ICT in Schools Research and Evaluation Series – No.9

ImpaCT2

Pupils' and Teachers' Perceptions of ICT in the Home, School and Community

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Becta
British Educational Communications and Technology Agency

This publication, as well as a summary sheet, is available on the Becta Research web site at:

www.becta.org.uk/research/impact2

A full report of the ImpaCT2 findings (including a more detailed description of the research methods employed), reports from the other strands of the study, the earlier Interim Findings and the Preliminary Reports, are also published on the Becta Research web site.

Other reports in the ICT in Schools Research and Evaluation series are also available on the Becta Research web site.

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Executive summary

1.1 Introduction

ImpaCT2 is one of a number of projects commissioned by the Department for Education and Skills and managed by Becta with the aim of evaluating the progress of the ICT in Schools Programme. It is a major study carried out between 1999 and 2002 involving 60 schools in England and is one of the most comprehensive investigations into the impact of information and communications technology (ICT) on educational attainment so far conducted in the United Kingdom.

ImpaCT2 was designed to:

- identify the impact of networked technologies on the school and out of school environment
- find out the degree to which these networked technologies affect the educational attainments of pupils at Key Stages 2, 3 and 4.

The study involved three related strands:

- Strand 1: to develop and apply appropriate methods for evaluating the use of ICT in school and out of school, and to analyse the statistical relationship between the effective implementation of ICT and standards of performance in National Tests and GCSEs.
- Strand 2: to develop and apply a variety of methods to establish *how* pupils use ICT, in particular out of school, and what is gained from such use.
- Strand 3: to explore the nature of teaching and learning involving ICT in various settings, with a focus on the views of pupils, teachers and parents.

The ImpaCT2 study was jointly carried out by a team of researchers from the University of Nottingham, the Open University, Manchester Metropolitan University and the University of Leicester, and led by Professor Colin Harrison at the University of Nottingham.

This publication reports primarily on the outcomes of Strand 2, but draws on some material from the other strands of the study.

1.2 Summary of key findings from this strand

Strand 2 explored the wider context of pupils' informal learning with ICT at home, in other out-of-school venues, and in school outside formal lessons. 'Informal learning' refers to the acquisition and development of skills, knowledge or conceptual understanding in ways and locations that differ from the traditional classroom situations and methods. This strand was designed to complement the statistical analysis of pupils' performance in National Tests and GCSEs that was the central focus of Strand 1.[1] It employed innovative methods to access evidence of pupils' learning about ICT, and with ICT.

By collecting evidence from pupils about their understanding of the role of computers in today's world, how they used them, where, when, how frequently and for what purposes, the study team aimed to develop theories which would be of practical value for teachers and policy makers. Teachers assisted in collecting the evidence and also provided their own accounts that provided a crosscheck to the evidence from pupils and added to the completeness of the picture.

The key findings from this strand of the study:

- For most pupils the amount of time spent on ICT at home greatly exceeds the time spent on ICT at school. Pupils perceive that they have greater autonomy to explore ICT at home and the opportunity to use it for longer periods of time.
- Many pupils have sustained access to powerful ICT equipment and resources at home to support a wide variety of leisure pursuits. They are discriminating in use of the Internet, which is enabling them to develop skills and literacies in networked ICT[2], confidence in its use, and a range of on-line social and communication skills.
- Home ownership of computers and home access to the Internet are increasing. However, at the time of carrying out the study, over a quarter of pupils did not have access to the Internet at home. Access to ICT (in public libraries, Internet cafés and on school premises outside lesson time) lacks flexibility and in some cases is expensive, so that pupils without access at home are disadvantaged.

[1] *ImpaCT2 – The Impact of Information and Communication Technologies on Pupil Learning and Attainment* (Becta, Coventry: 2002: www.becta.org.uk/research/impaCT2).

[2] A glossary of terms used in this report can be found in appendix 2.

- Pupils are aware of the moral and ethical debates surrounding the use of networked technologies and the perceived security risks. They are interested in discussing these issues and the majority use the Internet with discrimination as well as enjoyment.
- Pupils have an extensive awareness of the role of computers in today's world. Awareness varies between individuals but many are knowledgeable about a wide range of equipment and how it is used, as well as the varied purposes of its use by all kinds of people in many different locations. This has implications for the speed and ease with which they are likely to become skilled in using networked ICT: they may develop skills in using networked ICT more quickly and easily than is often anticipated by schools and teachers.
- At all three key stages included in the study there is a significant and positive relationship between the levels of awareness held by pupils of computers in today's world and whether they had home access to the Internet and their own personal e-mail address.
- There is also a significant and positive relationship at all three key stages between these levels of awareness and pupils' experience of surfing the Internet.
- Pupils' perceptions of what learning is are shaped by their experience in school settings. They associate 'learning' with school-related use and typically describe all ICT use at home as 'games'. When the meaning of 'games' is probed, it is clear that much learning is taking place through their use of ICT for leisure pursuits, including learning of factual knowledge and conceptual understanding.
- The arrival of networked ICT placed great demands on schools and teachers and it is taking time to embed it in teaching and learning practices. In the schools involved in the study, implementation of this innovation has progressed in three stages: during stage one the main focus is on the provision of equipment infrastructure and support; stage two focuses on teaching ICT skills, often in specialist ICT lessons; stage three moves to the integration of ICT with curriculum subjects, including numeracy and literacy. During the time of collecting the Strand 2 data, schools moved from stage one to stage two and only a few teachers in a few schools began to move to stage three.

1.3 Summary of key recommendations from this strand

These recommendations are based upon the key findings above:

- Since pupils are likely to acquire ICT skills quickly and easily through using them for self-directed tasks, more time should be spent on exploratory learning in curriculum subjects and less time on teaching skills in discrete ICT lessons. Check-lists and self-test programs could be used as a back-up to allow pupils to demonstrate their self-taught skills, perhaps with certification.
- Schools need to develop strategies for 'bridging the gap' for those pupils who do not have access to ICT resources, including the Internet, at home. This might be through loans, government grants, or 'thin client' access from home to the school computer servers. ('Thin client' technology enables less powerful models of computers to act as terminals as part of a more powerful network, so older and cheaper computers could be purchased which would still enable pupils to use the most powerful programs from home.)
- Parents need to be made more aware of the importance of home access to ICT and the learning that results from leisure use, including some of the stimulating activities that younger pupils categorise under the broad heading of 'games'.
- Teachers and governors need to consider how to build on their pupils' experience, developing skills and enthusiasm in relation to networked ICT. They could make much better use of this potential resource through a more creative approach to homework and self-directed projects.
- Schools and teachers need continuing support, including more funding for equipment which can be used flexibly, access to at least one technician on the premises, and more training for teachers in how to integrate ICT with subject learning. This will ensure that they are able to achieve the necessary changes in school culture and teaching practices to reap the benefits of the Government's investment.

Section 2 – Introduction

2.1 The ICT in Schools Programme

The ICT in Schools Programme is the Government's key initiative to stimulate and support the use of information and communications technology (ICT) to improve standards and to encourage new ways of teaching and learning.

Since 1998, when the Government published its proposals to develop a National Grid for Learning (NGfL)[3], schools and other institutions have made considerable progress in their use of ICT to support teaching and learning and to improve the efficiency of school management. This reflects tremendous vision, initiative and commitment at all levels of the education sector and has been achieved within the context of the programme.

Meanwhile, the educational potential and the accessibility of new technologies in schools and at home continue to grow. The period since the launch of the NGfL has witnessed significant advances in the range of technologies and applications available to the education and home markets and in the growth of access to ICT outside school. There is every sign that these trends are set to continue.

Hence while the progress has been significant and can rightly be celebrated, it is only the beginning of an ongoing transformation that over time will deliver exciting new opportunities for individuals to personalise their learning and realise their potential in school, at home and in the community. These opportunities will become a reality as ICT becomes firmly embedded in all aspects of school life rather than as an 'optional extra'.

A vision for the future of ICT in schools is provided in the paper *Transforming the Way We Learn*[4], available at: **www.dfes.gov.uk/ictfutures.**

2.2. ImpaCT2

ImpaCT2 is one of a number of projects commissioned by the Department for Education and Skills and managed by Becta, with the aim of evaluating the progress of this programme. It is a major study carried out between 1999 and 2002 involving 60 schools in England and is one of the most comprehensive investigations into the impact of information and communications technology (ICT) on educational attainment so far conducted in the UK.

The observations made as part of the study took place during the early-mid period of the ICT in Schools Programme, during which the nature of ICT in schools, in terms of both provision and practice, has been developing. This publication is intended to present the key findings from the second strand of the ImpaCT2 study for a broad audience, including teachers and parents and all others interested in school-age education.

This publication, as well as a summary sheet, is available on the Becta Research web site at: **www.becta.org.uk/research/impact2**

A full report of the ImpaCT2 findings (including a more detailed description of the research methods employed), reports from the other strands of the study, the earlier Interim Findings[5] and the Preliminary Reports[6] are also published on the Becta Research web site.

Other reports in the ICT in Schools Research and Evaluation series are also available on the Becta Research web site.

2.3 Objectives of the study

ImpaCT2 was designed to:

- identify the impact of networked technologies on the school and out of school environment.
- find out the degree to which these networked technologies affect the educational attainments of pupils at Key Stages 2, 3 and 4.[7]

[3] *Open for Learning, Open for Business – the NGfL Challenge* (DfEE, 1998).

[4] *Transforming the Way We Learn* (DfES, 2002: www.dfes.gov.uk/ictfutures).

[5] Becta (2001), *ImpaCT2 – Emerging Findings from the Evaluation of the Impact of Information and Communications Technologies on Pupil Attainment* (Becta, Coventry: www.becta.org.uk/research/reports/impact2).

[6] McFarlane *et al*. (2000), *ImpaCT2 Project Preliminary Study 1 – Establishing the Relationship between Networked Technology and Attainment* (Becta, Coventry: www.becta.org.uk/research/reports/impact2); Lewin *et al*. (2000), *ImpaCT2 Project Preliminary Study 2 – Promoting Achievement: Pupils, Teachers and Contexts* (Becta, Coventry: www.becta.org.uk/research/reports/impact2).

The study has taken place against a background of the developing nature of technology. Most obviously, it was important that the study took full account of the difference between networked ICT and computer-based learning as it existed prior to the recent expansion of the Internet and its penetration into schools and homes. It was also anticipated that the impact of ICT on curriculum learning would depend not merely on what went on in the classroom, but would be a result of many other factors. These include the use of ICT outside school, and especially in the home, as well as its use in school outside lesson time.

Consequently the study was extended to cover all of these areas, and sought to address the following questions:

1. What is the involvement of pupils with computers and the Internet at home and in school?
2. Does curriculum use of ICT have an effect on pupil performance and attitude?
3. Are these effects confined to use in school?
4. Are all kinds of computer use equally helpful to learning?
5. If ICT-based learning involves interactions between home and school, what are the problems that arise and how can these be resolved?

2.4 Organisation of the study

The study involved three related strands:

- Strand 1: to develop and apply appropriate methods for evaluating the use of ICT in school and out of school, and to analyse the statistical relationship between the effective implementation of ICT and standards of performance in National Tests and GCSEs.
- Strand 2: to develop and apply a variety of methods to establish how pupils use ICT, in particular out of school, and what is gained from such use.
- Strand 3: to explore the nature of teaching and learning involving ICT in various settings, with a focus on the views of pupils, teachers, parents and managers.

Strands 1 and 2 were combined within a single project to be run by a team of researchers from three universities under the general direction of Professor Colin Harrison at the University of Nottingham. Strand 3 was a separate project carried out from the University of Leicester under the direction of Dr Chris Comber, and involved 15 of the 60 schools that had been selected for Strands 1 and 2. This publication reports primarily on the outcomes of Strand 2, but draws on some material from the other strands of the study.

A glossary of terms can be found in Appendix 2 of this report.

2.5 The approach taken in this strand

Strand 2 of the ImpaCT2 study focused on the wider context of pupils' learning with ICT, particularly their informal learning, that is in the home and other out-of-school settings, and at school in relatively informal settings such as computer clubs or computer drop-in facilities available before or after school or during the lunch hour. The researchers worked closely with teacher-researchers[8] who co-ordinated the research activities in the 60 schools including the work of the pupil-researchers.[9] Despite the pressures on their time these teachers and pupils provided unique, independent insights.

ImpaCT2 research was carried out at the time when the Internet was just beginning to be widely used in UK homes. 'WWW dot' references became frequent on radio and television during the life of the project and the Internet became established as an important source of information and means of communication for individuals and families. It was important to understand the impact this was having on pupils outside school.

[7] More information regarding key stages, National Curriculum levels and National Tests can be found in the DfES publication series *Learning Journey*, the National Curriculum online web site (www.nc.uk.net) and on the DfES Parents web site (www.dfes.gov.uk/parents).

[8] 'Teacher-researchers' is the term employed in the ImpaCT2 study for those teachers that played a particularly important role in gathering data regarding how ICT was being used in the 60 schools involved in the project. Further information on the specific tasks carried out by the ImpaCT2 teacher-researchers can be found in the full ImpaCT2 report.

[9] The design of the ImpaCT2 study recognised that the wider learning context also includes the informal use of networked technologies in such activities as participating in chat rooms and playing on-line strategy games. In these out-of-school contexts the pupils themselves are clearly the best placed informants, so some children were invited to become pupil-researchers. Their tasks are explained in the next section.

To collect evidence of their use of ICT and informal learning, selected samples of pupil-researchers completed logs of their ICT activities, a questionnaire on their use of the Internet, and a special report of a key learning event with ICT, while some carried out interviews with their peers on attitudes to computer games, mobile phones or the Internet.

Further, a 'concept mapping' task provided evidence from all pupils in the sample of their awareness and understanding of the role of computers in today's world. Concept mapping is a system for presenting ideas in a diagram. Pupils were asked to draw objects and link them with lines to show the connections between them. This is a simple form of concept mapping and it was used to find out the pupils' awareness of networked computer systems.

2.6 Organisation of this report

This reports presents the findings from this strand of the study in three main sections. Section 3 reports on the extent, location and nature of pupil ICT use. Some additional evidence is presented from case study reports of schools in the ImpaCT2 study that were identified as having practices of particular interest. Section 4 focuses on the views of teachers and pupils regarding their use of ICT during the period from January 2000 to July 2001. Section 5 provides a perspective on pupils' understanding of the role of computers in today's world by presenting a selection of the concept maps they produced during the study alongside an analysis of the maps.

A brief explanation of the methods used in the study can be found in sections 3, 4 and 5 below. A more detailed explanation can be found in Appendix 1, and in the full report on the ImpaCT2 findings. The ImpaCT2 Preliminary Reports also provide a further rationale for the methods involved in the study.

A glossary of terms can be found in Appendix 2 of this report.

Note that where pupils and teachers are quoted referring to commercial products, brand names have been replaced by generic descriptions.

