUI) as the most popular type of software used. In order to run any software, an OS/GUI must be used, so that all the pupils in all the schools must have made use of this. On the whole, pupils in the other schools did not name the OS/GUI as a piece of software that they used. Pupils made use of software for school work to a much greater extent than games software.

	School D	School S	School K	School C
Most popular	Wordprocessing 96.3%	DTP 95.3%	OS/GUI 36.2%	Wordprocessing 56.3%
Games	2%	13%	15%	6%

Table 5.8: The percentage of pupils who had used the most popular generic type of software and games.

Pupils who failed to name 4 pieces of software either did not know the name of the software or had not used 4 pieces in the previous week (Table 5.9). This indicates the breadth of pupils' experiences of ICT. Pupils in schools D and S had a very much broader experience of ICT than pupils in schools K and C.

	School D	School S	School K	School C
4 pieces as requested	85.2%	76.7%	34.0%	37.5%
Only 0 or 1 piece	3.7%	2.3%	44.7%	31.2%

Table 5.9: The percentage of pupils who were able to identify the stated number of pieces of software.

Commercial and industrial users are more likely to use Microsoft software on a PC than software produced by any other vendor. Table 5.10 shows that schools S, K and C are less likely to use only industry standard software. This may indicate that pupils in schools that place more emphasis on cross curricular ICT gain experience of a broader range of software.

	School D	School S	School K	School C
4 pieces out of 4	42.6%	0.0%	34.0%	0.0%
2 or 3 pieces out of 4	51.9%	46.5%	21.3%	22.9%
0 or 1 piece out of 4	5.6%	53.5%	44.7%	77.1%

Table 5.10: The percentage of pupils who identified Microsoft software.

To summarise:

- In schools that taught ICT as a discrete subject throughout key stages 3 and 4, more pupils used ICT more often but a narrower range of software was used.
- Pupils made use of software for school work to a much greater extent than games software.
- Those schools which taught ICT across the curriculum were much less likely to have used only industry standard software.

Question 4

Pupils were asked to rate their own skill levels when using each of a wordprocessor, a Web browser, graphics software, a spreadsheet and a database. Considerably more pupils in schools D and S rated themselves as average or better across the five types of software, and fewer rated themselves as beginners (Table 5.11). In all the schools more pupils rated themselves as experts with wordprocessing software than with any other type of software but pupils in schools D and S were more confident that they were experts at wordprocessing (Table 5.12). Perhaps more significantly, in schools K and C, relatively large proportions of pupils did not rate their expertise at all, indicating that they did not even consider themselves to be beginners (Table 5.11).

Skill level	School D	School S	School K	School C
Average or better	89.3%	80.9%	63.8%	44.2%
Beginner	10.4%	18.1%	22.6%	39.2%
No response	0.4%	0.9%	13.6%	16.7%

Table 5.11: Skill level ratings showing the percentage of pupils who assessed themselves at the given level.

	Highest expert skill level rating
School D	Wordprocessing 31.5%
School S	Wordprocessing 39.5%
School K	Wordprocessing 19.1%
School C	Wordprocessing 25.0%

Table 5.12: Highest expert skill level ratings showing the percentage of pupils who assessed themselves at this level.

In all the schools, over 30% of pupils rated their expertise with every piece of software as average or better (Table 5.13). However, in schools K and C, fewer pupils rated themselves as average or better across a narrower range of software.

Percentage of pupils	School D	School S	School K	School C
over 30%	5	5	5	5
over 50%	5	5	3	1
over 70%	5	3	2	1
over 90%	3	2	0	0

Table 5.13: The number of pieces of software in which pupils rated themselves as average or better at the given percentage level

To summarise:

In all the schools:

- More pupils rated themselves as experts with wordprocessing software than any other software
- Over 30% of pupils rated their expertise with all the software as average or better

In the schools which teach discrete ICT throughout key stages 3 and 4:

- Considerably more pupils rated their expertise as average or better
- Fewer pupils rated themselves as beginners

In the schools that mainly deliver ICT across the curriculum:

- Fewer pupils rated themselves as average or better across a narrower range of software
- Large proportions of pupils had not begun to learn how to use some or all of the software

Question 5

Pupils were asked if they had performed a range of technical operations. For analysis, these operations were categorised into two distinct groups:

- Basic operations that are an intuitive part of a GUI
- File operations

It would be difficult to operate a modern computer without the ability to perform the basic GUI operations. It is not uncommon for pupils to discover and learn to use these operations themselves, but if they do so they are less likely to recognise the technical vocabulary that describes the operations. Consequently, answers to this question indicated that pupils both recognised and had performed particular technical operations.

Table 5.14 shows that in all the schools the overwhelming majority of pupils could recognise and perform basic GUI operations and that somewhat fewer pupils could recognise and perform file operations. In schools D and S, where there was discrete ICT teaching throughout key stages 3 and 4, more pupils were competent at a much wider range of GUI operations, and in these schools pupils were much better at file operations.

	Operations performed				
School	**GUI**	**File**	**All**	**Best**	**Worst**
D	96.6%	67.6%	82.1%	Select from a menu, 100%	Zip or unzip a file, 44.4%
S	93.4%	68.6%	81.0%	3 basic and 2 file operations, 95.3%	Defragment a disk, 34.9%
K	75.9%	46.8%	61.3%	Use a mouse to highlight, 93.6%	Make a backup, 25.5%
C	80.6%	56.3%	68.4%	Open a window, 89.6%	Defragment a disk, 33.3%

Table 5.14: The percentage of pupils who had the ability to recognise and perform technical operations.

The majority of pupils in all the schools could recognise and perform the basic GUI operations. In schools D and S, over 90% of pupils could recognise and perform all the GUI operations but few pupils from schools C and K could do this (Table 5.15).

The file operations demanded a higher level of technical understanding than the GUI operations. To perform them, pupils would need to understand file names, the function of memory and

backing storage, file compression and file backup. In schools D and S, more pupils could recognise and perform more file operations than pupils from schools C and S.

Only in school C, a small number of pupils responded to this question with silly comments under the 'Other' category, such as: 'closed a door'. Such responses may indicate a high level of frustration perhaps induced by a lack of understanding of the question as a whole.

	School			
GUI operations	**D**	**S**	**K**	**C**
Over 90%	6	6	2	0
Less than 50%	0	0	0	0
File operations				
Over 90%	2	3	0	0
Less than 50%	0	3	4	3

Table 5.15: The number of technical operations (out of 6) which the stated percentage of pupils could recognise and perform.

To summarise, in the schools that taught discrete ICT, more pupils stated that they could recognise and perform a much wider range of GUI and file operations

Question 6

Pupils were asked to identify which hardware they had used. This hardware could be categorised as three distinct groups:

- Hardware that is very commonly available to pupils in schools
- Hardware that is less commonly available to pupils in schools
- Hardware that is much less commonly available to pupils in schools and may only be available at home or elsewhere

Table 5.16, shows that in all the schools the overwhelming majority of pupils had used the hardware commonly available to pupils in schools. As availability declined, fewer pupils indicated that they had used it. This suggests that many pupils were dependent on the availability of hardware in schools for their experience of it. As in question 5, responses to this question also indicated whether pupils could recognise the terminology used. No response could indicate that the hardware had not been used, or that pupils did not have sufficient technical knowledge to identify what they had used. For example, in all the schools, the most common type of computer used by pupils, if not the only type, was the desk top computer. All those

pupils who had used a computer in school would have used a desk top computer. Over 80% of pupils in all the schools indicated that they had used a desk top computer but no school achieved greater than 95%. That is, some pupils who had used a desk top computer did not indicate this because they did not recognise the technical terminology (Table 5.16).

	School			
	D	**S**	**K**	**C**
Common hardware	89.0%	94.4%	73.2%	68.3%
Less common hardware	72.6%	73.0%	39.6%	52.9%
Much less common hardware	53.0%	41.9%	27.2%	33.4%
All hardware	71.7%	69.8%	46.7%	51.7
Most commonly used hardware	desk top computer 94.4%	colour printer 100.0%	colour printer 85.1%	desk top computer 83.1%
Least commonly used hardware	zip drive 33.3%	watched TV on a computer 25.6%	watched TV on a computer 10.6%	speech input 18.8%

Table 5.16: The percentage of pupils that identified the hardware they had used.

Most pupils in schools D and S had used a much wider range of hardware than pupils in schools K and S (Table 5.17). Pupils in schools D and S had a much wider experience of ICT hardware even that which was not available in schools. Greater access to the hardware in school and specialist teaching appeared to have helped pupils recognise and make use of ICT.

Percentage of pupils	**School D**	**School S**	**School K**	**School C**
Over 90%	3	6	0	0
Over 70%	10	7	4	4
Over 50%	13	11	6	7
Below 50%	2	4	9	8

Table 5.17: The number of different types of hardware (out of 15) which the stated percentage of pupils had used.

Responses to question 6, show that pupils could identify and use a greater variety of hardware when they had been regularly taught discrete ICT by ICT specialist teachers.