Section 3 – Pupils' experience of using ICT

The key findings from this section:

- Home ownership of computers and home access to the Internet are increasing. However, at the time of carrying out the study over a quarter of pupils did not have access to the Internet at home. Access to ICT (in public libraries, Internet cafés and on school premises outside lesson time) lacks flexibility and in some cases is expensive, so that pupils without access at home are disadvantaged.
- At Key Stage 2 substantial use of ICT in lessons was reported for both mathematics and English. At Key Stage 3, lesson use in these subjects is lower, but increases outside school for English and science. At Key Stage 4, ICT use at home became more prevalent than in school for most of the main subjects.
- Many pupils have sustained access to powerful ICT equipment and resources at home to support a wide variety of leisure pursuits. Leisure use takes precedence in the home.
- For most pupils the amount of time spent on ICT at home greatly exceeds the time spent on ICT at school. Primary school pupils revealed that ICT use at home averages three hours per week compared to an average of one hour's use at school per week.
- The average amount of use of ICT at home reported by secondary school pupils was almost four times as much as the average use of ICT reported in school (10 hours at home, two and half hours at school).
- Internet questionnaires suggest that pupils used the Internet more outside school than inside school across the whole age range.
- Use of ICT for personal interest in school was minimal and generally restricted to lunchtime or after-school access.
- Pupils' perceptions of what learning is are shaped by their experience in school settings. They associate 'learning' with school-related use and typically describe all ICT use at home as 'games'.

When the meaning of 'games' is probed, it is clear that much learning is taking place through their use of ICT for leisure pursuits, including learning of factual knowledge and conceptual understanding.

3.1 Introduction

This section reports on the extent, location and nature of pupil ICT use. Some additional evidence is presented from case study reports of schools in the ImpaCT2 study that were identified as having practices of particular interest.

Pupils' experience of using ICT was explored largely through five tasks designed to elicit their perceptions about school and home use both for homework and personal interest. These are briefly described here and explained more fully in Appendix 1.

Firstly, a pupil questionnaire was designed to investigate the extent and location of computer usage by every pupil in the project, approximately 2,100 across the three key stages. This questionnaire was administered in 2001 and 2002 to monitor changes over time.

The design of the ImpaCT2 study recognised that the wider learning context also includes the informal use of networked technologies such as researching a topic of personal interest, participating in chat rooms or playing on-line strategy games, all of which involve forms of learning and which may or may not be reflected in improved attainment in traditional school assessments. In these out-of-school contexts the pupils themselves are clearly the best placed informants, so some children were invited to become pupil-researchers. As a result, four pupil-researcher activities were developed:

- A pupil log – to monitor use of electronic devices and on-line resources both at school and at home over the period of one week.
- A special report – capturing an activity relating to school work where pupils had found ICT to be particularly helpful.
- An Internet questionnaire – to gather pupils' perceptions on how and why they use the Internet both in and out of school for their own interests and for school work.
- Pupil interviews with other pupils – giving them the opportunity to research aspects of ICT use that they considered to be relevant and important.

Approximately 20 pupils from each of the 60 schools in the project participated as pupil-researchers. In secondary schools this number was divided between the two key stages, that is Key Stage 3 and 4. Numbers were expected to vary in special schools and in some primary schools the whole class wished to contribute. Guidelines to teacher-researchers mentioned the need for a gender, ability and ethnic mix representative of the school and a variation in ICT use. Each was asked to conduct the pupil log activity with ten pupils altogether and one other activity with another ten pupils. The research activities were undertaken in the autumn term of 2001. The pupil-researchers were required to attend briefing sessions on each research activity. Detailed teacher guidance was prepared for the briefing to guarantee a level of consistency across the schools.

3.2 Extent and location of use

Home ownership

Over the lifetime of the study, the availability of ICT equipment in the home increased significantly, with the exception of games consoles (Table 3.1). Home ownership of a computer was reported by over 90% of the pupils surveyed in the study who completed the pupil questionnaire. Evidence relating to three different age groups revealed that access to computers, the Internet and e-mail at home increased as pupils progressed from primary to secondary education. Ownership of games consoles decreased during the same period, which may suggest that pupils develop a need for more complex ICT resources as they get older.

Table 3.1: Availability of ICT, summer 2000 and summer 2001, all pupils across whole age range (based on responses to 2,100 questionnaires administered in 2000 and again in 2001)

	2000	2001
Games console	80.5%	80.7%
Computer at home	83.2%	90.1%
Internet at home	59.1%	72.9%
Computers outside school	80.6%	79.3%
Internet outside school	69.5%	78.7%
E-mail address	62.9%	71.0%
Create web page	19.4%	24.0%
Mobile phone	36.3%	70.0%
Revision sites	N/A	49.8%

Although home access to ICT resources has increased, the 'digital divide' between those with and without computers at home remains a serious problem for a minority of pupils. For example, Figure 3.1 reveals stark differences between Key Stage 4 pupils who are most advantaged (group 1) in terms of socio-economic status (SES) and those who are least advantaged (group 5).[10] Access to a computer in the home is now universal among the most advantaged in terms of SES, while a number of pupils in the remaining groups do not have home access, and the difference is even more marked for Internet availability. Nevertheless, even here, only a minority of pupils in the sample were unable to access the Internet.

Extent of home use compared to school use

In addition, the pupil questionnaire revealed different patterns in the reported use of ICT for school work in lessons, in school but outside lessons and outside school (Figure 3.2). At Key Stage 2 substantial use of ICT in lessons was reported for both mathematics and English. At Key Stage 3, lesson use in these subjects is lower, but increases outside school for English and science. At Key Stage 4, ICT use at home became more prevalent than in school for most of the main subjects.

The evidence from pupil logs also indicated that overall pupils spend more time using ICT at home than using ICT at school, both for work and leisure purposes:

- The 280 responses from primary school pupils revealed that ICT use at home averages three hours per week compared to an average of one hour's use at school per week.
- The average amount of use of ICT at home reported by 115 secondary school pupils was almost four times as much as the average use of ICT reported in school (10 hours at home, two and half hours at school).
- However, leisure use takes precedence in the home; secondary school pupils also reported that they spent an average of six and a half hours per week using ICT at home for personal interests in comparison to two and a half hours a week for supporting homework.

Use of the Internet

Responses from 227 Internet questionnaires suggest that pupils used the Internet more outside school than inside school across the whole age range (Figure 3.3).

A variety of reasons were given to explain this difference. Pupils and teachers said that home use of ICT was preferred because they had access to superior hardware and software (although in some cases compatibility between home and school ICT was an issue):

> *"When it does become a bit of a divide is with those students who have better software packages [at home] and have got more on-line time, or can access good printing facilities or they're not worried about printing out lots of sheets."*
>
> *Key Stage 4 humanities teacher, Anglia Secondary School*

Comments taken from the Internet questionnaire indicate that pupils find that school Internet access may suffer from technical limitations, inaccessibility and the constraints of school policy (including blocking access to sites through filtering):

> *"…I have other things to do at lunch-time, and at break, and we don't really use it in class, whereas I can get a faster connection in a more comfortable place at home, and take my time."*
>
> *Key Stage 4 boy, Swanley Secondary School*

In comparison, computer and Internet access from home offers fewer restrictions, self-paced work schedules and better performance and unrestricted access. Some pupils were very aware of technical differences between the school and home computing environments. For instance:

> *"Out of school … I have support for [multimedia presentation software], [Web scripting languages], video, sound and the ability to download things which my school does not allow."*
>
> *Key Stage 4 boy, Pilgrim Secondary School*

However, use of the Internet in school does provide a more economical alternative for some students, although not always ideal:

> *"In school because it's cheaper and I can go on for a long time. But home is good because nothing is filtered."*
>
> *Key Stage 3 girl, Sedgewick Secondary School*

Access to ICT (and particularly the Internet) outside the confines of the classroom is engaging pupils who would

[10] For an explanation of SES groups see the glossary in Appendix 2.

Figure 3.1: Access to ICT by socio-economic status (SES) group at Key Stage 4 (based on a sample size of 700)

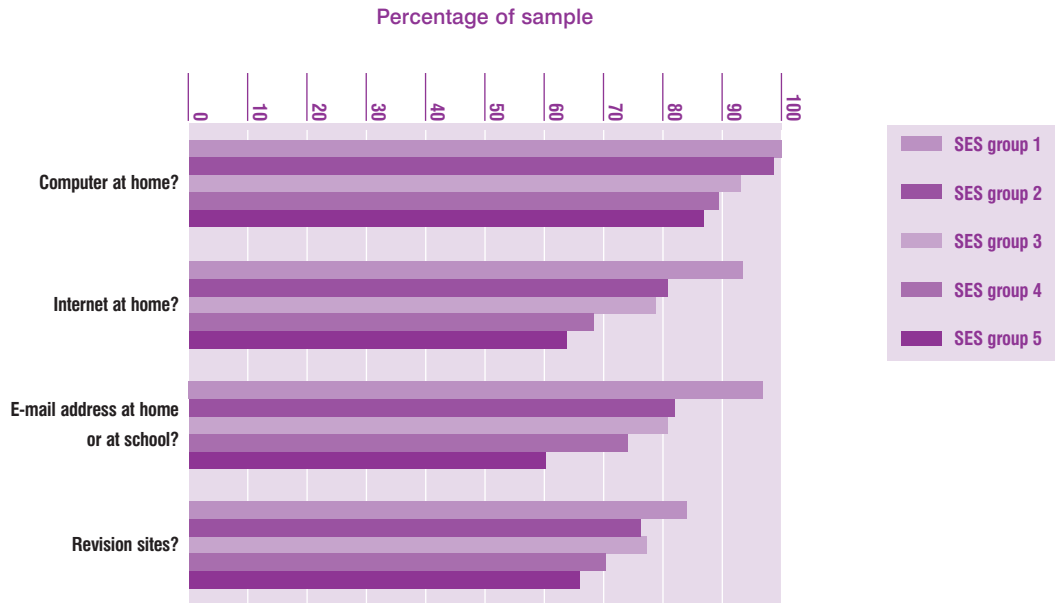


Figure 3.2: Percentage of pupils reporting at least some use of ICT to support schoolwork by key stage, subject and location (based on responses to 2,100 questionnaires administered in 2001, 700 in each key stage)

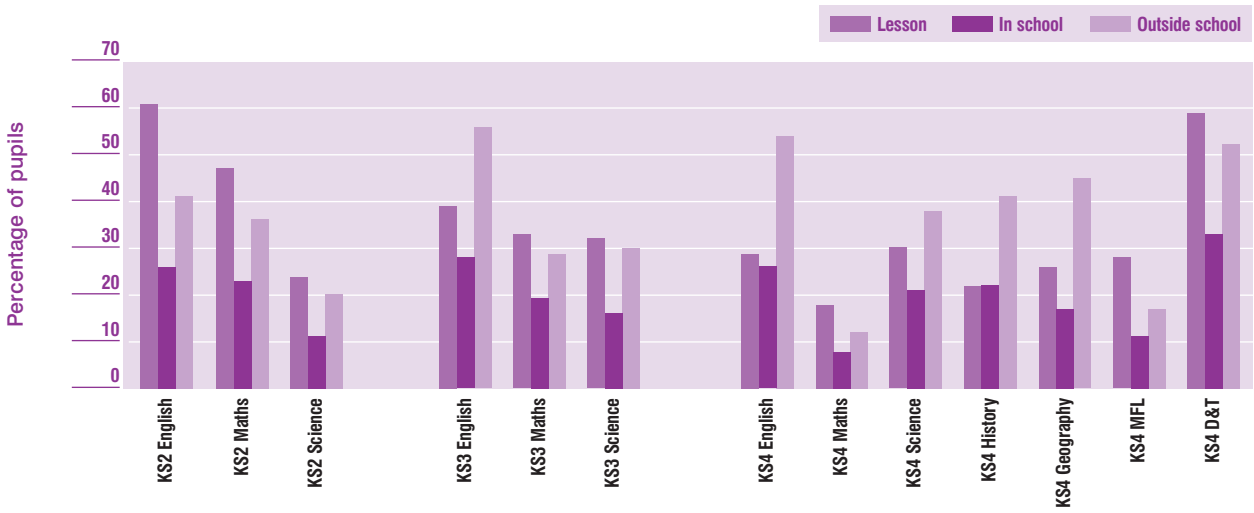
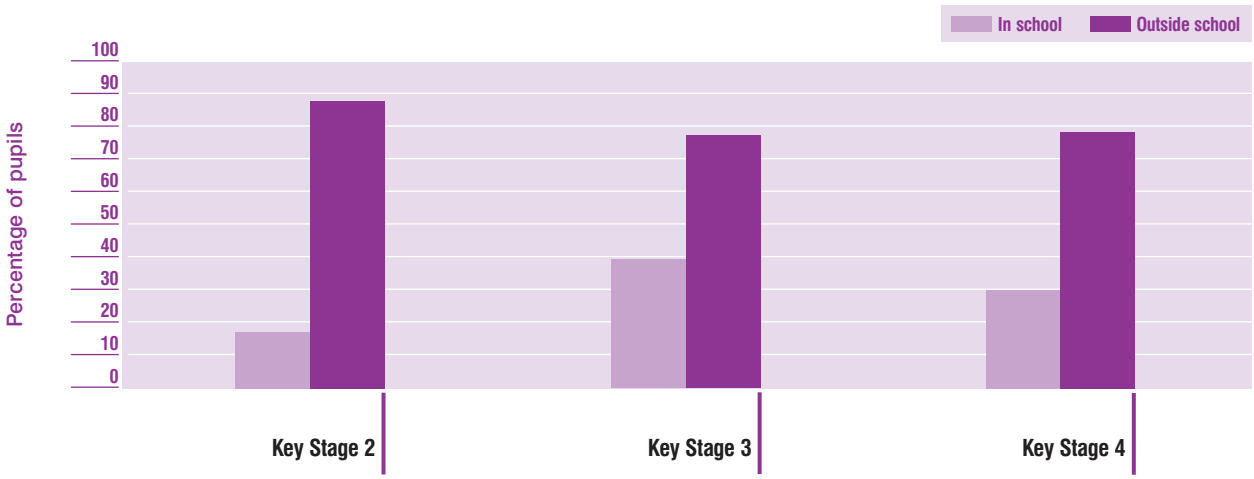


Figure 3.3: Where pupils make most use of Internet: in or out of school (based on 227 Internet questionnaires)



not otherwise be motivated to continue working outside school hours. In Lode Hall Secondary School, pupils doing an Easter holiday revision course used one particular well known revision site extensively. Staff supporting the school said that pupils had become more independent and responsible for their own learning.

Evidence from the case study reports also supports the conclusion that pupils have different levels of access at home and at school. The divide between out of school use and use in school was more obvious in secondary schools where the overall levels of academic achievement are higher. This is likely to be because the competitive exam based culture is more explicit in these schools and there is a corresponding (and increasing) emphasis on homework and coursework as part of GCSE, NVQ and A level requirements.

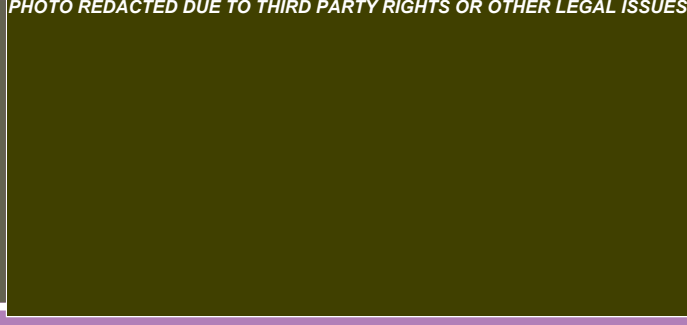
Hand in hand with these requirements is the need for pupils to both access ICT resources for longer periods and draw upon the abilities of significant adults other than teachers. At Anglia Secondary School one pupil said: "Until I got my own computer at home I definitely felt that I was getting behind [at school]." In some schools provision was made through lunchtime and after-school access. Pupils were of the opinion that those without Internet access at home are disadvantaged because restricted access to some sites at school meant that those pupils had to use local or city libraries. On-line access at home was therefore both a convenience and an academic advantage. Pupils were well aware of costs and consequent impacts on when they could use the Internet for homework. Parents were said to be 'quite strict', with on-line use for leisure being balanced against homework. As pupils are clearly able to spend far more time at home than at school using ICT for both self-directed and teacher-directed learning activities, the minority who do not have access at home are clearly disadvantaged.

3.3 The nature of home use of ICT

- At primary level the three most popular ICT activities outside school were CD-ROMs, the Internet and word processing.
- At secondary level, word processing and the Internet were the most common resources used to support work outside school. Encyclopaedias, desktop publishing software, spreadsheets and subject-specific software were also considered to be useful.
- Pupils of secondary age indicated that the Internet, e-mail and chat facilities were the most popular leisure activities.
- Games use was also considered to be an enjoyable activity by all pupils but to a greater degree by those of primary age than those of secondary age.

The next two passages, drawn from a pupil log and a special report respectively, illustrate different aspects of home ICT use by pupils.

The first, from a Key Stage 4 pupil, illustrates the extent



of home ICT use, the range of subjects it was used for, the difference in use for schoolwork and leisure, and the range of leisure uses.

In her pupil log, one Year 11 girl recorded brief use (five minutes) of word processing in an English lesson. All other use for both schoolwork and leisure took place out of school. Of the five subject areas where homework was set during the period, she said she used ICT resources for four of these. For English she conducted some research on the Internet using a search engine for a presentation on a popular band, which took two hours. For science, she used [a search engine] to find out about producers of genetically modified foodstuffs, which took 20 minutes. For art, she said she visited [an art gallery web site] to find out about the artist Tracy Emin, which took one hour. For graphics (a GCSE option under design and technology) she said she wrote up her coursework using a word processor and desktop publisher, which took two hours. Out of school use for school work totalled nine hours and consisted of word processing, CD-ROMs and surfing the Internet. For leisure use, she indicated that she had used the following resources, for a total of 25 hours: word processing (4 hours), art packages (2 hours), CD-rewriter (2 hours), CD-ROM (2 hours), e-mail (6 hours), surfing the Internet (3 hours), creating web pages (2 hours) and [a messenger service] (4 hours).

The second, from a Key Stage 3 pupil, illustrates the relatively thoughtful use of ICT for schoolwork, and an emphasis on the presentational value of ICT.

In his special report Diarmid (Year 9) described a 45-minute activity he did in his bedroom at home for history. The topic was Children in the Industrial Revolution – Domestic Service. His task, which he did alone, was to research information about this topic and then put it into a well-presented display that could be added to a poster. He said he chose to use the computer rather than being directed to use it by his teacher and used a word processing package because it was the best for presenting a large body of text. Diarmid felt the benefits of using this were that it made it easy to fix errors and typing was faster than writing. He also considered that it allowed all the pupils to work to the same font size; they had agreed that the posters should all have the same text size and font. He said he looked at three web sites recommended by the teacher, valuing the Internet as a faster way of finding information. Diarmid was pleased both with the presentation of the work and with how quickly he finished it. He perceived that he had learned nothing whatsoever that was new about ICT, and all he discovered about the subject that he did not know before was about housemaid's wages in the 18th century. He did not feel that his understanding had progressed, but would change nothing in what he had done.

Use of the Internet

Pupils reported that the Internet is used to support work at both school and home and is perceived to offer a number of benefits including access to up-to-date information and revision support:

"I'd use the Internet because sometimes you can get two or three books and they all have the same stuff in them but on the Internet it doesn't."

Key Stage 2 boy, Yew Tree Primary School

"It helped me get a good mark for my homework and it helped to prove the teacher wrong because I could prove what I was saying about thermal energy."

Key Stage 4 boy, Sedgewick Secondary School

Evidence from the case study reports suggests that on-line research for homework was considered to be enjoyable: "Homework can be quite good fun. You have to explore web sites." Pupils said that the advantages of the Internet over books are convenience and the extent of information, although they found searching time consuming and frustrating and much of the information and language too complex.

Teacher-researchers suggested that introducing pupils to effective search/research strategies can lead to more productive use of the Internet at school and at home. Similar supporting evidence was found in the Strand 3

research.[11] Teachers also often recommended educationally sound web sites for pupils to visit. Evidence from responses in the special reports, when pupils were asked to reflect on an occasion when using the computer for school work was particularly helpful, suggests that around three-quarters of the primary pupils and over half of the secondary pupils used the computer at the teacher's direction.

The Internet questionnaire also provided evidence that pupils use the Internet purposefully and employ a wide range of strategies when searching the web. Pupils' use of the Internet is often active and purposeful in contrast to the image of them passively 'surfing the Net' in a relatively aimless fashion. For example:

> *"…a well written title [usually indicates a well organised and maintained site], not overly 'loud' e.g. EVERYTHING ABOUT….!!!!"*
>
> *Key Stage 4 boy, Anglia Secondary School*
>
> *"I usually know what I'm looking for so I look at the description."*
>
> *Key Stage 2 boy, Claypit Lane Primary School*

However, as indicated above, use of the Internet at home for leisure was more commonplace than use for homework. For example, when asked to rank their favourite web sites in the Internet questionnaire 48% referred to personal interests and hobbies whilst only 13% of pupils listed revision or homework sites as one of their 'top five'. Internet use for leisure was reported to be wide and varied. For example: finding 'cheats', computer games, information on pop groups and music; chatting online with the cast of a well known TV soap opera; adopting a 'pet' from a collectable toy series; downloading software; and shopping. Use was also linked to supporting more traditional pursuits. For example: finding the fingerings for the high notes on the clarinet; finding bike riding maps; and finding out about go-karting clubs.

This perspective on the way pupils use the Internet is supported by examples from the case study reports. The pupils of Claypit Lane Primary School spoke enthusiastically and confidently about their use of the Internet at home. They reported using the web for leisure pursuits and their own interests. Pupils saw on-line information as relevant to everyday life and up to date. They considered that web sites promoted purposeful reading, which both improved reading skills and provided knowledge. Pupils at Whitehaven Secondary School said that they largely used the Internet at home for leisure purposes. This included accessing information on TV programmes, pop stars, a toy series and cookery, downloading film clips, digital music and images; playing on-line games and shopping on-line. One girl said that she regularly accessed stocks and shares data and looked forward to being able to invest.

Use of e-mail

In the pupil questionnaire over 70% (71%) of pupils reported that they had an e-mail address. However, when asked whether they had ever used e-mail to support homework it is clear that e-mail was rarely used in this way and it was more likely to be used for communication with family and friends. Of those pupils in Key Stage 3 and Key Stage 4 for example, no more than 4% of pupils indicated that they had ever used e-mail to support their work in any location (school or home), for any of the subjects for which evidence was collected. Pupils reported using the Internet outside school extensively for e-mail and chat, considering this 'fun' and supporting a breadth of interests. They were aware of associated dangers and explained how they used electronic communication with care (section 4.3.2 provides further information regarding this awareness).

Chat and e-mail were also important in Internet use for secondary-aged pupils with girls showing preference for chat-related sites. E-mail was considered by several secondary-aged pupils to be an efficient means of communication and a means of keeping in touch with friends which is less expensive than using the phone or helpful if people do not own a mobile. Chat was valued as a good way of 'interacting with other people' and meeting 'new people and friends'.

Use of games

The pupil-pupil interviews suggest that electronic games are valued by pupils for a number of reasons:

- The exciting and stimulating nature of the entertainment that they provide
- Their value in terms of 'cultural capital', that is enhanced personal status, knowledge and influence, especially in relationships with their peers

[11] ImpaCT2 – Learning at Home and School: Case Studies (Becta, Coventry: 2002: www.becta.org.uk/research/impaCT2

- The transferability of the skills they develop to other forms of ICT usage.

Favourite computer games were a focus of the interviews, particularly for primary pupils. Responses suggest a variety of types of electronic games although this differed according to gender. Girls spoke about knowledge-based games: "I like [character-based game] because it has got a quiz where you can play against a friend an it's got two games", and also the building and management of virtual environments: "My favourite game is [hospital simulation game]. It's great fun making the hospital". Boys on the other hand (although not exclusively) identified skill and strategy games which entail navigation around an environment and dealing with perilous situations. In one case, this related to conventionally gendered interests beyond computers:

"I have two but there's [driving game] and [military game]. I like [driving game] because it's one of my hobbies to go and watch them and [military game] because I like crawling about".

As indicated previously, the use of ICT for personal interest in school was minimal and generally restricted to lunchtime or after-school access.

3.4 ICT skills acquisition at home

One effect of differing levels of out-of-school experience, whether for schoolwork or leisure pursuits, is that of the varying levels of pupils' ICT skills and levels of confidence. It used to be the case that teachers could generally assume that most pupils had roughly the same degree of exposure to computers, but now they report clear differences between those pupils who have home access and those who do not. Additional evidence from Strand 3 suggests that relative to other core skills, even very young children now arrive at school with a fairly high degree of computer competence. Additionally, it seems that parental support at home can be a crucial factor:

> *"He can practise his keyboard skills, continue his work from school, and surf the Web for information to help with homework projects, and develop confidence to use a computer on his own."*
>
> *Parent, Sedgewick Secondary School*
>
> *"We are able to show them different packages which might not be available in school… and therefore my children are now conversant with [sophisticated commercial desktop publishing systems] rather than just a standard PC package."*
>
> *Parent, Arkwright Secondary School*

As computers in the home become commonplace, schools need to be aware of the wide-ranging and complex technical skills that pupils have. Evidence from the case study reports indicates that staff in two secondary schools in particular, in which ICT use was becoming embedded in school culture, realise the importance of this recent phenomenon. In these schools, the ICT schemes of work are rewritten yearly to ensure that standards in ICT achievement are raised.

In the special reports where pupils reported what they had learnt, more often it was ICT-related skills that were mentioned. This was particularly the case for those in Key Stage 2, as described below.

> Clare (Year 6) was looking for pictures and information on the Spanish flag and places in Spain. She described how she was working at home with her mother's help; she spent 40 minutes on the task, having decided to use a word-processing package to type up her information and an electronic world atlas to find the pictures. The task was part of a six-week project that in total took her 7 hours to complete. She said she found the most useful things about using the computer were being able to gain access to the information she needed, quickly and easily. Clare thought that using the computer was better than pencil and paper because she didn't have to draw the pictures and thought it quicker to type than to use pen and paper. She said she was also able to check spelling mistakes more easily. Clare was pleased with everything that she had done, because the presentation looked good and helped her to gain a high mark. She felt that she had learned to transfer pictures to the word-processing package, which made it easier than printing them out one by one.

In the Internet questionnaire responses, pupils reported sophisticated use of technology in the home, for example:

> *"I use [e-mail] to keep in touch with friends, send cool web sites to them as I have [a technically*

advanced e-mail system] I can send HTML mail which can contain multimedia".

Key Stage 4 boy, Pilgrim Secondary School

Further evidence from the concept mapping task (see section 5) strongly suggests that pupils have acquired wide-ranging ICT skills through extensive and regular use, and that this is more often at home than at school.

3.6 Examples of use drawing on the pupil-researcher materials

Two pupil-researchers have been selected below to illustrate the diversity and richness of ICT experience in the home. Simon, a Key Stage 2 boy, produced an extremely interesting pupil log, which indicates significant ICT use for leisure purposes. Olwen, a Key Stage 4 girl, produced a fascinating special report on how ICT had been used at home to support a school-related task. The concept maps drawn by these two pupils are also presented in section 5.6.

Simon's pupil log is of exceptional interest because he reports seven hours of computer use at home and just one at school during the week. The hour at school was spent on using a spreadsheet. The time spent at home is all categorised by him as 'games' but the information he provides suggests that these were games from which he would probably have been learning something of value. For example, on Monday he said: "I went on the Internet and got pictures", and on Wednesday and Thursday he spent a total of two hours playing 'a manager game' (about managing Liverpool football club). On Thursday he spent half an hour on another football game and on Friday: "I played on a game where you could make your own music".

This confirms what the study team frequently found when interviewing primary aged pupils about their use of ICT: anything that is engaging and fun on a computer – particularly if it is used at home – is referred to by them as 'games'. Questions about learning are narrowly interpreted by these pupils as things you are asked to do by a teacher at school. They operate very clear demarcations between 'learning' (equalling school work) and 'games' (equalling everything you do on a computer that is self-directed).

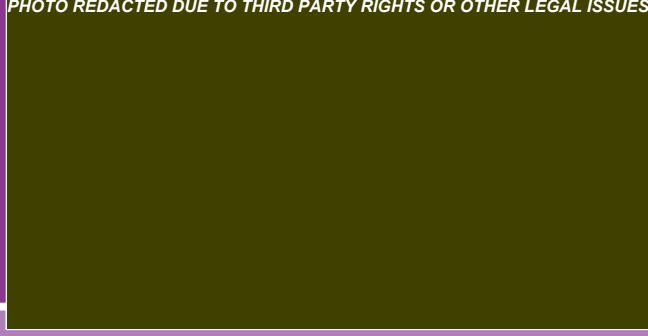
This pattern is more fully explained in Simon's responses to the next question on the pupil log, which asked for more specific details about what he used the computer for at school and at home. Once again, the in-school use is reported as one hour spent on using a spreadsheet. However, the seven hours spent at home are now recorded not as 'games' but as 'web sites' (2 hours), 'music' (2 hours), CD-ROM (2 hours), e-mail (30 minutes), desktop publishing, art packages and spreadsheets (20 minutes each), a discovery-based programming language (10 minutes) and 'scanner', 'maths games' and 'spelling games' (5 minutes each). His week has in fact included a wide range of uses of the computer, almost entirely carried out at home. Simon's concept map is presented in section 5.6.

Olwen's special report is also of great interest. This is an example of a pupil in Key Stage 4, who has apparently already acquired considerable ICT skills, and suggests that she found the time she had to spend at school on basic ICT skills classes somewhat de-motivating.