To summarise:

- Most pupils were dependent on the availability of hardware or their access to it in schools for their experience of it
- Pupils in schools where ICT was taught as a discrete subject could identify and use a wider range of hardware both in school and at home

Question 7

Pupils were asked to say what they would do if they got stuck when doing an ICT task at school. Responses were classified as indicative of: collaborative or autonomous learning; dependency on the teacher or other adults; or the avoidance of learning. Collaborative learning was the most popular first or second choice of learning strategy, and avoidance was always the least popular with very few pupils choosing it, though this was slightly more emphatic in school D than in the other schools (Table 5.18). However, Chi squared testing indicates that there was no association between the school attended and pupils' choice of learning strategy. This suggests that pupils' preferences are universal (Table 5.19).

	School			
Learning strategy	**D**	**S**	**K**	**C**
Collaborative	74.0%	74.4%	65.9%	54.2%
Autonomous	59.3%	41.8%	36.1%	22.9%
Dependent (teacher or adult)	30.6%	39.6%	42.6%	37.5%
Avoidance	0.0%	2.3%	2.1%	2.1%

Table 5.18: The percentage of pupils making the given learning strategy their first or second choice.

Ho: There is no association between the school attended and pupils' choice of learning strategy.
Chi-Squared = 9.44 (calculated from the raw data, and excluding 'avoidance' as the values are below 5)
From tables Chi-Squared with 6 degrees of freedom at 5% level is 12.6 so cannot reject Ho.
That is, there is no association between the school attended and pupils' choice of learning strategy.

Table 5.19: Hypothesis test on the association between the school attended and pupils' choice of learning strategy.

To summarise:

- No association was found between the school attended and pupils' choice of learning strategy
- In all the schools, collaborative learning was the most popular first or second choice of learning strategy, and avoiding problems was the least popular

Question 8

Pupils were asked to prioritise what they would do if they got stuck and decided to try to find the solution themselves. Responses were classified as indicative of: autonomous; autonomous/dependent, dependent and avoidance learning strategies. Tables 5.20 and 5.21 support the conclusions drawn from analysis of question 7. As before, these tables show that few pupils sought to avoid attempting to solve a problem. The more discrete ICT was taught, the fewer pupils sought to avoid problems. As the questionnaire no longer permits the option of collaborative learning, pupils' other choices become more evident. Pupils in schools D and K appear to have had a slight preference for autonomous styles of learning whereas pupils in schools S and C preferred dependent strategies. This preference contradicts the findings of question 7 for schools K and S (tables 5.18 and 5.19). However, Chi squared tests again indicate that there is no association between the school attended and pupils' choice of learning strategy. This emphasises the conclusion that pupils' preferences are universal.

Learning strategy	School D	School S	School K	School C
Autonomous	40.8%	44.2%	34.1%	14.6%
Autonomous/Dependent	68.5%	48.9%	59.6%	56.3%
Dependent (manual or exact help)	38.9%	50.0%	40.5%	32.3%
Avoidance	3.8%	7.0%	8.5%	10.4%

Table 5.20: The percentage of pupils who prioritised the given learning strategy as their first or second choice when they had already decided not to ask someone else.

Ho: There is no association between the school attended and pupils' choice of learning strategy when they had already decided not to ask someone else.
Chi-Squared = 1.4 (calculated from raw data) (calculated from the raw data, and excluding 'avoidance' as the values are below 5)
From tables Chi-Squared with 6 degrees of freedom at 5% level is 12.6 so cannot reject Ho
That is, there is no association between the school attended and pupils' choice of learning strategy.

Table 5.21: Hypothesis test on the association between the school attended and pupils' choice of learning strategy when they had already decided not to ask someone else.

To summarise:

- The results from this question confirm those from question 7
- The more discrete ICT was taught, the fewer pupils sought to avoid problems, otherwise no association was found between the school attended and pupils' choice of learning strategy
- In all the schools, most pupils did not seek to avoid problems

Question 9

Pupils were asked to rate the effects of ICT on the way they did several common activities. Hypothesis testing (tables 5.22 and 5.23) indicates that overall there is no association between the school pupils attended and the number of pupils who indicated that ICT had no affect or a major effect on the given activities. However, inspection of Table 5.21 shows that the highest percentage of pupils indicating that ICT had no effect is always in school S. In addition, almost twice as many pupils attending schools K and C, that is some 1 in 3 of them, indicated that ICT had not affected the skills needed to do a job.

	School			
Activity affected	**D**	**S**	**K**	**C**
How you find out what's on TV	63.0%	69.8%	70.2%	66.7%
How you pay when you go shopping	75.9%	58.1%	80.9%	56.3%
How you get your money from the bank	77.8%	65.1%	80.9%	62.5%
When you catch the bus or train	68.5%	69.8%	80.9%	62.5%
The skills you need to do a job	16.7%	16.3%	29.8%	31.3%
Have you noticed how ICT has affected any thing else?	18.5%	16.3%	31.9%	16.7%

Table 5.22: The percentage of pupils who indicated that ICT had not affected the given activity.

Ho: There is no association between the school attended and the number of pupils indicating that ICT had not affected the given activity.
Chi-Squared = 8.4 (calculated from raw data)
From tables Chi-Squared with 15 degrees of freedom at 5% level is 25.0 so cannot reject Ho.
That is, there is no association between the school attended and the number of pupils indicating that ICT has not affected the given activity.

Table 5.23: Hypothesis test on the association between the school attended and the number of pupils indicating that ICT had not affected the given activity.

Ho: There is no association between the school attended and the number of pupils indicating that ICT had a major affect on the given activity.
Chi-Squared = 21.7 (calculated from raw data)
From tables Chi-Squared with 15 degrees of freedom at 5% level is 25.0 so cannot reject Ho.
That is, there is no association between the school attended and the number of pupils indicating that ICT has a major affect on the given activity.

Table 5.24: Hypothesis test on the association between the school attended and the number of pupils indicating that ICT had a major affect on the given activity.

To summarise:

- Overall there is no association between the school pupils attended and the number of pupils who indicated that ICT had no affect or a major effect on a particular activity
- Pupils in school K were less likely to believe that ICT had affected the given activities
- Almost a third of pupils in schools K and C believed that ICT had not affected the skills needed to do a job, and this was almost twice as many pupils as in schools D and S

Summary of findings from analysis of the questionnaires

In the schools which taught discrete ICT throughout key stages 3 and 4 more pupils used ICT at school in a wider range of subjects and they used it to a greater extent (Tables 5.1; 5.3). Pupils that attended these schools had a much broader experience of different generic types of software but they used a narrower range of branded software (Tables 5.6; 5.7; 5.8). That is, more pupils had used a wordprocessor, database, spreadsheet, graphics software and a Web browser but these had been chosen from a much narrower range of branded software. Where pupils use a particular brand of software at school, they tended not to use different software at home.

In general, more pupils used ICT at home in the schools which taught discrete ICT throughout key stages 3 and 4. In all the schools, the percentage of boys using ICT at home was greater than girls, but this tendency was much less pronounced in the schools which taught discrete ICT (Tables 5.1; 5.4). A much higher proportion of girls used ICT at home in schools D and S. In those schools where ICT is predominantly taught across the curriculum, some pupils did not use ICT at home or at school (Table 5.2).

In all the schools, most pupils used software for school work to a much greater extent than games software (Table 5.8); more pupils rated themselves as experts with wordprocessing software than with any other software; and at least 30% of pupils rated their expertise with all the software used as average or better. However, in the schools which taught discrete ICT throughout key stages 3 and 4, considerably more pupils rated their expertise as average or better with a wider range of software, and fewer pupils rated themselves as beginners. In the schools that mainly delivered ICT across the curriculum, fewer pupils rated themselves as average or better across a much narrower range of software; and large proportions of pupils had not begun to learn how to use some or all of the software. The more discrete ICT was taught, the more confident pupils were that they had expertise in using a wider range of different types of software (Tables 5.11; 5.12; 5.13).

While most pupils were dependent on availability of or access to hardware in schools for their experiences of it, those pupils in schools where ICT was taught as a discrete subject used a wider range of hardware both in school and at home (Tables 5.16; 5.17). In addition, in the schools that taught discrete ICT, more pupils could recognise and perform a much wider range of GUI and file operations (Tables 5.14; 5.15).

In all the case study schools, collaborative learning was pupils' most popular first or second choice of learning strategy, and avoiding the problem was the least popular. The more discrete ICT was taught, the fewer pupils sought to avoid problems, otherwise no association was found between the school attended and pupils' choice of learning strategy.

Almost a third of pupils in schools where ICT is mainly taught across the curriculum believe that ICT has not affected the skills needed to do a job when they leave school, and this is almost twice as many as pupils in schools where ICT is taught as a discrete subject throughout key stages 3 and 4. However, in general, the school pupils attend does not influence whether they believe ICT affects particular social activities, such as shopping, and banking (Table 5.22).

This summary of findings is based on an analysis of the data collected from the four case study schools using the pupil questionnaires. It applies only to these schools, and may not be representative of schools in general.

Chapter 6: Discussion

Planning a research study that explores the factors associated with high levels of ICT capability among 14-16 year olds in English schools requires some pre-selection of those factors that will be investigated. At the start of the research study, the factors considered important were: different approaches to organising the ICT curriculum; teaching and learning; management; and ICT resources and staffing. In Chapter 2, these factors are described in detail and the reasons they were chosen are explored. The manifestation of these factors in each of the case study schools is described (Chapter 4), and compared, and the pupil questionnaires analysed to describe features of pupils' ICT capability (Chapter 5). This chapter integrates and summarises earlier chapters to provide concise descriptions of those schools which are successful in developing the ICT capability of pupils aged 14-16, and those which are less successful. There is discussion of some of the issues that arose during the research, and aspects requiring further study are indicated. These descriptions and the discussion are based on an analysis of the data collected in the four case study schools, and may not be representative of schools in general.