She chose to undertake a project for English, in which she had to "type up my comparative writing and also use the Internet to find out information on the authors". She undertook this work at home in the study. It was her own idea to use the computer. It took 4 hours and she worked by herself. She used a word processor and a 'question-style' search engine, which she chose "because I had specific questions I needed answering on Thomas Hardy".

The computer was particularly helpful because of the spelling and grammar checker, which 'saves time'. It also provided good information: "The life story I received on Thomas Hardy gave me facts to focus on." The knowledge and information to do this work came from "teachers in class". When asked to say what she had learnt from this task she said "new web sites" and also that "I learnt more information on Hardy".

However, when asked whether her understanding had progressed, she answered: "No because I am already very familiar with the computer and Internet". She was entirely happy with her work and said that using the computer did change her attitude to the task: "Yes, because I got on with it quicker, so it wasn't as boring". Olwen's concept map, as presented in section 5.6, suggests that she was capable of making very good use of a computer as a tool to help her learn. There are important messages here about the use of ICT in schools.



3.7 Implications of these findings

Home ownership of computers and home access to the Internet are increasing. However, a minority of pupils still do not have home access and this is particularly the case for those who are already underprivileged. Furthermore, at the time of this study over a quarter of pupils did not have access to the Internet at home. Pupils perceive that the digital divide is a major issue and that those without home access to ICT and the Internet can be seriously disadvantaged in terms of academic achievement, the amount and flexibility of access, and in some cases costs. Whilst lunchtime and after-school access, and provision of ICT resources in public libraries and Internet cafés goes some way towards addressing this issue, these solutions are still limited in terms of flexibility and costs. Another alternative is to loan ICT equipment to those without access. In this case, consideration should also be given to the costs of Internet access at home.

The amount of access to ICT is significantly greater at home (or in other contexts outside school) than it is in school. Furthermore, the pursuit of leisure interests is more commonplace than supporting schoolwork. Internet access at home is also greater than at school. Pupils perceive that home access provides greater autonomy than school use, where access is often limited and tightly controlled and available resources are often less sophisticated. In contrast to school use, the nature of use in the home is diverse and wide ranging, leading to rich experiences and facilitating new kinds of self-directed learning. Pupils use the Internet to support a wide variety of leisure pursuits including traditional ones as well as new opportunities such as shopping on line. They are discriminating in their use of the Internet. This involves searching for and scanning of web sites and the development of skills and literacies in the use of the Internet. ICT also enables pupils to develop their social skills and practices through the use of e-mail and chat rooms and this is seen to be important and valuable. This form of purposeful use again is likely to contribute to skills development.

The opportunities to spend extended periods using ICT in the home and the motivational aspects of pursuing personal interests using such technologies mean that many pupils have highly developed ICT skills and levels of confidence. In many cases, pupils also have access to more sophisticated technologies and software packages in the home. Some parents are able to provide technical assistance.

Pupils' perceptions of what learning is are shaped by their experiences in school settings. Primary aged children seem to associate learning with school-related use whilst any leisure use is often described as 'games'. However, evidence suggests that this term is used to describe a wide range of applications and skills. When asked what has been learned in an ICT-supported task, pupils often refer to new ICT skills (and less commonly to specific facts) rather than to the development of deep conceptual understanding and knowledge. Yet learning is clearly taking place, both formally and informally, including the development of ICT skills and competencies, acquiring factual knowledge and understanding, and the development of sophisticated communication and social skills.

These findings suggest that:

- Parents should be aware of the importance of home access to ICT and the learning and development of skills that can arise from leisure use including games.
- Teachers and governors should be aware of levels of competency and confidence that many pupils have and ensure that programmes designed to develop ICT skills in schools are tailored to meet individual needs and regularly reviewed. In addition, opportunities for extended ICT access and increased pupil autonomy should be explored.
- Teachers should also be aware of the benefits that can arise from extended home use both from school-related and self-directed learning. The setting of homework tasks should be reconsidered to maximise the advantages afforded by home access of ICT whilst ensuring that those without access have alternative provision.
- Pupils value the social practices of Internet and e-mail use and this could support learning through encouraging access to subject experts and providing support and feedback on school-related tasks from both teachers and peers.

Section 4 – Making sense of ICT use in the home, school and society – the views of teachers and pupils

The key findings from this section are:

- The arrival of networked ICT placed great demands on schools and teachers and it is taking time to embed it in teaching and learning practices. In the schools involved in the study, implementation of this innovation has progressed in three stages: during stage one the main focus is on the provision of equipment infrastructure and support; stage two focuses on teaching ICT skills, often in specialist ICT lessons; stage three moves to the integration of ICT with curriculum subjects, including numeracy and literacy. During the time of collecting the Strand 2 data, schools moved from stage one to stage two and only a few teachers in a few schools began to move to stage three.
- Home use of networked technologies such as web sites supports both self-directed and school-directed learning.
- Teachers' and pupils' views of using ICT clearly show the significant differences between school use and home use of networked ICT by pupils during 2000-2001. They confirm that, at this early stage in the penetration of the Internet into our society, home use is likely to have a much greater impact on many pupils' learning than use at school.
- Pupils are discriminating in their use of the Internet in terms of appropriateness and searching for web sites that appeal to them.
- Pupils are aware of the moral and ethical debates surrounding the use of networked technologies and the perceived security risks. They are interested in discussing these issues and the majority use the Internet with discrimination as well as enjoyment.
- Communication with family and friends is very important to pupils and the way they use electronic forms of communication clearly supports skill development.

4.1 Introduction

This section presents teachers' and pupils' views of using ICT during the period from January 2000 to July 2001. The teachers' views are taken from the short reports that they wrote on the work in their school every month. The pupils' views are drawn from interviews conducted by pupils themselves with their peers. Taken together these two sets of views clearly show the very significant differences between school use and home use of networked ICT by pupils during 2000 - 2001. They confirm that, at this early stage in the penetration of the Internet into our society, home use is likely to have a much greater impact on many pupils' learning than use at school. As a result, the findings in this section support and deepen those from the previous section.

4.2 Teachers' views

4.2.1 First steps: setting up the network infrastructure and support

In this section we look at the extent of networked ICT and support in the schools when the study team began work, early in the implementation of the National Grid for Learning programme. For their first report, in May 2000, teachers were asked to give an overview of ICT work in their school. The picture that emerged from 47 teachers (from 22 secondary schools, 20 primary schools and 5 special schools) was of an education system in the process of change. The following extract from a primary teacher's report conveys the mixture of enthusiasm and turmoil that was characteristic of many of the schools involved in the ImpaCT2 study at the beginning:

> *"We have in the school a computer suite in a room that used to be the staff room – that caused a stir as we now have a staff room that rather resembles a railway carriage!!!! This was set up in 1999 and although an exciting project, has caused me as ICT co-ordinator many problems. Due to limited funds to set up the suite we decided to go for [network product] – a product, as you probably know that enables two monitors and keyboards to share one hard-drive. This product 'does NOT do exactly as it says on the tin' and hence two years later we have taken away the [network product] boxes and thanks to NGfL money and some very kind help from our nearest secondary school's ICT technician (Oh wouldn't it be lovely to have one of those!!!) we are now in the process of setting up a*

networked suite which will mean 19 PCs all with access to e-mail and the Internet. This is very exciting and I am looking forward to using these facilities with the children and other staff."

Key Stage 2 teacher, Maidenhall Primary School

Overall, ICT infrastructure was not yet fully in place: teachers from 11 secondary schools (eight with Technology College status, one with Language Specialist status and two others) reported that they were very well equipped whereas, those from 6 other schools (2 special, 1 primary and 3 secondary) reported that they were very poorly equipped. However, these were early days and 19 of the 47 reports indicated that schools had acquired substantial new equipment in the previous year.

Innovative schools were keen to experiment with ICT, although they were not always well prepared. Here are two examples of teachers who reported that their schools were engaged in cutting-edge developments in wireless connectivity only just becoming available in May 2000. One suggests a sense of excitement about what is about to be possible, and the other a sense of confusion in trying to take decisions with insufficient knowledge:

"The most intriguing new development concerns our purchase of 7 laptop computers, each containing a wireless network connection – or at least they will eventually contain this connection. There is, apparently a world shortage of the 11mb bandwidth processor that is required, so we have the laptops, but not network connection!"

Key Stage 2 teacher, Claypit Lane Primary School

"The ICT working party suggested that all pupils should buy their own laptop computers. The school would then establish a wireless network in order to access the Internet. The problems with this are the high costs of the network connection cards, which cost £100 each and the fact that it is expected that the students will have WAP phones first. (Most students have mobiles at the moment.) The Network technician also has reservations about the longevity of the computers. As a result, it is still a recommendation at the moment, rather than a firm plan."

ICT Co-ordinator, Swanley Secondary School

Teachers needed training in how to use the new equipment as it arrived. However, the training funded by the New Opportunities Fund (NOF) was still in the early stages in May 2000. Only ten of the teachers (six secondary and four primary) reported that their schools had already embarked on NOF training. However, all but eight of the reports mentioned that staff were actively involved in ICT training, in many cases citing the CLAIT courses and/or the European Driving Licence in ICT.[12]

Technical support was of great importance, as noted in the opening quotation, but was rare and difficult to retain, as is made clear by these extracts from the first two reports from a primary school:

"We are lucky at our school in that we also have a classroom assistant [name] who is an absolute whiz with PCs and the kids, and each teacher has [name] for a morning or afternoon per week – usually."

Key Stage 2 teacher, Robert Peel Primary, May 2000

"Then to add insult to injury [name of classroom assistant] (our computer wizard and technician) was told by the local Job Centre that he had to go on a 13 week course to update his communication skills to enhance his employment prospects, so it looks like we have lost him for the summer at least."

Key Stage 2 teacher, Robert Peel Primary, June 2000

Many of the problems identified by teachers in this section might have been resolved if they had access to a technician on site.

In May 2000 many teachers had only a low level of awareness of the opportunities offered by networked ICT. In all, 30 of the 47 who wrote reports (16 secondary, 11 primary and three special) specifically mentioned use of the Internet. Of these, only two (one secondary and one special) said that all staff and students had e-mail addresses. This low number was partly because there was unease about giving pupils open-ended access to information and related material on the Web. Nine said that pupils' access was restricted: one special school limited it to the library and three password protected work stations 'by agreement with parents', one primary said the school made no provision for use of the Internet outside lesson time, one special school restricted access

[12] Computer Literacy and Information Technology (CLAIT), and the European Driving Licence in ICT, are widely taken ICT user qualifications.

to computers in the computer suite where their use could be closely supervised, and one secondary said pupils were forbidden to use it 'for fun', adding:

> *"The Internet connection is switched on from 11am-1pm and from 2pm until 4.30pm, unless a member of staff requests it is turned on at other times. This means that students only have about 1 hour of access each day outside of lesson time (3.35-4.30pm)."*
>
> *ICT Co-ordinator, Cow Lane Secondary School*

In addition, two primary teachers reported that their schools (Meadow Rise and Aspley) had only one computer linked to the Internet which of necessity must have severely limited access.

4.2.2 Starting to use networked ICT in teaching

By the autumn of 2000 most schools had received the equipment purchased with their NGfL funding. Between October 2000 and March 2001, reports on the use of ICT to support subject teaching were received from 12 primary schools, 13 secondary schools and 2 special schools. They were based on a pro-forma which asked three questions about the use of ICT in the teaching of English, mathematics and science, with an open-ended section at the end for a more general account of the use of ICT in subject teaching. The teacher-researchers completed them after collecting the views of subject specialists (often Heads of Department) in secondary schools or subject co-ordinators in primary schools. The questions were:

- To what extent does ICT support learning in relation to pupils' preparation for the end of key stage National Tests and GCSEs in each subject area?
- To what extent do you think that the outcomes of the end of key stage National Tests and GCSEs are affected by pupils' knowledge and experience of ICT in each subject area?
- To what extent is the use of ICT in lessons constrained or increased as a result of pupils preparation for the end of key stage assessments and/or the demands of the syllabus for each subject area?

These three questions were asked in relation to each of the three key stages – Key Stage 2 in the primary schools and Key Stage 3 and Key Stage 4 in the secondary schools.

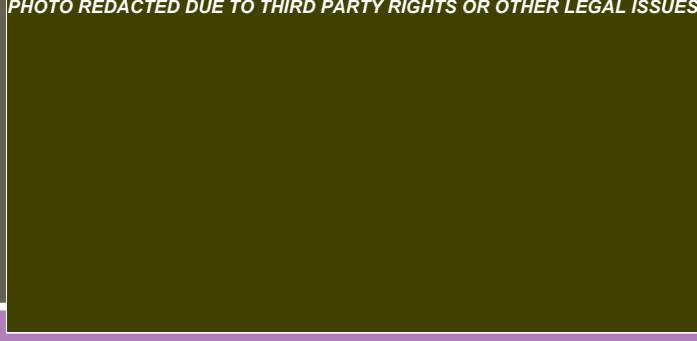
Since there is not space here to cover teachers' answers to all subjects, examples have been drawn from mathematics. The responses to English and science were not significantly different, although word processing was often used in English to improve the presentation of work and there was some use of the Internet to obtain information for science.

It seemed clear from the responses to the questions on mathematics that it was still too early in the implementation of the NGfL for teachers to be able to respond positively. Only one of the primary teachers, from Claypit Lane school, described the use of ICT in the school to support a range of activities in teaching maths at Key Stage 2. This included one particular product which was used with two computers in the classroom to support work on the Numeracy Strategy: "The catalogue presentation of the program allows children to select the activity most closely linked to the lesson objective. The program has an extensive range of activities and usually, this allows a very close link to occur." This teacher also cited a revision site for National Tests, adding that the self-test feature "proved very popular and gave a good, immediate feedback to the children of their performance". This teacher felt that the use of ICT was having a positive impact on pupils' learning of mathematics.

In secondary schools, at Key Stage 3, ICT appeared to be used very little for teaching mathematics. One school, Swanley Secondary, was the exception, with the teacher saying that specialist software was regularly used for teaching concepts, and that this had a positive impact on learning outcomes: "It is not the knowledge of ICT which is important, but using the specially designed software".

Only two of the 13 secondary teachers who submitted reports said that they thought ICT had a positive impact on National Tests and GCSE results in mathematics in their school. For Pilgrim Secondary School, this was in terms of making coursework 'more presentable', using spreadsheets which "help find number patterns and can improve pupil grades", and a revision site which "allows pupils to concentrate their efforts on weak topics and provides instant feedback on individual progress", "boosts confidence" and if used extensively at home "improves their potential grade".

A majority of these teachers reported that ICT was hardly ever used to support the teaching of mathematics at Key Stage 4. This concurs with the responses of pupils reported in section 3 of this report. One possible reason



for this, given by a school that had responded positively to the use of ICT for mathematics teaching, was inadequate levels of equipment; another teacher said that the logistics of moving pupils to equipment were too time-consuming when time was short. However, several other teachers believed that ICT was not relevant to the examination syllabuses and it was, therefore, only likely to be of use for pupils' independent revision. This brief response sums up the problem as this teacher perceives it:

> *"…often exam regs [regulations] do not allow coursework to be ICT generated. Staff aware of lack of time to deliver syllabus."*
>
> *Key Stage 4 mathematics teacher, Sedgewick Secondary School*

It is important to remember here that the study team's questions related specifically to use of ICT in teaching subjects, whereas for many schools the main focus of activity following installation of networked ICT infrastructure was on teaching ICT skills. Cross-curricular use of ICT is difficult for secondary schools to achieve because ICT has traditionally been a specialist subject for GCSE; and the arrival of ICT suites in primary schools has tended to encourage more emphasis on the teaching of skills by a specialist ICT co-ordinator. A major shift in culture and established practice is involved in the introduction of ICT within subject teaching. One teacher believed her school had found a successful strategy by making 'discrete IT' the starting point:

> *"The evolution of cross-curricular IT has been slow and part of a cultural shift in the school. We have not imposed IT on people but have backed up those who want to use it and worked to quietly persuade the more hesitant that it will enhance their subject area. In this way the shift is deep-rooted and done without antagonizing people. The softly, softly approach seems to have worked. The discrete course has given most students a firm capability and in their use of IT they exert some pressure on staff to conform to its use for learning and communication."*
>
> *ICT Co-ordinator, Walsham Howe Secondary School*

In summary, the evidence suggested that the introduction of networked learning was still at too early a stage, that levels of equipment were still too low, and most clearly of all that assessment practices were acting as a significant barrier to any radical shift to using ICT in teaching mathematics.

The proviso that things are about to get better and ICT will have an impact on attainment in mathematics in the near future was stated by several teachers and tended to support the theory that the negative response on the impact of ICT on learning mathematics was the result of asking the questions too early, rather than being an indication of major problems with the implementation of the NGfL.

The case studies carried out by Strand 3 of ImpaCT2, in the second half of 2001, confirmed that schools were beginning to make progress in embedding the use of ICT in teaching and learning.

4.3 Pupils' views

4.3.1 Interview techniques

One of the concerns of the study team within the ImpaCT2 project was to include the voice of pupils themselves. The study team came closest to this in the pupil-researcher task that required pupils to develop interview schedules and then interview each other about their use of the following:

- Electronic games
- The Internet
- Mobile phones
- Rules about using ICT at home.

In asking pupils to carry out tape-recorded interviews, report on and interpret the resulting data, the team believed they could get some ideas about:

- How pupils are using networked technologies outside school for their own interests
- The ways in which they communicate and handle information for leisure and entertainment as well as for schoolwork
- Their perceptions, concerns and values with regard to networked technologies.

It is important to set these interviews in context. In the briefing, teachers were asked to suggest that pupils should think about interviewing techniques seen on television, and the guidelines for the interview asked them to plan the interviews carefully. When pupils were subsequently interviewed about their research, there was evidence that they took their responsibilities seriously and enjoyed the experience whilst finding it demanding. One group of Year 9 girls said with conviction that they had asked the questions they wanted to ask and been absolutely frank in their replies

because this was their opportunity to have their voice heard. On the other hand, all the pupils were conscious that their reports would be seen by university researchers and were both excited and nervous about this. These perceptions of an audience with particular aims and objectives influenced the way that the pupils carried out the interviews. For example, to some extent they will have planned to ask questions that they believed would be appropriate for the research and reflected their understanding of the issues likely to be of concern to adults.

4.3.2 What pupils chose to talk about

There is only space here to present a selection of the outcomes from one of the interview themes: the pupils' use of the Internet. The Internet has been chosen because it is the one which is likely to be having the most consistent impact on pupils' learning. A discussion of the outcomes of all four interview themes is included in the full report of the ImpaCT2 study.

The Internet

There were many questions about favourite web sites and Internet games and a corresponding diversity of response, ranging across film, comics, pop music, sport and geography. This indicated not only that pupils are using the web as a means of pursuing their own leisure interests but that they are wide ranging in their usage and apparently making assessments about the potential of these sites, their presentation and content. For one primary girl this extended to on-line interactions with other people who shared similar interests: "I'll have to say [children's' channel] because that's got the most games on, and the very exciting have got action and they've got lot of clubs on that one".

Although the Internet did emerge as a focus at Key Stage 2, it was significantly more prominent in the interviews of secondary pupils. The more interesting conversations in this theme, however, were those that touched on frequency of use. These interchanges between secondary school pupils are fairly typical of these conversations:

Q. So how often do you use the Internet?
A. Every single day at about 5 o'clock.
Q. So how many hours would you say each day?
A. About one hour 30 minutes to two hours.

Another interchange is as follows:

Q. How much time a week approximately do you spend on the Internet?
A. About an hour I'd say.
Q. A week?
A. No sorry, 6 or 7 hours.
Q. How much time do you spend using your PC then approximately?
A. About 20-25 hours.

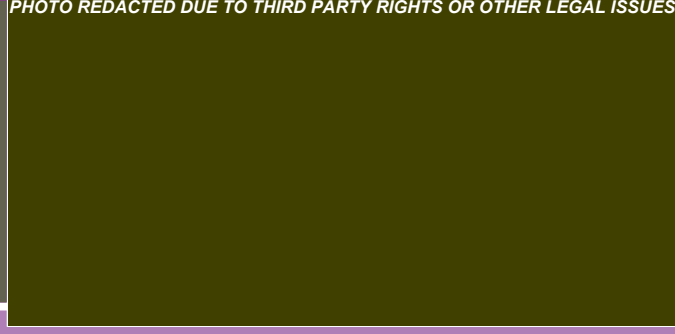
Associated questions focused on what pupils think or like about the Internet and what they use it for. Responses were unanimously positive with descriptors such as 'brilliant', 'great', 'very good and useful', 'a good resource for finding stuff' and 'very helpful for research'.

Comments by pupils linked Internet use with the development of educational knowledge. The interviews of both primary and secondary pupils highlighted the value of the Internet for schoolwork, finding it convenient and information rich, for example: "I think it is easier to go on the Internet than go to the library and it gives you that bit more information that you need and it is easier to read". Homework was prioritised over leisure use, for example one primary interviewee said: "I like using the Internet because it helps with my homework and sometimes I play if I have more time". One Key Stage 2 girl expressed enjoyment of educational resources for her own interests in her talk about a Netherlands web site where: "you get to look at maps… I think it is useful for education like I just told you it's great for looking at map and learning stuff about other countries and history and around the world and stuff about education and stuff you learn in school."

These comments may reflect parents' thinking and the priorities parents give to how home computers are used. This extends to responses about ICT and future employment and the interviews drew out the potential that skilled use of the Internet can have for the prospect of employment: "It can be very useful for looking up stuff on the Internet, help your learning skills because at the moment computer skills are very important in jobs". One Year 9 pupil commented: "…my dad says the world is computer mad, and that being computer literate will help loads in getting a job".

The Internet is also used by secondary aged pupils for leisure purposes. Particularly interesting is the references to the creation by male pupils only of personal web sites:

A: www.[personal web site].com It's my favourite web site because it is my own web site.
Q: Why did you decide to make up your own web site?
A: Because XX was making a web site and I decided to try and make mine better than his.



Chat and e-mail are also important in Internet use for secondary pupils with girls showing preference for chat-related sites. E-mail is considered by several secondary pupils to be an efficient means of communication and a means of keeping in touch with friends which is less expensive than using the phone or helpful if people do not own a mobile. Chat is valued as a good way of 'interacting with other people' and meeting 'new people and friends'.

Safety issues

The pupils interviewed showed a sophisticated and informed awareness of the dangers of the Internet: "Well if their mum and dad aren't careful about the Internet, don't put like special programmes on them, then they could be very dangerous!" Ten- and eleven-year-olds showed particular concerns with regard to chat rooms perhaps because this had been a particular storyline on several teenage dramas at around that time. This was sometimes linked with getting into trouble with parents. When asked whether children should be able to use the chat room without a parent or guardian looking over them, one primary male pupil commented: "No because there could be some rude things and naughty things and stuff on there, so they shouldn't go on it". This is not an isolated reference to 'rude' materials on the Internet, although access by younger children is implicitly referred to as accidental rather than deliberate, as they may "not know what they are doing". As with health hazards, whilst recognising the dangers of Internet access, primary pupils keep it in perspective: "I think it is more fun than dangerous, because you can play games". Ten- and eleven-year-olds consider having their own e-mail address as being a "good way to communicate" as well as being "fun and stuff. It's just nice". One pupil adds that it helps in that "you're learning stuff on the computer".

Although questions focusing on values and moral or ethical issues were predominantly located in a batch of reports from one primary school, other secondary pupils also explored the issue of unsuitable on-line materials. Both Key Stage 3 and 4 interviewers asked about lying about one's age in chat rooms. The reason for this, according to one Year 9 girl, is that: "There are usually a lot of stupid people who try to show off". She adds: "I think it's better to lie about yourself, because if you just go out and give everybody your real age, address and name, it is easier to find you" but also commented: "This topic is also exaggerated." Asked what should be classed as "misusing the Internet", one Key Stage 4 male replied: "Making bombs and such equipment because it's a hazard to everybody else". When asked if he had ever seen such sites on the Internet, the pupil replied: "I have five floppies actually, which contain a read me file all about making bombs and stuff." Risks to personal savings are raised as one Year 9 girl asks her interviewee if she is against on-line bank accounts. The reply indicates that security in a bank and on-line is similar in that "the assistant gets the same details". The same Year 9 female's response to a question about viruses indicates a knowledge and opinion about on-line transmission: "I think that it's greatly exaggerated because nobody opens attachments if they don't know who they're off."

4.4 Implications of these findings

4.4.1 The teachers' views

From the teachers' descriptions of the arrival of networked ICT in their schools, the demanding nature of the NGfL programme becomes clear. Implementation of ICT innovation on this scale is very challenging for schools and teachers and it takes time to embed it in the education system.

Implementation of the NGfL progressed in stages in the ImpaCT2 schools:

- Stage one, which saw the arrival of the new PCs and infrastructure mainly during 1999-2000
- Stage two, during 2000-2001, which focused mainly upon using networked ICT to teach pupils skills in its use
- Stage three, which will see the embedding of networked ICT in teaching and learning of subjects, had not begun in many of the schools involved in the ImpaCT2 study by the time the Strand 1 and 2 research ended. However, there is some evidence from Strand 3 research to suggest that this stage began to be implemented in some schools by the autumn of 2001.

It proved to be rather premature in 2000-2001 to ask teachers questions about the impact of ICT on pupils' learning in National Curriculum subjects. Teachers were taking the first steps to integrate ICT in their teaching, but faced difficulties because the education system was based on traditional assumptions in matters such as timetabling and assessment.

The positive gains in test scores in some subjects in 'high ICT' schools[13] show that despite difficulties, networked ICT was beginning to have an impact on pupils' attainment during this time. It may be that the use of ICT at home, including the use of 'revision sites' (also amongst the most frequent uses at school) was a major factor in these gains.

It seems reasonable to assume that if gains were made by pupils in some 'high ICT' schools during 2000-2001, much greater gains will be likely to occur in future years when ICT is being used much more frequently and fully in teaching National Curriculum subjects.

4.4.2 The pupils' views

The interviews which pupils conducted with their peers provided rich insights into the wide range of Internet activities that pupils engage in, mainly at home. Their accounts of their Internet experiences, and the enthusiasm they showed in describing them, contrasted strongly with their teachers' accounts of the use of ICT in schools.

This wide-ranging use of the Internet by many pupils in their homes has great potential to support their learning. Schools need to consider how to build on their pupils' experience, developing skills and enthusiasm in relation to networked ICT.

In the questions pupils chose to ask, the replies they were given and their analysis, we have a different insight into pupils' perceptions of networked technologies and through this how they connect to a range of ideas and values that adults hold with respect to ICT. From this analysis it is possible to make the following observations:

- Pupils are discriminating in their use of the Internet in terms of appropriateness and searching for web sites that appeal to them.
- Pupils are aware of the moral and ethical debates surrounding the use of networked technologies, and the perceived security risks associated with the use of the Internet.
- Home use of networked technologies such as web sites supports both self-directed and school-directed learning.
- Communication with family and friends is very important to pupils and the way they use electronic forms of communication may well support skill development.

The picture clearly emerging from this data is of the potential of ICT to be used with more vision in the school curriculum. ICT connects with a range of social practices specific to cultures in general and youth culture in particular. The meanings, practices, images and identities pupils take on board in relation to ICT allow them to come to terms with a range of social, health and political ideas raised by the use and marketing of ICT. In these interviews about their experience of ICT, pupils are engaged in discussions about important matters of concern to the adult world, such as health dangers, virtual worlds, gender issues, and the role of the media. This suggests that ICT not only has an impact on attainment in National Tests, it may also be able to provide motivating and stimulating teaching connected in a real way to a wealth of curricular issues.

Section 5 – Pupils' understanding of the role of computers in today's world

The key findings from this section are:

- Pupils have an extensive awareness of the role of computers in today's world. Awareness varies between individuals but many are knowledgeable about a wide range of equipment and how it is used, as well as the varied purposes of its use by all kinds of people in many different locations. This has implications for the speed and ease with which they are likely to become skilled in using networked ICT: they may develop skills in using networked ICT more quickly and easily than is often anticipated by schools and teachers.
- At all three key stages included in the study there is a significant and positive relationship between the levels of awareness held by pupils of computers in today's world (as suggested by the complexity of their concept maps) and whether they had home access to the Internet and their own personal e-mail address.

[13] *ImpaCT2 – The Impact of Information and Communication Technologies on Pupil Learning and Attainment* (Becta, Coventry: 2002: www.becta.org.uk/research/impaCT2).

- There is also a significant and positive relationship at all three key stages between these levels of awareness and pupils' experience of surfing the Internet.

5.1 Introduction

This section reports on the 'concept maps' as drawn by pupils, in order to reveal their understandings of what technologies are, and how and where they are used in everyday life. The relationship between pupils' self-reported experience of use of ICT and their understanding of the complex nature of ICT as portrayed in their concept maps is also considered.

The kind of concept mapping used in ImpaCT2 aims to get a picture of how a person thinks about a topic. It is useful for school pupils, whose verbal abilities may vary widely, to sketch out in a simple visual language what they think.

The results are not only interesting; they can be of practical value. We know from recent research on learning that how learners think about a tool (such as ICT) affects their ability to acquire the skills to use that tool effectively.[14] That is, models of thinking about a tool and the skills necessary to use it develop in tandem. This being the case, teachers might benefit from understanding in more depth the relationship between the models of thinking about ICT held by their pupils and how they acquire ICT skills.

A concept map contains:

- 'nodes' – which name or illustrate key ideas or elements, and
- links between those nodes – which show the links between those key ideas or elements.

This means that a straightforward concept map has two kinds of complexity:

- The number and types of nodes – which show the richness of a pupil's thinking (the more nodes there are, the more the pupil has 'to say')
- The number of links – which show how a pupil is structuring ideas, and the richness of the perceived relationships between different ideas or elements.