The more successful schools

Pupils who attended the case study schools where ICT was taught as a discrete subject throughout key stages 3 and 4, that is schools D and S, tended to have higher levels of ICT capability than pupils attending the other case study schools. In this sense, schools D and S were the more successful schools.

Curriculum organisation

School D organised the teaching of ICT as a discrete subject; and school S adopted the skills core approach with less time devoted to teaching discrete ICT than school D and some reliance on pupils developing their ICT capability across the curriculum. In both schools, most pupils followed well planned discrete ICT programmes of study throughout key stages 3 and 4, and these prepared them for assessment for GCSE or GNVQ ICT at the end of key stage 4. Pupils attending these schools attempted a greater variety of open-ended, advanced and challenging ICT tasks, especially in key stage 4. For example, where pupils were doing GCSE coursework which was structured according to the systems life cycle approach.

Teaching and learning

ICT teachers at these schools were more aware of the differences between teaching ICT and other subjects. They anticipated that they would be asked questions about ICT that they would not be able to answer immediately and were at ease with this. Perhaps as a result, they tended to manage the learning process rather than expecting to control all aspects and outcomes of it, and planned opportunities for pupils to autonomously explore the capabilities of the software being used. Teachers set pupils tasks where they were expected to make use of the same ICT tools used in commerce and industry, or software that simulated these, to do realistic tasks within authentic contexts. The relationship between pupils' work in the classroom and the use of ICT in the wider world was explicitly modelled so that pupils were made aware of how their work in the classroom modelled real world tasks.

Management

The successful schools had more elaborate management structures that resulted in strong leadership, good forward planning, and provided opportunities for all teachers to contribute to the development of ICT provision within the school. Both schools had an ICT management committee consisting of senior managers, the HoD ICT and an ICT manager, and an ICT user group which was attended by representatives from other subject departments. In school D, the headteacher provided strong leadership in developing ICT within the school, and in school S, the deputy headteachers had responsibility for developing ICT. The more effective HoD ICT were open, approachable, enthusiastic, encouraged and supported others, and had good ICT knowledge skills and understanding. They were able to obtain support from other teachers because they provide support for them.

Teachers of other subjects used ICT more in schools D and S, perhaps because they could not avoid this. Both schools made a considerable effort to encourage teachers to use ICT but also made arrangements to ensure that teachers could not avoid this. In school D, teachers registered pupils using a networked computer provided in every classroom, and in school S, disciplinary action would be considered if teachers failed to make use of ICT in the classroom as required by the NC.

The successful schools valued their investment in ICT more highly, and pupils received prizes for academic achievement in ICT.

Staffing and resources

Schools D and S had at least twice as many specialist ICT staff as the other case study schools, and these teachers had either substantial experience teaching ICT or had a related qualification.

Funds for purchasing hardware were obtained from very similar sources in all the schools but in schools D and S long term development planning for the acquisition of ICT resources was more effective. Perhaps as a result, the successful schools had more hardware. School D had a pupil:computer ratio of 4:1 which was much better than the national average of 7.9:1 (DfEE, 2000a). School S had a ratio of 9.2:1 which was below the national average but much better than those of the less successful schools (S, 15.4:1,C, 19:1). In addition, school D had a whole school network with a computer connected to it in every classroom.

ICT capability

Pupils who attended the more successful schools, were more confident and expert ICT users. They used ICT more often in a wider range of school subjects, and used a wider range of different types of software and hardware. A greater proportion of boys and a much greater proportion of girls used ICT at home. More pupils rated their expertise as average or above with a wider range of software, and fewer rated themselves as beginners. Pupils recognised and could perform a wider range of ICT operations. Almost twice as many pupils as in schools K and C believed ICT had affected the skills needed for employment. The more discrete ICT was taught, the fewer pupils sought to avoid problems learning ICT, otherwise no association was found between the school attended and pupils' choice of learning strategy.

Summary

When ICT was taught as a discrete subject throughout key stages 3 and 4:

- There were well planned programmes of study for discrete ICT but the use of ICT across the curriculum was not planned in detail
- Pupils were entered for external assessment at the end of key stage 4, and there were academic prizes for achievement in ICT
- ICT teachers were aware of the ways in which teaching ICT differed from other subjects, and set realistic, open-ended tasks derived from authentic contexts that required pupils to use the actual ICT tools used in commerce and industry

- There was strong leadership and broad-based management, with opportunities for all teachers to be involved in decision making
- There was a management committee including senior managers, the HoD ICT and other ICT specialists, and a user group with representatives from other subjects
- Teachers of other subjects could not avoid using ICT in the classroom and for aspects of school administration
- Schools valued their investment in ICT resources
- There were significantly more specialist ICT teachers employed by the school, and the HoD ICT was enthusiastic, approachable and supported others
- There was an adequate quantity of modern ICT resources
- Forward planning was effective, and higher levels of funding were acquired

Perhaps as a result:

- Pupils were more confident and expert ICT users, and fewer pupils sought to avoid problems learning ICT
- Pupils used ICT more often in a wider range of subjects
- A greater proportion of boys and considerably more girls used ICT at home
- All pupils had used ICT at school or at home
- Pupils recognised and could perform a wider range of technical operations
- Pupils had used a wider range of ICT hardware and software
- More pupils believed that ICT had affected the skills needed to do a job when they left school

The less successful schools

Pupils who attended the case study schools where ICT was mainly taught across the curriculum during key stage 4 tended to have lower levels of ICT capability than pupils who attended the other case study schools. In this sense, schools K and C were less successful schools.

Curriculum organisation

In school K, the kick start model was used, that is, discrete ICT was taught only in year 7 and ICT was taught across the curriculum in years 8 to 11; in school C, ICT was taught across the curriculum throughout key stages 3 and 4. Neither of these schools had a clear mapping of ICT across the curriculum, and this was not available as a written document or otherwise. School K

had an arrangement that, for example, English would be timetabled in the ICT room for one hour per week for three weeks, in a carousel with other subjects, however, school C had no specific arrangements what-so-ever. Pupils attending these schools had fewer opportunities to use ICT resources, and when they used them this was to achieve limited objectives in the other subject where ICT was being used to support teaching and learning. Pupils were not challenged to achieve the higher levels of the NC by designing and implementing ICT systems for others to use, and pupils were not entered for external assessment at the end of key stage 4.

Teaching and learning

Teachers at schools K and C were largely unaware of the differences between teaching ICT and other subjects, and stated that they had not considered these before being interviewed (IKST; ICDB). Even so, their initial reactions were in agreement with the opinions given by teachers in the more successful schools. Teachers found the focus of pupils' attention harder to control when ICT was used in the classroom, and they tended to provide pupils with worksheets that initially helped pupils to make progress step-by-step followed by more open ended tasks. However, pupils used only basic ICT skills as their use of ICT was to support teaching and learning in another subject. There was little emphasis on developing pupils ICT skills, and sometimes there was no requirement to use ICT.

Management

The least successful schools lacked management structures that would encourage leadership based on mutual cooperation and understanding. In both schools K and C, there was no formal management committee and no user group to encourage staff involvement and collaboration. Perhaps as a result, planning was less effective, and there were long standing disagreements and misunderstandings between middle managers that had not been fully recognised and that remained unresolved. The ICT coordinator at school C lacked personal ICT knowledge, skills and understanding but was enthusiastic and keen to develop ICT in the school. In contrast, the ICT coordinator at school K was highly skilled but had taken a defensive position that discouraged participation by other teachers, and these circumstances had led to a lack of support for other teachers to develop their ICT skills.

Teachers of other subjects used ICT less in schools C and K perhaps because they had fewer opportunities to use ICT in the classroom even though these schools purported to deliver ICT

mainly across the curriculum. Most teachers were able to avoid using ICT if they wished. In school K, it was thought that it was not yet appropriate to insist all teachers used ICT in the classroom, and school C was only just beginning to consider whether this should be compulsory (IKST; ICDB). Both schools deliberately prevented most teachers using ICT for school administration.

These schools were equivocal about the value their investment in ICT, and pupils did not receive prizes for academic achievement in ICT.

Staffing and resources

There were fewer ICT specialist teachers: school K had one and a half full time equivalent specialist ICT teachers and school C had none. The ICT specialist teachers at school K were trained to teach ICT but those at school C were not. The expectation that teachers would train themselves was perhaps most problematic in school C where the general level of ICT knowledge, skills and understanding was poor.

The least successful schools had much less hardware and software, and even though funds for purchasing hardware were obtained from very similar sources in all the schools, schools K and C were much less effective in acquiring funding, perhaps because forward planning was much less effective. School K had a pupil:computer ratio of 15.4:1, and school C had a ratio of 19:1, both of which are much worse than the national average of 7.9:1 (DfEE, 2000a).

ICT capability

In the least successful schools a minority of pupils had not used ICT at school or at home on any occasion (school K, 4.3%;C, 10.4%), and the majority had used ICT to support teaching and learning in only a very few school subjects. Pupils in these schools had a relatively narrow experience of using ICT, and they used ICT the least at home with significantly fewer girls making use of it at home. Fewer pupils rated their expertise as average or above with a narrower range of software, and more rated themselves as beginners. In general, pupils recognised and could perform a narrower range of ICT operations. Almost a third of pupils in schools C and K believed that ICT had not affected the skills needed for employment, and this was twice as many as those in schools D and S. The less discrete ICT was taught, the more pupils sought to

avoid problems learning ICT, otherwise no association was found between the school attended and pupils' choice of learning strategy.