The more nodes and links there are in a concept map, the more extensive a pupil's understanding of the topic is likely to be. However, analysing concept maps is not a simple task. A systematic approach was developed during this study for the interpretation of concept maps. This approach recorded the following:

- The number of nodes in the map (the images or words in boxes)
- The number of links (the lines joining the nodes together)
- Connectivity (the number of links divided by the number of nodes)
- 'Spheres of thinking' (the different ways that technologies are used)
- 'Zones of use' (the places where technologies are used).

These results were then analysed using statistical methods.

In addition, the study team was aware of emerging patterns in pupils' ways of thinking about computer technologies. Just as in a photograph, some elements were in the foreground, others were in focus but more distant, and some were out of focus and in the background.

This section of the report presents the findings based on these two ways of analysing the concept maps as drawn by the pupils.

Further explanation of the concept mapping exercise and how it was carried out can be found in appendix 1.

5.2 An overview of the concept maps

The concept maps provided the study team with insights into pupils' thinking at that time. Producing concept maps rather than writing allowed ideas to be communicated in a particular way. The ways in which pupils chose to link their images and structure their maps also gave clues about their thinking. The following sections highlight the key respects in which this thinking can be analysed.

Complexity

The data suggested that maps with a large number of images generally indicated awareness of a wide range of computer equipment and electronically based human interactions and activities, and locations where they can be found. Those maps which had a large number of links suggested understanding of the networked nature of digital technologies. As a whole sample, the maps provided a measure of the complexity of each pupil's awareness of

[14] See appendix 1 for more on this, in particular the section 'Why concept mapping?'

computers in their world, those with more images and links being likely to have a broader understanding of the role of computer technology in our society.

A comparison across the key stages indicated a general increase in mental models with age, although there were exceptions across the sample. This was particularly evident in the baseline data (Table 5.1). Mean (average) scores for the five categories of analysis showed a general trend of progressively higher scoring across the key stages. However, the change in the task at Key Stage 4, which permitted text in place of the images, may have slightly inflated these scores (given that writing a word takes on average less time than drawing an icon).

Table 5.1: Baseline concept mapping descriptive statistics

	Key Stage 2			Key Stage 3			Key Stage 4		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Nodes	2	68	13.96	2	73	17.59	2	95	25.12
Links	0	213	29.13	0	168	38.18	0	392	60.93
Connect	0	8.64	1.91	0	7.38	2.05	0	6.83	2.41
Spheres	0	8	4.04	0	9	4.63	0	10	4.95
Zones	0	8	2.02	0	10	2.90	0	9	3.48

A further comparison between those pupils who produced concept maps in both June 2000 and June 2001 was also undertaken. The scores (nodes, links, connectivity, spheres of thinking, zones of use) from both of the maps for each of these pupils were tested to establish whether or not there were statistically significant gains over time. The 470 Key Stage 2 pupils showed an increase in the number of nodes they drew (the mean increasing from 14 to 17), the number of links (the mean increasing from 31 to 37) and the number of spheres of thinking (the mean increasing from 4 to 5). At Key Stage 3 the 309 pupils showed an increase in number of nodes (the mean increasing from 19 to 20) and an increase in the number of spheres of thinking (the mean increasing from 4.9 to 5.5). These gains over time were all statistically significant.[15]

Overall, comparison between the data for Key Stage 2 and Key Stage 3 indicated that the pupils' knowledge of 'Computers in My World' had increased over the period of a year. This would be expected on three counts: the pupils were all one year older; the uptake of computers and networked technologies within British society (including schools and homes) had continued to increase during the year; and the National Grid for Learning innovation had been more fully implemented over that time, with almost all of the schools involved in the ImpaCT2 study having received a substantial amount of new equipment by June 2001. The increase provided the study team with confirmation that the image-based concept maps provided robust data on pupils' experience and learning about 'Computers in My World'.

The data for the 249 Key Stage 4 pupils did not demonstrate the same trend of increased complexity. In fact, there was a decrease in the number of links (the mean decreasing from 67 to 61), a decrease in the number of zones of use (the mean decreasing from 3.8 to 3.1) and also a decrease in connectivity scores (from 2.39 to 2.21). These changes in scores over time were all statistically significant. Although this might appear to be a disappointing result, it should be interpreted with caution. A contingent factor was that the ImpaCT2 16-year-olds completed the 2001 concept mapping task in the period immediately prior to taking GCSE or other national examinations, or in one or two cases immediately after they had completed an examination paper (while they were available in school). Many of the teacher-researchers reported that these pupils had, as a result, not given the task the same commitment as they had the previous year. However, these decreases might also be seen to be consistent with other strong indications in the ImpaCT2 data of the extent to which pupils' use of ICT either reduced or became more narrowly focused in the period leading up to GCSE. As concept maps captured their thinking at the time, rather than measuring the extent of their knowledge, this might have led to a reduction in the complexity of the maps.

The concept maps produced by one pupil over the course of a year are presented in section 5.3 in order to illustrate the increase in complexity that can be found between concept maps.

Recurring patterns

Although each concept map was unique and varied in detail, content and complexity, there were patterns of

[15] Statistical significance is a way if measuring how certain we can be regarding a particular finding. All results obtained by statistical methods are open to the possibility that they might be the result of 'statistical accident'. Statistical significance is determined by the possibility that this accident has not happened. Further information on the methods used in this study can be found in Appendix 1 of this report and in the full ImpaCT2 report.

frequently recurring images across the sample that provided the study team with an overview of how pupils generally thought about new technologies in their world. These fell into the two main categories mentioned above: 'spheres of thinking' and 'zones of use'.

Through the process of coding the spheres of thinking and zones of use categories, the kinds of patterns of awareness predicted by the theory behind the procedure used to analyse the concept maps began to be revealed (this theory is called phenomenography and is explained further in Appendix 1). Some pupils focused their awareness mainly on one sphere of thinking. For example, some focused mainly on communications, some mainly (or occasionally exclusively) on games, and others on information gathering. Sometimes, pupils' maps gave higher significance to some items than others, for example with three of four drawings relating to communications and only one relating to locations. Some did not include any zones of use in their maps, while some focused their awareness on use of computers in the home, some on their use in the workplace, and others on school. Sometimes, there was a more even distribution, with maps showing awareness of items in each category.

Two concept maps are presented in section 5.3 in order to illustrate the two main categories of concept map.

Relationship with access to ICT outside school

One of the statistical analyses undertaken by the study team was to look at the concept mapping against the pupil questionnaire data.[16] This enabled the study team to study the possibility of a relationship between pupils' conceptions of ICT and individual access to and experience of ICT outside school. However, the fact that the questionnaire responses were recorded on a two-point scale (yes or no responses) made it difficult to demonstrate strong associations between these data. Nevertheless, it is of note that, in the baseline data, significant positive associations were found at all three key stages between pupils who had high concept mapping scores and those who had home access to the Internet and their own personal e-mail address. Significant positive associations were also found at all three key stages between high concept map scores in at least three of the five categories (that is, nodes, links, connectivity, spheres or zones) and experience of surfing the Internet. At all three key stages these included either nodes, links or connectivity and also spheres of thinking, and this was considered to be sufficient evidence to suggest a relationship between surfing the Internet and levels of awareness of the role of computers.

Within each individual key stage, there were also significant positive associations between high concept map scores and other aspects of home ownership and ICT experience. Interestingly, however, there was no pattern of significant associations between high concept map scores and those aspects of ICT ownership and use which are not directly related to the Internet (for example, games console ownership, mobile phone ownership, games playing, word processing and desk-top publishing).

The interconnectedness of technologies – communication and the Internet

In some of the maps the images were connected by a single link to a central node much like a spider diagram. Other nodes were joined together adjacently to form a chain. In other maps, links were drawn between several objects (particularly the most complex maps where the links criss-crossed one another and became highly complex). The latter indicated knowledge of the extensive interconnectedness of information and communication technologies. Together, the nodes and links imply the communicative power of technologies, their interdependence with other technological devices and the ways in which they connect human beings. These images of electronic information and communication provide insights into pupils' perceptions of the cultural and social uses of computers, that is, how people use them in their everyday working and personal lives. Representations of the Internet were evident across the key stages but were perhaps particularly developed in the maps of older pupils. A concept map is presented in section 5.3 that illustrates a pupil's awareness of the uses of computer technologies for information and communication.

Technological versus human focus

Another respect in which the study team was aware of emerging patterns in pupils' ways of thinking about computer technologies was, as mentioned above, the way in which pupils chose to place elements in the 'foreground' or 'background' of their concept maps. One example of this was the way in which some pupils focused on

[16] See *ImpaCT2 – The Impact of Information and Communication Technologies on Pupil Learning and Attainment* (Becta, Coventry: 2002: www.becta.org.uk/research/impaCT2).

technical detail, while others provided a more balanced view of the use and value of computer technologies in today's world. Two concept maps are presented in section 5.3 in order to illustrate this difference of focus.

Newly available technologies

Trends in the maps produced in June 2001 reflected the appearance of newly available technological devices; there was an increase in the number of mobile phones and DVD players. Interview data suggested that the ways in which pupils acquired this knowledge were not the result of a single source. In some cases it appeared to be based on experience (for example, owning a mobile phone), whereas in others it appeared to be a result of popular culture (that is, shared knowing through advertising and discussion with peers).

Other elements in the concept maps

Particularly in the word-based Key Stage 4 maps, pupils indicated emotions about their computer use. These included excitement and fun, as well as boredom and frustration. References to the potential dangers of the Internet implied broader social concerns. The older pupils also made reference to specific uses of ICT in curriculum subject areas and there were some references to the use of computers to enhance job prospects.

5.3 Illustrative examples of the concept maps

A number of the concept maps produced by pupils are presented below in order to illustrate some of the themes identified above.

Complexity

An illustration of an increase in a pupil's complexity of understanding as revealed in a concept map is included below. Gail is a Key Stage 4 pupil. Her scores are shown in Table 5.2.

Table 5.2: Gail's concept mapping scores for 2000 and 2001 (Key Stage 4)

	Nodes	Links	Connectivity	Spheres of thinking	Zones of use
June 2000	43	102	2.37	6	3
June 2001	62	140	2.26	7	4

Gail's June 2000 concept map (Figure 5.1a) is made up of words in boxes linked with ruled lines. It appears to have been carefully planned around three zones of use (school, shops and home) and two spheres of thinking (the Internet and e-mail). In contrast, her 2001 concept map (Figure 5.1b) has been drawn freehand, once again using text only (no drawing of the central image of a computer this time) and without boxes around the nodes. School-related nodes still occupy mainly the top right-hand quarter and the rest of the map presents a wide-ranging account of computers in her world. The range of zones of use is broader – for example, hospitals, cinemas, holidays and banking are included, none of which appeared before. There is also extension to represented equipment which included digital cameras, scanners and CAD/CAM (Computer-Aided Design/Computer-Aided Manufacture).

Recurring patterns

As mentioned above, although each concept map was unique, there were patterns of frequently recurring images across the sample. These fell into two main categories: 'spheres of thinking' and 'zones of use'; 'spheres of thinking' relates to the different ways that technologies are used, while 'zones of use' relates to the places where technologies are used.

With regard to spheres of thinking, it is no surprise that the overwhelming majority of pupils drew a computer somewhere in their concept map, and included related items of equipment such as monitors, keyboards, printers and mice. However, they also often included other electronic devices such as televisions, telephones, digital cameras, scanners, camcorders, microphones, speakers, CD players and hi-fi equipment. In particular, electronic games devices (consoles, hand-held games and PC computer games, appeared in a vast majority of concept maps.

The games were drawn in a way that made them readily recognisable and often included very specific detail such as cards and control buttons (see Figure 5.2). The names of particular games were sometimes recorded, as in Figure 5.2, where James positioned his electronic games together as a group to the top right of his map.

With regard to spheres of thinking, across the three key stages, pupils recorded a range of locations where computers are used, for example the home, school, workplaces (for example, the office or factory), banks, shops, hospitals, libraries, Internet cafés and transport. Examples of more unusual locations such as games arcades, cinemas and prisons appeared, but less frequently. An example of a map where the individual's focal vision was clearly focused on zones of use is shown in Figure 5.3.

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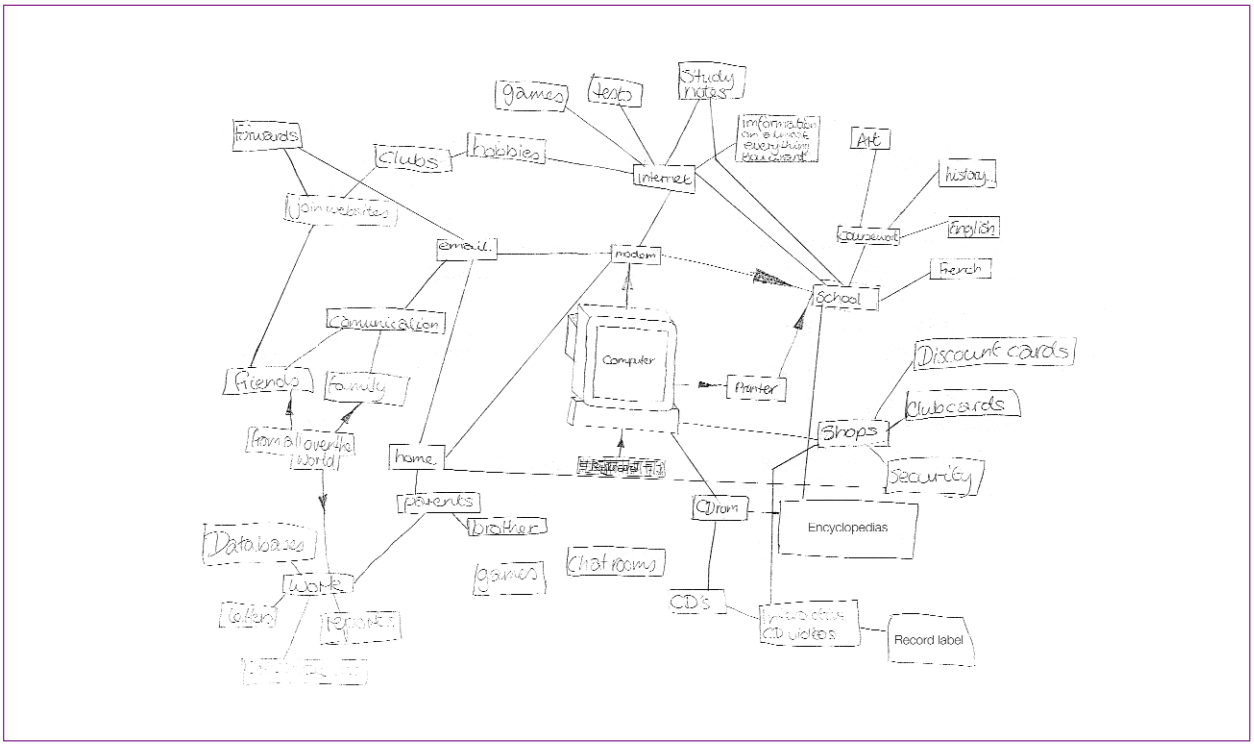
Figure 5.1: Gail's concept maps (Key Stage 4)