Summary

When ICT was taught mainly across the curriculum in key stages 3 and 4:

- There was no clear, written mapping of the ICT curriculum
- Pupils were not entered for external assessment at the end of key stage 4
- ICT teachers were not aware of the ways in which teaching ICT differs from other subjects, and tended to provide worksheets which required pupils to use only basic ICT skills if any
- Management structures that would encourage leadership based on mutual cooperation and understanding were lacking
- Teachers of other subjects could avoid using ICT
- Teachers were not encouraged to use ICT for school administration
- Schools did not especially value their investment in ICT resources
- There were very few specialist ICT teachers, and the ICT coordinator was not highly skilled (school C), or open and enthusiastic (school K)
- The quantity of modern ICT resources was inadequate
- Forward planning was much less effective, and the schools had much less success in acquiring bid based funding

Perhaps as a result:

- Fewer pupils rated themselves as expert ICT users, and more pupils sought to avoid problems learning ICT
- Pupils used ICT in only a very few school subjects
- Fewer boys and considerably fewer girls used ICT at home
- A minority of pupils did not use ICT at home or at school
- Pupils made use of a narrower range of ICT hardware and software
- Fewer pupils rated their expertise as average or above with a narrower range of software, and more rated themselves as beginners
- Pupils recognised and could perform a narrower range of technical operations
- Fewer pupils believed that ICT had affected the skills needed to do a job when they left school

Similarities between the more and less successful schools

There was insufficient evidence to identify significant differences in approaches to teaching and learning between the more and less successful schools, but what evidence was available indicated more similarities than differences. All the teachers observed attempted to find ways to direct or control pupils' learning, with a tendency to provide step-by-step worksheets that became progressively more open ended. The most popular first or second choice of learning strategy chosen by pupils was collaborative learning in all the schools, and the least popular alternative was avoidance. Over 30% of pupils in each school rated themselves as expert or better with all the software used, and they used software for school work to a much greater extent than games software. Most pupils were dependent on the availability of hardware and software in school for their experience of it.

Arrangements for the purchase of hardware and software were also very similar between schools with a heavy reliance on bid based funding. The distribution pattern of computers throughout all the schools was similar, with whole school networks connecting computers in ICT rooms, small clusters in departmental and other areas, and some single computers in classrooms and offices. Visitors to the schools were almost always taken to see the ICT resources provided for teaching and learning.

Arrangements for staff training lacked sufficient consistency between schools to allow meaningful comparison. These were ad hoc and did not systematically address the needs of schools or teachers.

Issues

Teaching ICT across the curriculum and the development of pupils' ICT capability

If ICT is used across the curriculum, it is a consequence that ICT NC will be taught in other subjects. However, if ICT coordinators insist that teachers of other subjects deliver the ICT NC as well as their own subject, this may lead to a lack of progress in making use of ICT in these other subjects. For example, at school K, the ICT coordinator believed that when a subject department was prepared to '...deliver what ICT wants, not just what the subject wants, then you can get a dialogue...' (IKST). Unfortunately, the ICT coordinator's insistence, that a dialogue

could only be established when teachers of other subjects were prepared to help deliver the ICT curriculum, may have impeded progress. Mathematics teachers at the school believed that their first responsibility was the delivery of mathematics, and that because of limited access to ICT resources they were unlikely to progress beyond this (IKSD). Similarly, at school C, the HoD mathematics complained that it was necessary to teach pupils basic ICT skills in mathematics lessons because they did not already have appropriate ICT skills (ICSW). The HoD mathematics was very supportive of the school's decision to deliver ICT across the curriculum but believed mathematics teachers should be teaching mathematics not ICT. He did not identify the contradiction in the school's policy of teaching ICT across the curriculum, which he agreed with, and his expectation that mathematics teachers should not need to teach pupils basic ICT skills (ICSW).

The majority of teachers resent being required to teach ICT skills within their subjects (Williams and Moss, 1993), and when ICT is taught as a discrete subject, teachers of other subjects do not expect to teach ICT. In schools D and S, pupils are expect to acquire sufficient skills in discrete ICT so that they can use it in other subjects. For example, at school D, the headteacher believes that when ICT teachers are teaching discrete ICT they will '...link into other curriculum areas...' (IDHL), and that teachers of other subjects will not need to teach pupils ICT skills in their lessons as pupils will have been taught these in discrete ICT lessons. For example, the headteacher observed an English lesson where the teacher did not need to teach pupils how to use the Internet as they had been taught this in discrete ICT (IDHL). However, pupils will not have perfect recall of what they have learnt in ICT lessons, so that teachers of other subjects will not be able to avoid teaching ICT to some pupils as they would not otherwise make progress.

There can be conflict between teaching strategies that are effective for the other subject and those for ICT. For example, in a DT lesson pupils were observed using Legodacta models to learn about computer control and robotics. From the perspective of learning DT it was seen as desirable for pupils to build the robotic devices using the legodacta. Unfortunately, pupils could not build these quickly and ensure that they did not fall apart. However, the ICT aspect of this lesson, i.e. programming robotic devices, could not begin until working robotic devices were available. Consequently, very little ICT was used and pupils made very little progress in relation to the ICT aspects of the lesson. To improve the ICT content of this activity the models could be permanently assembled, however, pupils would not then have the opportunity to assemble them. Time constraints did not allow for both assembly and programming, so that either a satisfactory DT or ICT activity could take place but not both (LKSR).

In the lessons observed, when ICT was used in other subjects, its use did not go beyond being useful in teaching and learning the other subject. In such circumstances, pupils may not develop their ICT capability or may use ICT ineffectively. Teachers of other subjects may have only a limited understanding of what it is necessary to know about ICT and how to teach it, and pupils' progress with ICT can be affected if they do not make progress with the other subject. For example, in school K, year 10 pupils had a booklet setting a series of tasks that had to be completed over several weeks, working towards the completion of GCSE business studies coursework (LKST2). This booklet had no support to help pupils develop their ICT capability or suggestions to encourage their use of ICT. As a result, pupils underachieved in ICT, making only basic use of wordprocessing, the Web and graphics. The teacher had prepared adequate resources for learning business studies but had entirely omitted to indicate opportunities for pupils to develop their ICT knowledge, skills and understanding. In school C, ICT is taught by non-specialist teachers in subjects other than ICT, and as a result pupils more often consolidate the ICT skills they already have rather than extending them. As there is no provision for all pupils to learn ICT skills through teaching by specialist ICT teachers, pupils' progress can be limited (Ofsted, 1998, p21).

Teachers' readiness to make use of ICT

There are different perceptions of teachers' 'readiness' to use ICT in the classroom, and these can impede the adoption of ICT throughout the curriculum. If ICT is taught across the curriculum, it is a consequence that other subjects must deliver the ICT NC. If this is not known, teachers' self assessment of their readiness to make use of ICT may not be in agreement with the assessment of their readiness by ICT teachers. For example, in school K, the HoD mathematics was enthusiastic; had trained teachers in his department; and believed that they were ready to use ICT to support teaching and learning in mathematics. The HoD mathematics perceived his 'readiness' in terms of preparedness to use ICT to support the teaching and learning of mathematics, not to teach ICT. This viewpoint was consistent with that of Roper (2001, p17), that 'ICT should serve the mathematics and its teaching, not the reverse.', and Ofsted (2001a) that 'Teachers are advised that ICT should only be used if it enhances and supports good mathematics teaching.'. In contrast, the HoD ICT did not believe that the mathematics department was ready to participate in teaching ICT across the curriculum because the HoD mathematics did not wish to be involved in teaching the ICT NC. 'Readiness' to teach ICT was the most important factor from the viewpoint of the ICT coordinator who was attempting to deliver the ICT NC across the curriculum.

The appropriate use of ICT

Pupils could not use ICT resources in other subjects as the need arose because ICT resources were not always available. There was insufficient hardware in schools, hardware was not distributed throughout the school, and ICT rooms were usually timetabled. This may result in pupils using ICT resources because they are available at the time rather than when it is most appropriate. For example, at school D, there were no opportunities to use ICT in mathematics classrooms (IDPR). Mathematics teachers taught a topic then took the class to an ICT room when it was available. This could lead to lessons which were mathematically incoherent as pupils covered a variety of topics because they briefly had access to an ICT room (LDMS).

Management

In all the schools, the HoD ICT had responsibility for coordinating the use of ICT across the curriculum and the HoD(s) for other subject departments had responsibility for the use of ICT in their subjects. If the other subjects do not fully cooperate with the HoD ICT, then it may be difficult for the HoD ICT to coordinate cross curricular ICT. For example, in school D, the curriculum for discrete ICT was the responsibility of the HoD ICT but the use of ICT in other subjects was the responsibility of the HoD for the subject (IDHL). The HoD ICT had planned the ICT curriculum in detail for discrete ICT but she had found it more difficult to do this across the curriculum as she could only influence developments in other subject departments. The HoD ICT knew that in key stage 3, ICT was used in English, mathematics, science, DT and MFL, but was not fully aware of how it was used or the extent of its use (IDAI). Unfortunately, little progress had been made developing this over several years at a time when the discrete ICT curriculum had seen continuous improvement. The school made more extensive use of ICT across the curriculum 10 years ago but the HoD ICT found it too difficult to monitor what was being done (Crawford, 1994; IDAI; Ofsted, 1996, p98).

Schools D and S had active user groups which facilitated communication between users, experts and managers. Each subject department had a representative on the group, and these were generally the teachers with the most enthusiasm and ICT expertise. A dilemma is that as these teachers develop their knowledge, skills and understanding of ICT, they may begin to teach ICT more than their original subjects. For example, in school C, a mathematics teacher who had good ICT skills taught the ICT component for all the mathematics classes. As a result, this teacher had reduced contact with her own classes and the other mathematics teachers did not

improve their ICT skills. In some instances, teachers who taught much of the ICT for their department had begun to teach ICT full time. This weakened the ICT support immediately accessible to subject departments by weakening the links with those teachers that had the most highly developed ICT capability. Teachers of other subjects who became ICT teachers no longer provided the previous level of support for their original subject department. For example, in school D, several of the specialist ICT teachers had previously been mathematics teachers. By their own preference, these teachers now taught only ICT and they were happy with this arrangement. However, the HoD mathematics was unhappy that his department could no longer rely on these teachers to develop and support the use of ICT in mathematics (IDPR).

Staffing and resources

In all the case study schools, specialist ICT teachers or other ICT specialists employed by the school had trained teachers of other subjects to use ICT. This training strategy is less expensive than using external training providers, and the training can be organised in ways that more closely match teachers' needs and the time they have available. However, if training is to help teachers use ICT in the classroom, trainers will need both ICT skills and an understanding of how ICT can be used to support teaching and learning in their subject. The later is often omitted. For example, School D was delivering NOF training to help teachers' learn how to use ICT in the classroom, and had enrolled a high proportion of the teaching staff. The same teachers of discrete ICT, who had not previously been successful in encouraging and training teachers of other subjects to use ICT in the classroom were delivering the training. These specialist ICT teachers did not have expertise in other subjects, and did not intend to go beyond teaching their colleagues ICT skills. It may not be an effective strategy for teachers of other subjects to be trained to make use of ICT in the classroom by specialist ICT teachers who do not have expertise in the other subject.

ICT resource provision is likely to be driven by the needs of ICT specialists. However, it is unlikely that the provision of ICT resources will meet the needs of other subject departments unless they determine what is provided. For example, in school D, the HoD mathematics is a member of the ICT user group but does not feel that the way ICT is organised in the school helps the department in developing its use of ICT. He feels that the needs of the ICT department have driven the development of ICT resources in the school, and reported that other departments expressed similar views at recent ICT user group meetings (IDPR). Perhaps as a result, the ICT user group is now considering how internal service level agreements could be implemented.

Even so, these will not necessarily address the different needs of subject departments unless they have more control over the content.

On the whole, the case study schools funded the acquisition of ICT resources through bid based funding. The extent to which they were successful at this largely determined the quantity and quality of hardware available. Schools allocated annually only very small amounts from capitation for the provision of ICT resources, and there was a general lack of financial forward planning for the regular replacement of equipment. However, ICT resources no longer provide pupils with an adequate experience of modern software and hardware when they are more than 3 to 5 years old. When the quantity of ICT resources available is increased it is important to take into account the need for regular renewal and replacement, otherwise improvements will not be sustained over future years. Ad hoc, unplanned approaches to the acquisition, renewal and replacement of ICT resources may not lead to satisfactory provision of ICT resources, and is likely to lead to funding shortfalls in the future when hardware and software need replacing. Where ICT resources are sufficiently extensive to provide a rich experience of ICT in the curriculum, provision for renewal and replacement in the school's annual budget is essential. The more ICT resources a school has, the more important it is that there is adequate provision for annual renewal and replacement. Unfortunately, the case study schools relied too much on bid based funding, and financial provision in annual budgets and forward planning were inadequate.

Further research

Contextualisation

An argument in favour of delivering ICT across the curriculum is that pupils' experiences of ICT are enhanced by the rich contexts in which ICT is used in other subjects. Conversely, pupils' experiences of ICT in discrete ICT lessons are thought to be decontextualised and sterile (DES, 1990b; Hammond, 2000; NCET, 1996, p7). However, if the other subject has problems with contextualisation, then these may also affect the contextualisation of ICT. For example, ICT was used effectively in a science lesson to produce cooling curves quickly and accurately, and analyse them, thus making a considerable contribution to pupils' progress in learning science (LSPS). However, the real world application of this was not explained so that the ICT was contextualised only in the other subject but not in the real world.

This partial decontextualisation has similar problems to 'bolt-on' ICT, though these are not as acute. 'Bolt-on' ICT describes situations where teachers get pupils to use ICT in another subject but lack clear objectives for the lesson, and consequently, the objective of the lesson becomes to use ICT rather than for the ICT to make a well targeted contribution to achieving clear learning objectives in the other subject. For example, in a mathematics lesson the teacher encouraged pupils to use a diverse range of mathematics resources available on the school's networks and on the Web. Pupils spent the entire lesson using a variety of different pieces of software that they had chosen freely and that developed a wide variety of mathematical content and skill. Each pupil used several pieces of software and these were likely to be different from those used by other pupils. Pupils enjoyed these activities but many of them were frivolous and the lesson had no mathematical coherence. The teacher did not use the ICT resources to direct and extend pupils' learning of mathematics during the lesson (LDMS).

The real world decontextualisation of ICT may not be equally problematic in all subjects. Decontextualisation may be much more likely in, for example, mathematics where the skills to be learnt can be separated easily from their context. For example, it is possible to learn to generate regular polygons using Logo without considering the real world application of this. It is likely that the ability to separate the application of skills from their real world contexts is not the same in all subjects.

In discrete ICT lessons, teachers intentionally modelled real world activities, and explained to pupils the connections between these real world activities and classroom activities (LDAI, LDRB, LSBG). On occasions, these contexts were developed in detail over extended periods of time, often as GCSE coursework tasks, and provided a useful framework for understanding the perspectives of a variety of audiences.

The importance of contextualisation and its role in developing pupils' ICT capability has not been explored in depth in this research. Further research is required to fully explore the validity of the assumption that cross curricular ICT takes place in richer contexts or whether, as this research suggests, that these richer contexts are more likely to occur in discrete ICT lessons.

Approaches to teaching and learning

In all the ICT lessons observed, teachers spent more time facilitating pupils' progress than in didactic whole class teaching. Whether this was significantly more or less than in other subjects

was not investigated (LSBG; LSPS; LSSB). Most of the teachers interviewed believed that teaching ICT was different from teaching other subjects, though some believed there was little, if any difference. Whether teachers believed there was a difference appeared to depend on the subject background of the teacher. For example, teachers who had previously taught mathematics believed that teaching ICT was different to teaching mathematics. In school C, the HoD mathematics believed that the content of mathematics lessons was more predictable and controllable when ICT was not used. He explained that because mathematics teachers typically decided what exercises pupils would be given and the topics these covered, they were able to anticipate pupils' difficulties and plan for these in advance. In addition, because all pupils worked on the same learning materials and made similar mistakes, there were opportunities for whole class reviews of pupils' progress towards the middle and the end of lessons. However, when ICT was used a wider range of difficulties arose which made this tightly structured approach less effective (ICSW). In contrast, the science teacher at school S believed that there was little difference between teaching ICT and teaching science (ISPS). She was aware that colleagues found teaching ICT less predictable but explained that this was also a feature of the way she taught science. Such differences in teachers' experiences of teaching and learning would benefit from further investigation.

Teacher intervention may be critical in developing pupils ICT capability. For example, in one of the lessons observed, the teacher found it difficult to maintain the pace and focus of the lesson. Pupils worked through a series of tasks described in a booklet in order to complete their GCSE ICT coursework. This activity was spread over several lessons and weeks. At the start of the lesson, the teacher asked pupils to continue from where they left off. The pace and focus of the lesson were variable as pupils worked through the booklet at their own pace. Some pupils concentrated and remained on task but others did very little (LDAI; LDRB). Significant teacher intervention may be needed in each lesson to ensure that all pupils make adequate progress lesson by lesson. This may be especially so when teaching mixed ability classes. There may be a danger that lower ability pupils will become stuck at the beginning of extended tasks and make very little progress. As ICT is often taught to mixed ability groups, the impact of teacher intervention on pupils' progress may be critical in developing pupils' ICT capability. However, teacher intervention was not a focus of the research and further study is needed.

The case study schools which prepared pupils for external examination for GCSE ICT were the schools where pupils' ICT capability was highest. Was it simply that the discrete ICT curriculum was well planned and this provided more opportunities for pupils to develop their ICT capability, or was it some feature of GCSE ICT, such as, the extended coursework tasks, that encouraged pupils to develop high levels of ICT capability?

Gender

Does teaching discrete ICT encourage more girls to use ICT? More pupils attending the case study schools that taught discrete ICT throughout key stage 4 used ICT at home. For these schools, the number of both boys and girls using ICT at home was greater but it was much greater for the girls. However, this research is not sufficiently extensive to draw firm conclusions, and a more focused research study might be of interest.