(a) June 2000



(b) June 2001

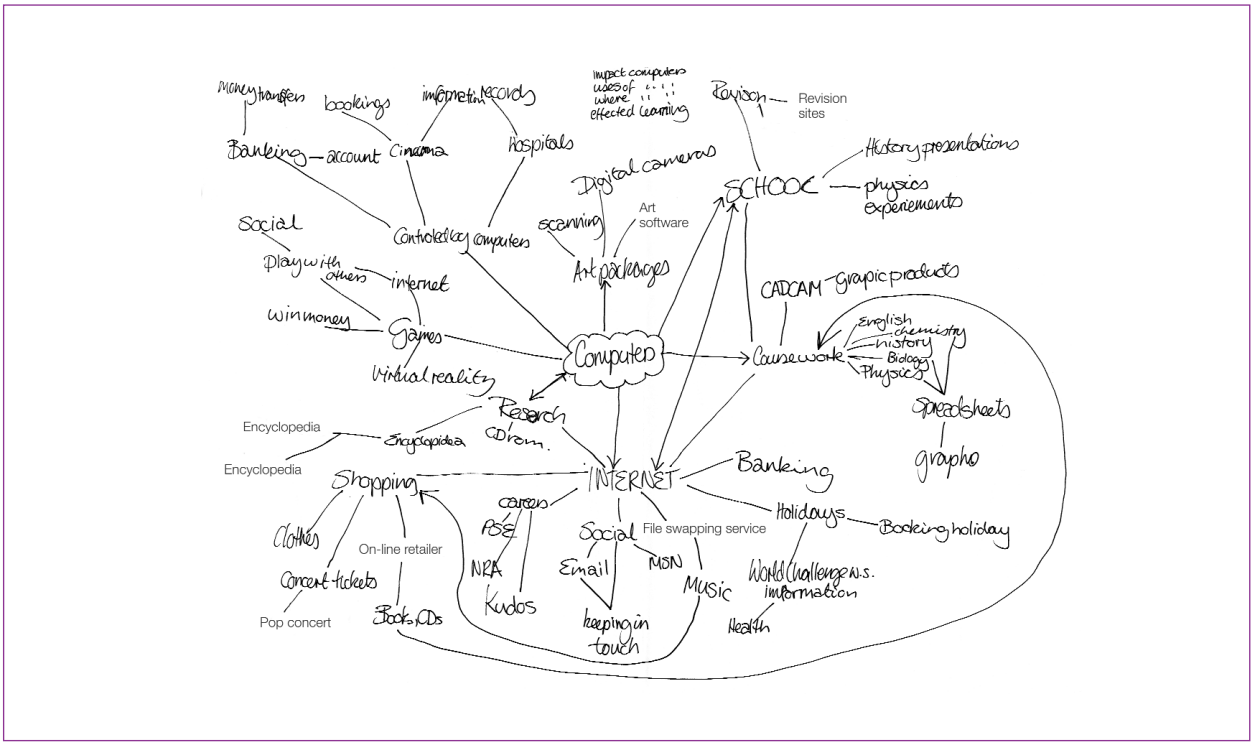


Figure 5.2: Electronic games (Key Stage 2 boy, June 2000)

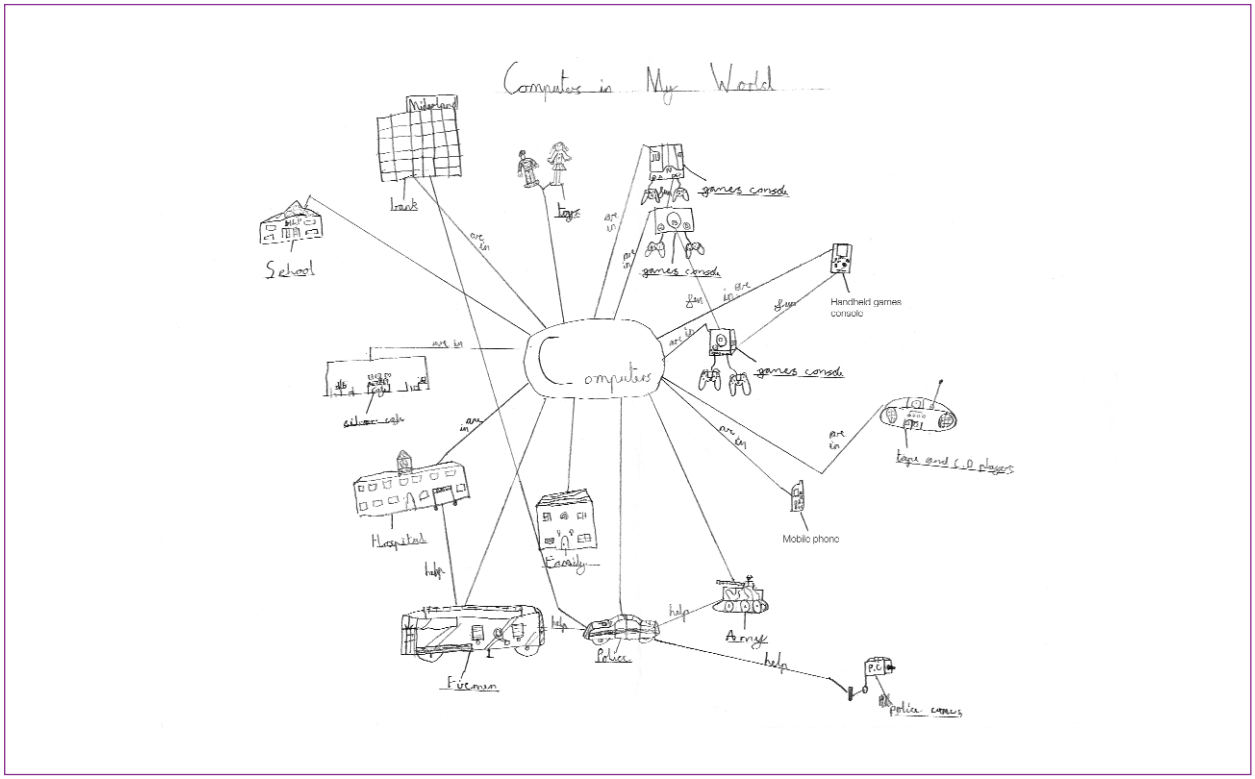


Figure 5.3: Zones of use (Key Stage 3 boy, June 2001)

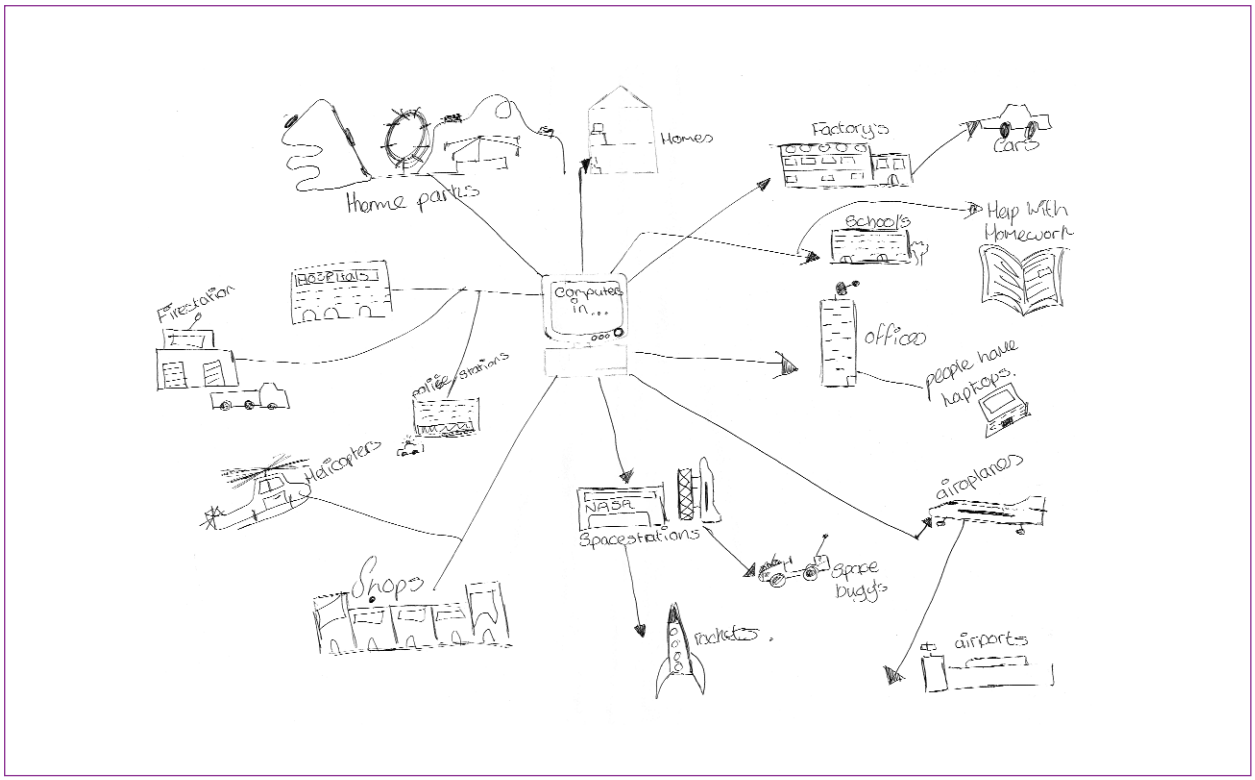


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Figure 5.4: Information and communication (Key Stage 3 girl, June 2000)

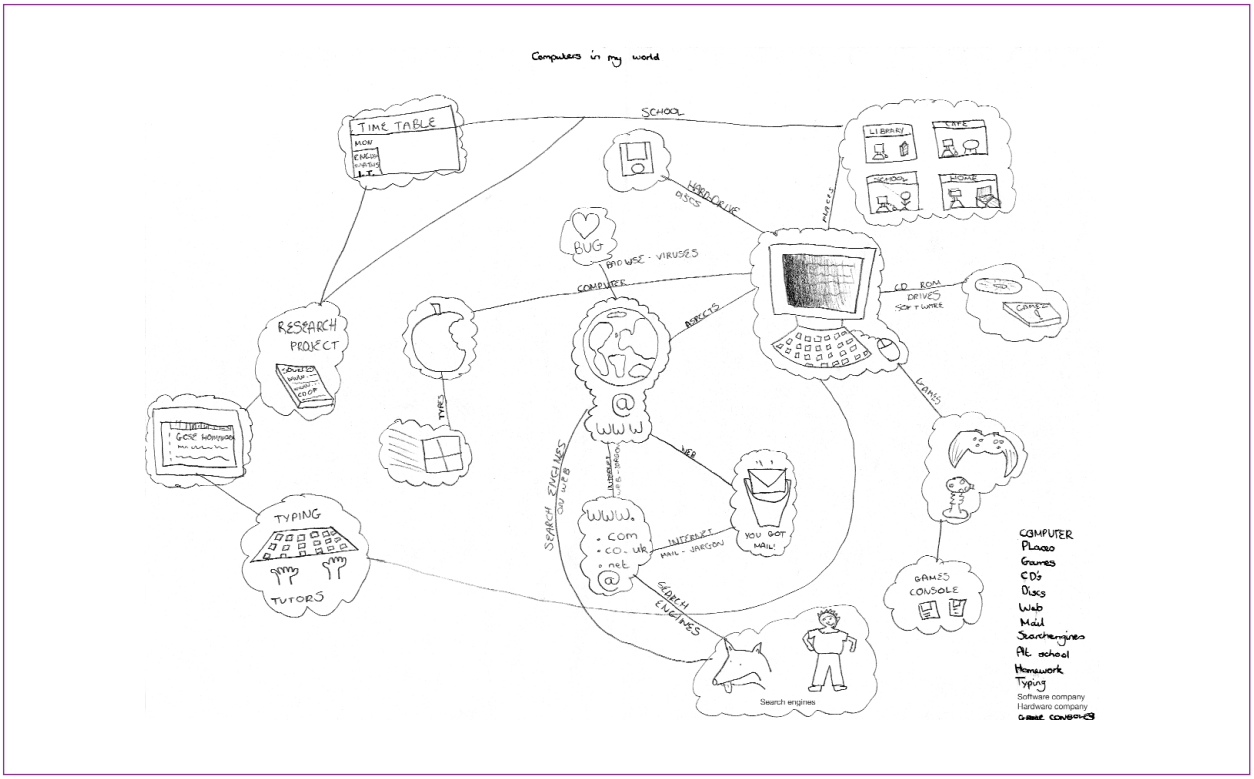
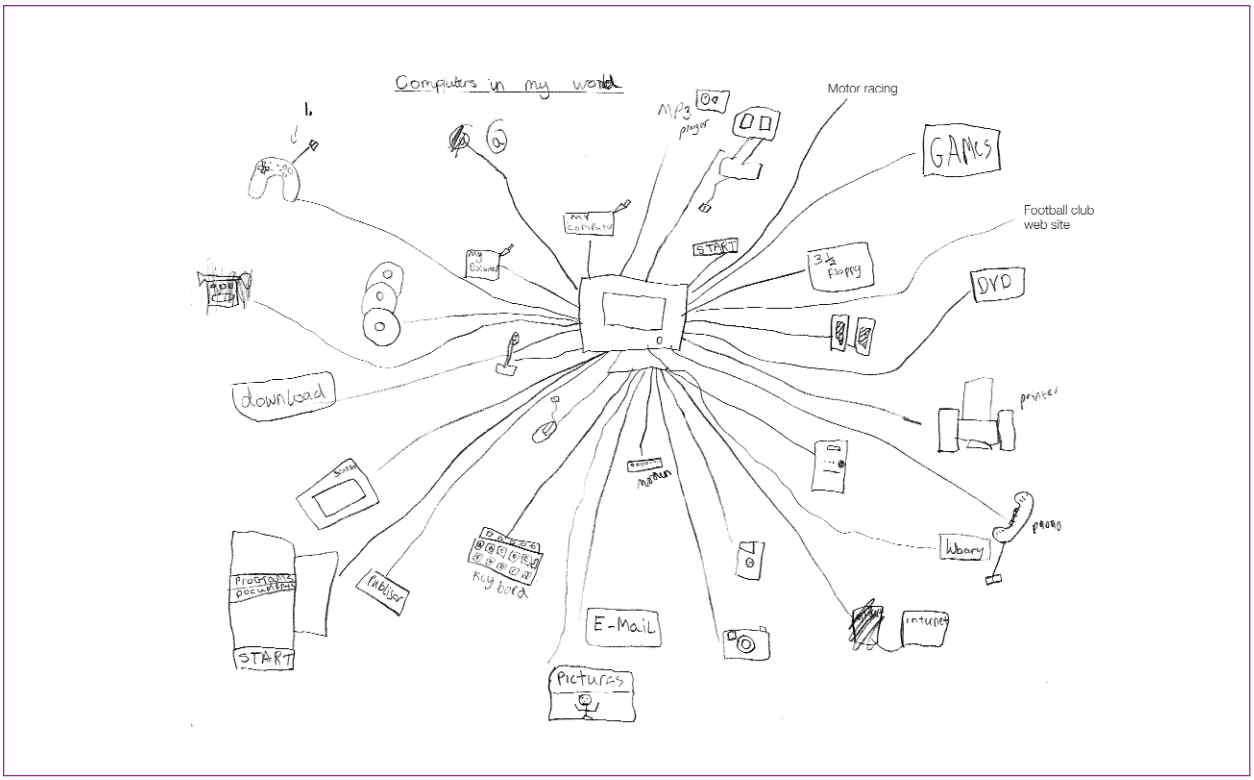


Figure 5.5: Simon's concept map (Key Stage 2, June 2001)



The interconnectedness of technologies – communication and the Internet

As suggested above, in concept maps the nodes and links can imply the communicative power of technologies, their interdependence with other technological devices and the ways in which they connect human beings. Figure 5.4 is a good example of a pupil concept map that captures the uses of computer technologies for information and communication.