Causality

It is notable that in the case study schools that taught ICT as a discrete subject: there were more specialist ICT teachers employed; management organisation was more extensive and facilitated communication and planning; there were more ICT resources available to pupils; and pupils had experience of a wider range of ICT hardware and software. Although these features of the schools are associated with pupils developing higher levels of ICT capability, no attempt has been made to determine causality.

Did the teaching of ICT as a discrete subject lead to a demand for specialist ICT teachers to be employed, or did the employment of specialist ICT teachers lead to an perception that pupils' needs would be best met through teaching ICT as a discrete subject? Did the employment of specialist ICT teachers lead to more elaborate and inclusive management organisation that would support the development of the ICT curriculum and resource provision; or did the need to manage the ICT curriculum and resources lead to the development of such management structures and the employment of specialist ICT teachers?

It may be that causality is not unidirectional but bi-directional and cyclical. If so, what is the catalyst that starts the cycle of improvement? This is an important issue for those schools, including case study schools K and C, where the majority of pupils leave at the end of key stage 4 with low levels of ICT capability and no ICT qualifications.

Chapter 7: Conclusion

The purpose of this research was to determine which factors are associated with high levels of ICT capability among 14-16 year olds in English schools. The factors, that is, curriculum organisation, teaching and learning, management, staffing and resources were investigated in each of four secondary schools. Pupils' ICT capability was self reported using a questionnaire, and may not be entirely reliable. The research evidence was collected only from the four schools involved in the research, and may not be representative of schools in general.

The schools where pupils had the highest levels of ICT capability had these features in common:

- ICT was taught as a discrete subject throughout key stages 3 and 4, and pupils were entered for GCSE ICT at the end of key stage 4
- There were well planned programmes of study for discrete ICT but the use of ICT across the curriculum was not planned in detail
- ICT teachers were more aware of the differences between teaching ICT and other subjects, and set realistic, open-ended tasks derived from authentic contexts that required pupils to use real ICT tools or realistic simulation of them
- There was strong leadership by senior management; the HoD ICT was enthusiastic and approachable; and there were opportunities for all teachers to be involved in decision making
- There was a management committee that included senior managers, the HoD ICT and ICT teachers; and a user group with representatives from other subject departments
- Teachers of other subjects could not avoid using ICT in the classroom and for aspects of school administration
- Schools valued their investment in ICT resources
- There were significantly more specialist ICT teachers employed by the school
- There was an adequate quantity of modern ICT resources
- Higher levels of bid based funding were acquired

Perhaps as a result:

- Pupils were more confident and expert ICT users, and fewer pupils sought to avoid problems learning ICT
- Pupils used ICT more often in a wider range of subjects
- A greater proportion of boys and considerably more girls used ICT at home
- All pupils had used ICT at school or at home

- Pupils recognised and could perform a wider range of technical operations
- Pupils had used a wider range of ICT hardware and software
- More pupils believed that ICT had affected the skills needed to do a job when they left school

All the case study schools had many common features in the ways they approached teaching and learning. Teachers attempted to direct and control pupils' learning but found it harder to do this in ICT lessons. Worksheets had more step-by-step, operational instructions at the start than towards the end where more demanding, open-ended tasks were set, however, there was usually no explanation of why pupils were using ICT. Many pupils apparently preferred to learn how to use software by trial and error, rather than following the teacher's instructions, and pupils' first or second choice of learning strategy was collaborative learning. Where ICT was taught through another subject, there was usually a good balance between the ICT subject content and the other subject, however, where there was a lack of balance it was the ICT that was neglected.

Several issues arose during the research. There was a lack of awareness among teachers that if ICT was used across the curriculum, it was a consequence that the ICT NC would be taught in other subjects. Teachers assessed their readiness to make use of ICT in relation to their ability to make use of ICT to support teaching and learning in their subject. However, if ICT was delivered across the curriculum, HoD ICT expected them to be ready to teach the ICT NC. HoD ICT found it easier to plan the ICT curriculum in detail for discrete ICT than coordinate the use of ICT across the curriculum as other subject departments had responsibility for the use of ICT in their subjects.

Specialist ICT teachers trained teachers of other subjects to use ICT. However, they did not always have expertise in using ICT to support teaching and learning in the other subjects, and did not go beyond teaching colleagues ICT skills. However, if training is to help teachers use ICT in the classroom, they also need an understanding of how ICT can be used to support teaching and learning in their subjects. Despite the convenience and cost effectiveness, it may not be an effective strategy for teachers of other subjects to be trained to make use of ICT in the classroom by specialist ICT teachers who are not familiar with their subject.

On the whole, the case study schools funded the acquisition of ICT resources through bid based funding. Financial provision in annual budgets was inadequate, and there was a lack of forward planning for the regular replacement of equipment. When ICT resources are purchased it is important to plan their replacement within three to five years. Ad hoc, unplanned approaches to

the replacement of ICT resources may lead to unsatisfactory provision and funding shortfalls in the future when hardware and software need replacing.

Pupils' experiences of ICT are thought to be enhanced by the rich contexts in which ICT is used in other subjects. Conversely, pupils' experiences of ICT in discrete ICT lessons is thought to be decontextualised and sterile. However, if the other subject has problems with contextualisation, then these may also affect the contextualisation of ICT. Even where ICT was well used to support teaching and learning in another subject, its use did not go beyond this because teachers did not relate their subjects to real world activities. In contrast, in discrete ICT lessons, teachers intentionally and overtly modelled real world activities, and explained to pupils the connections between these real world activities and classroom activities.

Teachers believed that ICT lessons were unpredictable. However, whether they believed that teaching ICT was different from teaching other subjects appeared to depend on the subject background of the teacher. Whether and how teaching ICT is different from teaching other subjects could usefully be investigated.

ICT teachers tended to encourage autonomous learning but teacher intervention may be critical in developing pupils ICT capability. Significant teacher intervention may be needed in each lesson to ensure that all pupils make adequate progress lesson by lesson. The appropriate balance between teacher intervention and autonomous learning requires further study.

The case study schools which prepared pupils for external examination for GCSE ICT were the schools where pupils' ICT capability was highest. Is it simply that the discrete ICT curriculum is more organised in these schools and that this provides more opportunities for pupils to develop their ICT capability, or is it some feature of GCSE ICT, such as, the extended coursework tasks, that encourages high ICT capability?

Does teaching discrete ICT encourage more girls to use ICT? More pupils attending the case study schools that taught discrete ICT throughout key stage 4 used ICT at home. For these schools, the number of both boys and girls using ICT at home was greater but it was much greater for the girls. However, the research is not sufficiently extensive to draw firm conclusions, and a more focused research study might be of interest.

Features of curriculum organisation, approaches to teaching and learning, management, staffing and resources have been associated with high levels of ICT capability. These features may be interdependent and causality has not been established. Causality may be bi-directional and

cyclical. If so, what is the catalyst that starts the cycle of improvement? This is an important issue for those schools, including schools K and C, where the majority of pupils leave with low levels of ICT capability and no ICT qualifications.

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Abbreviations

CLAIT	Computer Literacy and Information Technology
DES	Department of Education and Science
DfE	Department for Education
DfEE	Department for Education and Employment
DfES	Department for Education and Skills
DT	Design Technology
DTP	Desk Top Publishing
FE	Further Education
GCSE	General Certificate of Secondary Education
GNVQ	General National Vocational Qualifications
ICT	Information and Communication Technology
IT	Information Technology
ITT	Initial Teacher Training
LEA	Local Education Authority
LRC	Learning Resource Centre (a development of school libraries)
MFL	Modern Foreign Languages
NC	National Curriculum
NCET	National Council for Educational Technology
NGfL	National Grid for Learning
NOF	New Opportunities Fund
SEN	Special Educational Need
SIMS	Schools Information and Management System
SMART	Specific Measurable Achievable Relevant Time-related
SMT	Senior Management Team
TSI	Technology Schools Initiative
TTA	Teacher Training Agency

Appendix 1 - Mapping of the sub-questions to the research instruments

Sub-questions	Map
Q = Questionnaire; I = Interview; D = Documentation; V = Observation	
Curriculum organisation	
What curriculum model is used in KS3 and KS4?	QI
– What timetabled arrangements are made for teaching ICT as a discrete subject in years 7 to 11?	QID
– What arrangements are made for teaching cross curricular ICT in years 7 to 11?	QID
– Does the teaching, use and assessment of ICT take place in timetabled ICT lessons or in cross curricular lessons?	D
– What do teachers believe is the ideal curriculum model?	I
Approaches to teaching and learning	
What approach to teaching and learning is used?	IV
– Is teaching and learning pupil centred or teacher centred?	IV
– Are teaching styles didactic or facilitatory?	IV
– What approaches to classroom organisation do ICT teachers use, for example, whole class teaching or individualised?	IV
– Do teachers plan classroom activities using tools, tasks and contexts or SMART learning objectives?	IV
– Do ICT teachers expect learners to follow step-by-step instructions; or complete of holistic tasks?	IV
– Do ICT teachers set closed or open tasks?	IV
Management of ICT	
Is management model hierarchical, flat-topped or consultative?	QID
For the person in charge of ICT throughout the school:	
– What status have they?	QID
– What level of ICT skills do they have?	ID
– What is their specialist subject?	I
– Are they ICT enthusiasts?	I
How do ICT coordinators enhance their formal power? by:	I
– personal charisma	I
– technical expertise	I
– providing information	I
– supporting colleagues' use of ICT	I
– building coalitions with colleagues	I
How is the use of ICT by teachers who are not ICT specialists encouraged?	I
– By respecting the different ways teachers value ICT, and taking into account that change is likely to be a slow process.	I
– By showing them how ICT can be used for:	
– professional activities	I
– supporting teaching and learning	I
– solving a wide range of existing/potential problems	I
– By providing easy access to up-to-date hardware and software	I

How does the school show it values its investment in ICT?	**ID**
Are visitors shown the ICT facilities?	I
Is there sufficient support for ICT?	ID
– Is the ICT coordinator trained to manage ICT resources?	I
– Does the ICT coordinator get time to manage ICT resources?	ID
– Does the ICT coordinator get time to support others' use of ICT?	ID
Are computers essential for school administration?	QI
Are there academic or achievement prizes for ICT for pupils'?	QID
Does the Headteacher have and use a computer in his/her office?	QI
Staffing – teaching and technician support	
Are there sufficient ICT specialist teachers with adequate training and qualifications?	ID
– How many teachers are ICT specialists?	QID
– What is the whole school ICT specialist pupil:teacher ratio?	ID
– What are ICT teachers qualifications and training?	I
– How were ICT teachers trained? Did they train themselves?	I
Are there sufficient technicians with adequate training?	I
– How many ICT technicians are there?	QID
– What is the whole school technician:pupil ratio?	QID
– What is the computer:technician ratio?	QID
– Did technicians train themselves or attend a training course?	I
– What are technicians ICT qualifications and training?	ID
ICT resources	
What type, quantity and age are ICT resources?	QIDV
Are ICT resources up-to-date, i.e. less than three years old?	QIDV
What is the pupil:computer ratio?	QIDV
Is the organisation of ICT resources centralised or distributed?	QIDV
Is hardware and software standardised or is there a variety?	IDV
Are ICT resources funded by annual budget or one-off bids?	ID
Output measures	
ICT policy: further information regarding above sub-questions?	D
Ofsted report:	D
– What profile of ICT NC levels do pupils achieve when teachers assess their ICT capability at the end of KS3?	D
– What external assessment in ICT are pupils entered for, and what outcomes do they achieve?	D
– From the last Ofsted inspection report: what? Are any of the main findings and key issues ICT related?	D

Appendix 2 - Staff questionnaire

Staff Questionnaire:
Different ways of delivering ICT in secondary schools at key stages 3 and 4

1. You are: (please tick one or more boxes)

Headteacher, Deputy Headteacher or Senior teacher
ICT coordinator on salary scale cps +1 +2 +3 +4 +5 (please circle)
Other (please state)

2. In which years is ICT timetabled as a discrete subject, and how is this organised?
(for each year, please tick one statement in each table)

Year 7	Year 8	Year 9	Year 10	Year 11
☐ 2 hrs. per week	☐ 2 hrs. per week	☐ 2 hrs. per week	☐ 2 hrs. per week	☐ 2 hrs. per week
☐ 1 hr. per week	☐ 1 hr. per week	☐ 1 hr. per week	☐ 1 hr. per week	☐ 1 hr. per week
☐ 30 mins. per week	☐ 30 mins. per week	☐ 30 mins. per week	☐ 30 mins. per week	☐ 30 mins. per week
☐ Don't know	☐ Don't know	☐ Don't know	☐ Don't know	☐ Don't know

Year 7	Year 8	Year 9	Year 10	Year 11
☐ For 3 terms	☐ For 3 terms	☐ For 3 terms	☐ For 3 terms	☐ For 3 terms
☐ For 2 terms	☐ For 2 terms	☐ For 2 terms	☐ For 2 terms	☐ For 2 terms
☐ For 1 term	☐ For 1 term	☐ For 1 term	☐ For 1 term	☐ For 1 term
☐ For ½ term or less	☐ For ½ term or less	☐ For ½ term or less	☐ For ½ term or less	☐ For ½ term or less
☐ Don't know	☐ Don't know	☐ Don't know	☐ Don't know	☐ Don't know

3. In which years is ICT taught across the curriculum? In which subjects?
(please tick all subjects where ICT is taught)

Year 7	Year 8	Year 9	Year 10	Year 11
☐ En	☐ En	☐ En	☐ En	☐ En
☐ Ma	☐ Ma	☐ Ma	☐ Ma	☐ Ma
☐ Sc	☐ Sc	☐ Sc	☐ Sc	☐ Sc
☐ DT	☐ DT	☐ DT	☐ DT	☐ DT
☐ ML	☐ ML	☐ ML	☐ ML	☐ ML
☐ PE	☐ PE	☐ PE	☐ PE	☐ PE
☐ RE	☐ RE	☐ RE	☐ RE	☐ RE
☐ Mu	☐ Mu	☐ Mu	☐ Mu	☐ Mu
☐ BS	☐ BS	☐ BS	☐ BS	☐ BS
☐ Ge	☐ Ge	☐ Ge	☐ Ge	☐ Ge
☐ Hi	☐ Hi	☐ Hi	☐ Hi	☐ Hi
☐ Don't know	☐ Don't know	☐ Don't know	☐ Don't know	☐ Don't know

4. Please estimate if exact numbers are not known

	Exact	Estimate
How many computers does the school have?		
How many of these are less than 3 years old?		
How many classrooms does the school have?		
How many classrooms are specialist ICT rooms?		
How many other classrooms have 1 or more computers?		
How many specialist ICT teachers are there?		
How many other teachers teach ICT?		
How many ICT technicians are there?		

5. Please describe how arrangements for managing ICT fit into the management structure in your school.

6. If you are willing to participate in more extensive research related to delivering ICT in secondary schools in key stages 3 and 4, please give your name and contact details below.

NAME:

Address:

TELEPHONE NUMBER:

Email address:

Please return to:

Roger Crawford, School of Education and Professional Development
University of Huddersfield, Huddersfield HD1 3DH
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Appendix 3 - Interview agenda

Introduction:
My research is concerned with finding the best ways to deliver ICT in secondary schools in key stages 3 and 4.

1. Curriculum models:	✔
Is ICT taught as a discrete subject, across the curriculum or as a hybrid of these?	
– What are the timetabled arrangements for teaching ICT in year 7?	
– What are the timetabled arrangements for teaching ICT in year 8?	
– What are the timetabled arrangements for teaching ICT in year 9?	
– What are the timetabled arrangements for teaching ICT in year 10?	
– What are the timetabled arrangements for teaching ICT in year 11?	
2. Approaches to teaching - Behaviourist or Constructivist:	
Can you describe a typical ICT lesson?	
Do you do whole class teaching, or does the class work in small groups or individually at tasks you have set?	
Do you expect pupils to work through worksheets step-by-step or do you set general tasks and expect pupils to work out how to do them?	
Do you tell pupils exactly what to do or do you expect them to decide for themselves?	
When you set pupils a task, do you expect them to find the right answer or would you accept different answers?	
In a lesson, would you expect pupils to ask you a question that you can't answer?	
If a pupils asked you a question you couldn't answer immediately, what would you do?	
– work out the answer	
– work it out yourself and tell the pupil later	
Do you set ICT homework? How often is this?	
Do you teach another subject? How is teaching ICT different to teaching this other subject?	
3. Managing ICT: how is ICT managed across the whole school?	
How do arrangements for managing ICT fit into the management structure in your school?	
For the person who has overall responsibility for ICT in the school:	
– what status have they?	
– what level of ICT skills do they have?	
– what subject(s) do they teach?	
– are they ICT enthusiasts?	
How do ICT coordinators get other staff to support them? by:	
– personal charisma?	
– technical expertise?	
– providing information?	
– supporting colleagues' use of ICT?	
– building coalitions with colleagues?	
How is the use of ICT by teachers who are not ICT specialists encouraged?	
– by respecting their views about the value of ICT?	
– by taking into account that change is likely to be a slow process?	
– by showing them how ICT can be used for professional activities?	
– by showing them how ICT can be used to support teaching and learning?	
– by showing them how ICT provides solutions to existing and potential problems?	
– by providing easy access to up-to-date hardware and software?	

In what ways does the school demonstrate that it values its investment in ICT?	
– Are visitors shown the ICT facilities?	
– Is there sufficient support for staff and pupils to make use of ICT in the curriculum?	
– Does the ICT coordinator get training to manage the ICT resources?	
– Does the ICT coordinator get time to manage the ICT resources?	
– Does the ICT coordinator get time to support others' use of ICT resources?	
– Are there prizes for ICT for pupils' academic achievement or effort?	
– Does the Headteacher have and use a computer in his/her office?	
– Are computers essential for school administration?	
4. **ICT resources:**	
What ICT resources are there for pupils to use, and how are these organised?	
– What type of hardware? quantity? standardised?	
– Is the organisation of hardware, centralised or distributed?	
– Is the school networked?	
– What software is available ? standardised?	
What proportion of hardware and software have been purchased in the last 3 years?	
How is the purchase of ICT resources funded?	
– by sufficient annual funding in the context of long term developmental planning or one-off bids?	
5. **Staffing:**	
How many teachers are ICT specialists?	
Are these ICT specialist teachers trained to teach ICT?	
– Did they train themselves in ICT or attend training courses?	
– What ICT related qualifications have they?	
– Are their teaching qualifications in teaching ICT?	
Are there sufficient ICT specialist teachers?	
How many other teachers teach ICT?	
Are these other teachers trained to teach ICT?	
– Did they train themselves in ICT or attend training courses?	
– What ICT related qualifications have they?	
– Are their teaching qualifications in teaching ICT?	
Altogether, are there sufficient ICT teachers?	
How many ICT technicians are there?	
Are these technicians adequately trained?	
– Did they train themselves in ICT or attend training courses?	
– What ICT related qualifications do have they?	
Are there sufficient ICT technicians?	

Appendix 4 - Lesson observation schedule

Subject:.							**DATE:**			
Class/Group/Room:							**Period:**			
No. of Pupils:							**Start Time:**			
Teacher:							**Duration:**			
Timetabled ICT lesson or cross curricular lesson?										
Lesson plan	Yes/No									
Use of SMART learning objectives or tools, tasks and contexts?										
Time:										
Organisation										
– whole class										
– small group by design										
– small group forced										
– individualised										
Teaching style Didactic(D); facilitatory (F); collaborative learning (C)										
Pupils using ICT										
– no context										
– multiple contexts										
– one context										
– authentic context(s)										
– step by step										
– closed task										
– open task										
– synthetic CAL										
– real tools										
Assessment										
– related to task (T) or learning outcomes (L)										
– informal tightly specified										
– informal general competency										
– formal tightly specified										
– formal general competency										
ICT resources										
– type?										
– standardised?										
– networked?										
– quantity?										
– age?										

Appendix 5 – Pupil questionnaire

How do you use Information Technology (ICT)?

You should complete this questionnaire if you are in year 11.

Your answers should take into account how you use ICT at home, at school and elsewhere. This questionnaire is NOT a test. The purpose of the questionnaire is to find out what you know about ICT so that the use of ICT in schools can be improved.

1. You are: (please tick one box) ☐ male ☐ female

2. You use ICT: (please tick one or more boxes)

☐ in English
☐ in Art
☐ in RE
☐ in Geography
☐ in History
☐ in Foreign Languages
☐ in PE
☐ Other, please explain:

☐ in Mathematics
☐ in Science
☐ in GCSE ICT lessons
☐ in ICT lessons not for GCSE ICT
☐ in Design Technology
☐ in Personal and Social education
☐ at home

3. Name 4 pieces of software you used last week:

4. You can use: (please tick your skill level)	**Beginner**	**Average**	**Expert**
Wordprocessor	☐	☐	☐
Web browser	☐	☐	☐
Graphics software	☐	☐	☐
Spreadsheet	☐	☐	☐
Database	☐	☐	☐
Other, please describe:	☐	☐	☐

5. You have: (please tick one or more boxes)

☐ opened a window
☐ selected from a menu
☐ used an icon
☐ used a mouse to highlight
☐ used drag and drop
☐ used cut, copy and paste
☐ Other, please describe:

☐ renamed a file
☐ copied a file
☐ deleted a file
☐ defragmented a disk
☐ zipped or unzipped a file
☐ made a backup of a hard disk

6. You have: (please tick one or more boxes)

- ☐ used a desk top computer
- ☐ used a laser printer
- ☐ used a zip drive
- ☐ used a portable computer
- ☐ used a colour printer
- ☐ used speech input
- ☐ used a modem
- ☐ used CD-ROM or DVD
- ☐ used a digital camera
- ☐ used an ink jet printer
- ☐ played music using computer
- ☐ watched video on a computer
- ☐ listened to speech on a computer
- ☐ recorded sound using a computer
- ☐ watched TV on a computer
- ☐ Other, please describe:

7. If you are using ICT, get stuck and don't know what to do, do you:
(please number: 1=first, 2=second, 3=third, 4=fourth, 5=fifth)

- ☐ Ask a friend
- ☐ Ask a teacher
- ☐ Ask an adult other than a teacher
- ☐ Work it out yourself
- ☐ Switch off the computer and leave the problem for another time
- ☐ Other, please describe:

8. You get stuck, and you've decided to try and work it out for yourself, do you:
(please number: 1=first, 2=second, 3=third, 4=fourth, 5=fifth)

- ☐ Read the manual
- ☐ Read the help to give you some idea what to do next
- ☐ Read the help and try to find out exactly what to do
- ☐ Use the software to try out different approaches and see if they work
- ☐ Switch off the computer and leave the problem for another time
- ☐ Other, please describe:

9. Has ICT had any affect on:

(please tick to show how much effect)	**No effect**	**Some effect**	**Major effect**
How you find out what's on TV	☐	☐	☐
How you pay when you go shopping	☐	☐	☐
How you get your money from the bank	☐	☐	☐
When you catch the bus or train	☐	☐	☐
The skills you need to do a job	☐	☐	☐
Have you noticed how ICT has affected any thing else? Please explain:	☐	☐	☐

Thank you for filling in this questionnaire. Please give it to your teacher to return to:

R. Crawford, School of Education and Professional Development
University of Huddersfield, Huddersfield HD1 3DH.
Email: R.A.Crawford@hud.ac.uk
Phone: 01484-478264 Fax: 01484-514784

Appendix 6 – Mapping of the pupil questionnaire to the operational definition of ICT capability

The following operational definition of ICT capability is copied from p26.

Pupils would currently be considered to have high levels of ICT capability if they were able to:

A. Use ICT to support their learning in all subjects
B. Use common ICT tools
C. Take responsibility for their own learning, developing strategies to help them learn how to use unfamiliar ICT tools, and work collaboratively
D. Use current ICT hardware and software and understand its potential and limitations
E. Understand that using ICT affects social processes

Question number in the pupil questionnaire	Element of ICT capability (see above)
1	Not applicable
2	A
3	B and E
4	B and E
5	B and E
6	E
7	C and D
8	C and D
9	E

Appendix 7 – Record of research evidence

What follows is a record of the primary evidence collected at each of the four case study schools. References to this are coded as follows:

First letter	Identifies the type of evidence: S = staff questionnaire I = interview L = lesson observation P = pupil questionnaire
Second letter	Identifies the school and the way it organises the ICT curriculum: D = discrete S = skills core K = kick start C = cross curricular
Third and fourth letters	If present, identify the person interviewed or observed
Fifth letter	If the above leads to replication, this letter is used to make it unique

School D – discrete		
Code	**Type**	**Source of evidence and comments**
SD	staff questionnaire	Filled in by the HoD ICT. Consistent with interview IDAI.
IDAI	interview transcript	HoD ICT. Reliable evidence.
IDHL	interview transcript	Headteacher responsible for whole school ICT. Reliable evidence.
IDPR	interview transcript	HoD mathematics. Reliable evidence.
LDRB	lesson observation	ICT curriculum manager teaching GCSE ICT short course to year 10.
LDAI	lesson observation	HoD ICT teaching GCSE ICT full course to year 10.
LDMS	lesson observation	Mathematics teacher using ICT in a year 10 GCSE mathematics lesson.
PD	pupil questionnaire	54 questionnaires filled in by year 11 pupils from 2 GCSE ICT classes and a GNVQ class.

School S – skills core		
Code	**Type**	**Source of evidence and comments**
SS	staff questionnaire	Filled in by ICT coordinator. Consistent with interview ISBG.
ISBG	interview transcript	ICT coordinator; teacher of discrete ICT. Reliable evidence.
ISPS	interview transcript	Deputy headteacher; HoD science; responsible for whole school ICT. Reliable evidence.
LSBG	lesson observation	ICT coordinator observed teaching discrete ICT to year 8 class.
LSPS	lesson observation	Deputy headteacher; HoD science; teaching using ICT year 10 science class.
LSSB	lesson observation	HoD mathematics teaching using ICT in year 9 mathematics class.
PS	pupil questionnaires	43 questionnaires filled in by year 11 pupils from three GCSE ICT classes.

School K – kick start		
Code	**Type**	**Source of evidence and comments**
SK	staff questionnaire	Filled in by ICT coordinator.
IKST	interview transcript	ICT coordinator; teaches discrete and supports cross curricular ICT. Reliable evidence.
IKSD	interview transcript	HoD mathematics. Reliable evidence.
IKCB	interview transcript	Deputy headteacher i/c whole school ICT. Evidence is unrealistic and favours the school.
LKST1	lesson observation	ICT coordinator observed supporting a geography teacher in a year 8 class.
LKSR	lesson observation	ICT teacher observed teaching control in a DT lesson to a year 9 class.
LKST2	lesson observation	ICT coordinator observed supporting a year 10 business studies lesson.
PK	pupil questionnaires	47 pupil questionnaires filled in by pupils in year 11 classes that are not discrete ICT.

School C – cross curricular		
Code	**Type**	**Source of evidence and comments**
SC	staff questionnaire	Questionnaire filled in by deputy headteacher i/c ICT. Consistent with interview ICDB.
ICDB	interview transcript	Deputy headteacher i/c whole school ICT. Reliable but lacks understanding of the issues.
ICVL	interview transcript	Mathematics teacher i/c ICT in mathematics. Reliable evidence.
ICSW	interview transcript	HoD mathematics and senior teacher. Reliable but limited experience of ICT in mathematics
ICPE	interview transcript	ICT manager. Unplanned, informal interview in LRC.
	lesson observations	No lesson observations arranged. The reasons for this are explained in Chapter 4.
PC	pupil questionnaires	48 pupil questionnaires filled in by pupils in mixed ability form groups in year 11.