Technological versus human focus

One example of the way in which pupils chose to place elements in the 'foreground' or 'background' of their concept maps was a focus on technical detail as compared to providing a more balanced view of computer technologies in today's world.

Technical detail was at the forefront of Simon's thinking, as illustrated in his concept map (Figure 5.5). Simon was a Key Stage 2 pupil. He said that he spent most of his time on the computer playing games with the joystick and a 'dual pad', using the mouse to install, load, remove and download games, MP3s and video clips. His references to aspects of the graphical user interface of the operating system on computers, passwords and saving downloads in a specific folder implicitly suggest knowledge about technical skills and electronic organisational strategies. He also mentioned using e-mail and voicemail.

However, when specifically asked about the Internet, he focused on accessing information "in your own house sometimes, for finding information out like in a museum or something, like the air force, or like garages, where you buy cars from, if they haven't got it yet and you can buy it and they could show the customers what car it is and what it is like". He also mentioned computers in libraries and "they use them mostly in schools to try and educate pupils and they use them in colleges and universities". Thus, it was not that he did not know about spheres of thinking and zones of use but that his 'focal vision' was technically oriented.

Another pupil's concept map represents a more balanced view of the use of computers. Paul's (Figure 5.6) contains 29 nodes and 149 links, giving it a connectivity score of 5.14. This is above the mean (average) of the Key Stage 3 baseline data. Each node consists of a word or words and an iconic image. Some of these pictures communicate specific ideas. For example, the Internet is represented as a web alongside a telephone receiver, and the world image shows computers located on landmasses. Together, these carry Paul's thinking about the global interconnections of technologies and suggest interrelationships between people through technologies. The central 'Computers in My World' node, which has an area of unoccupied space around it, acts as the title for the map whose remaining nodes are organised non-hierarchically.

Close study shows three main groupings. At the top of the page, Paul has represented technologies for leisure: games console, computer games, DVD, surfing the net, films, computer animated films, fun, CDs and 'PC leisure'. Their location here may suggest importance in the top to bottom orientation of the page. To centre left and bottom Paul's nodes are zones of use: school (where ICT is used for learning and 'good presentation'), business and shopping (a score of three). The area with the largest number of nodes focuses on information and communication: the Internet, communications, information, phone calls, mobile phones, text messages, e-mail, television e-mail, digital television and world computers (with a quantitative score for spheres of thinking of eight). This section of the map also contains the most complex links. The communications node has the greatest number of links in Paul's map, largely to others in the same grouping. Interestingly, this grouping's links beyond itself are to the title node, the leisure area, shopping and business/work – hence it represents a balanced view of the use of computers, that is, for enjoying living, for everyday living and for making a living.

5.4 Examples of use drawing on concept maps and pupil-researcher materials

In section 3.6 two pupil-researchers were selected to illustrate the diversity and richness of some pupils' ICT experience in the home. We now return to these pupils to see how this is also reflected in their concept maps.

Simon, a Key Stage 2 pupil, was used in section 3.6 to illustrate the significant use of ICT for leisure purposes, with evidence drawn from his pupil log. Simon's concept map has already been presented in section 5.3.

Table 5.3: Simon's (Key Stage 2) concept mapping scores for 2000 and 2001

	Nodes	Links	Connectivity	Spheres of thinking	Zones of use
June 2000	28	64	2.26	7	1
June 2001	32	63	2	6	1

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Figure 5.6: Paul's concept map (Key Stage 3, June 2000)

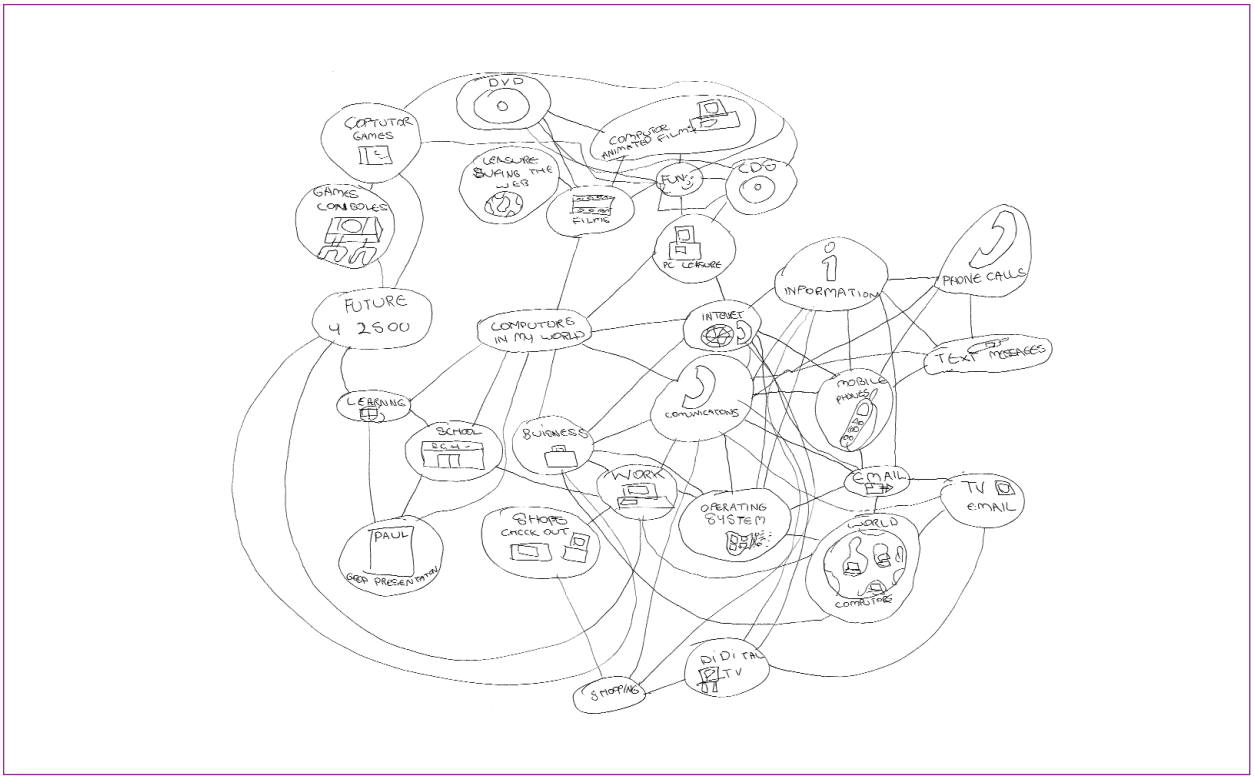
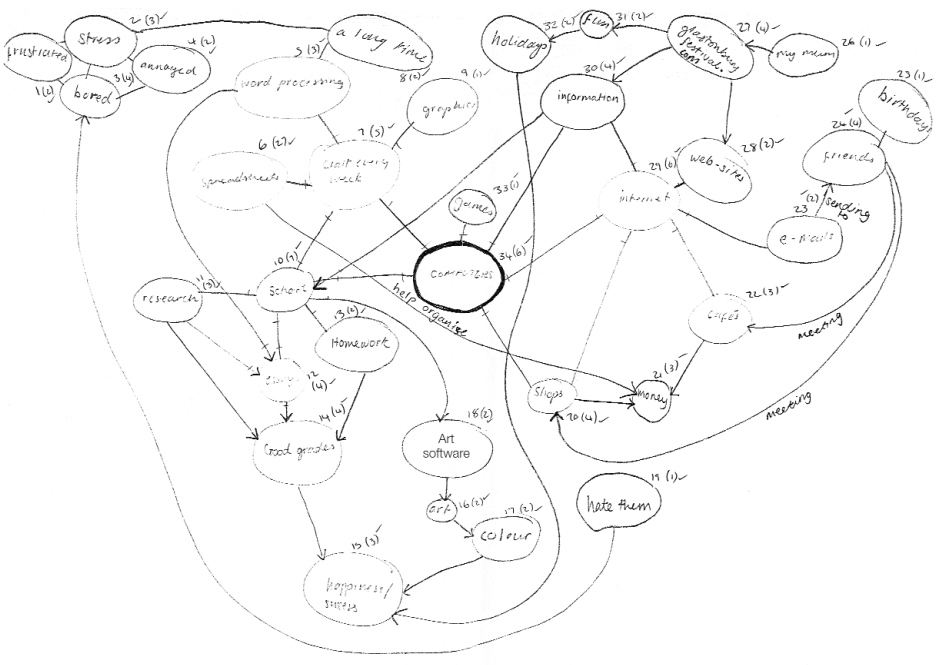


Figure 5.7: Olwen's concept map (Key Stage 4, June 2000)



Simon's concept map is typical of those in which the central node is a computer surrounded by objects linked to it and not to one another. Of the 32 nodes, 28 were listed on the back of the original drawing which assisted in the identification of some of the objects, for example, the monitor which appears between 'library' and 'phone'.

There are six 'spheres of thinking' (different types of use of ICT): computers or parts of computers (12 nodes), games (3), the Internet/information (3), e-mail/communications (4), music/sound (4) and images/photos (3). There is only one 'zone of use' (different locations in which ICT is used) – 'library', although 'my computer' probably indicates use at home. A comparison between this map and the one he drew a year earlier suggested that during that time he had learnt more about using computers to download and record music and images, and that he had become more aware of the Internet and communications.

Olwen, a Key Stage 4 pupil, produced a fascinating special report on how ICT had been used at home to support a school-related task. This was included in section 3.6. Her concept map is included here (Figure 5.7) along with her scores for the two concept mapping tasks. Olwen's special report suggested a pupil who has already acquired considerable ICT skills and who found the time she had to spend at school on basic ICT skills classes somewhat de-motivating. The concept map she drew supports these mixed emotions.

Table 5.4: Olwen's (Key Stage 4) concept mapping scores for 2000 and 2001

	Nodes	Links	Connectivity	Spheres of thinking	Zones of use
June 2000	34	99	2.91	4	3
June 2001	42	104	2.45	7	5

Olwen's June 2000 concept map is made up entirely of ringed text rather than images. The word 'Computers' is in the middle and other nodes are grouped round this, with the Internet and nodes representing social activities, leisure and fun on the right-hand side, and school and related activities taking up most of the left. Some of the nodes represent emotions rather than objects.

A large node linked to both 'computers' and 'school' is labelled 'Clait every week'[17] and linked to a cluster of skills (spreadsheets, word processing and graphics), and then, through a node labelled 'a long time', to another cluster of four nodes labelled: 'annoyed', 'stress', 'bored' and 'frustration'. And then, in what Olwen may think is an act of rebellion because the link goes two thirds round the sheet of paper to the bottom centre right, this cluster of nodes about negative feelings is linked to one called 'hate them'. Other aspects of school use of computers, however, express more positive emotions. The lower part of the left-hand side of the map shows essays, research and homework linked to 'good grades' and then on to 'happiness/success'.

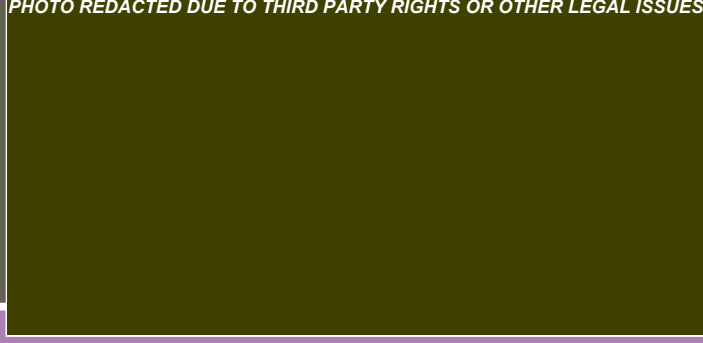
Yet Olwen also presents a glimpse of how computers integrate with her social and family life. 'Shops' is part of the Internet cluster, linked to 'money' and 'meeting friends', with other happy references such as 'birthdays', 'e-mails', 'friends' and 'cafés'. The Internet is also linked, via web sites to 'Glastonbury Festival', 'my mum', 'fun' and 'holidays'.

5.5 Implications of these findings

The concept maps revealed the surprising and fascinating extent and scope of pupils' thinking about 'Computers in My World'. Patterns emerged clearly across the sample: the maps depicted not only computer equipment, but the uses to which digital technologies are put and the places where they are used in everyday life. Sometimes, pupils' awareness focused largely on items of technological equipment, sometimes on a particular 'sphere of thinking' such as communication or information, sometimes on 'zones of use' such as home, the library or the bank. Often, their awareness combined two or three of these. Yet each map was unique in that each individual included a different combination of images and words according to his or her own interests at that point in time. This indicates both commonalties in pupils' shared cultural and social thinking about computers in their world, and individuality within it.

Statistical analysis of the quantitative evidence from the maps shows that pupils who reported frequent use of networked technologies, such as the Internet and e-mail, tend also to produce complex concept maps: there was an association between frequency of use of networked ICT and a well developed awareness of the role of computers in today's world. The importance of this finding was confirmed by the fact that there was no association between complex concept maps and uses of ICT that did not involve networking, such as word processing and games consoles.

[17] Computer Literacy and Information Technology (CLAIT) is a widely taken IT user qualification.



The concept maps show that many pupils have the kinds of conceptions of ICT that are needed to imagine and plan creative ways of using networked ICT. This strongly suggests that they are ready to acquire skills in the use of ICT easily and quickly and use it in self-directed ways for a wide range of purposes. This concurs with their use of ICT in the home as presented in the previous sections.

This has important implications for the use of ICT in schools. In particular, it suggests that the emphasis on teaching ICT skills rather than integrating the use of ICT in subject learning is unlikely to make the best use of expensive resources. Pupils who have a well developed awareness of the role of ICT in the world should be able to take more responsibility for developing ICT skills in self-directed learning. Safeguards such as checklists and self-test exercises could, of course, be used as a back-up. A shift in emphasis of this kind would also depend on pupils being well motivated to use ICT at school, as they are at home. This suggests that the curriculum needs to allow individual pupils more choice, perhaps by including more scope for self-directed project work.

Concept mapping proved to be a valuable tool in evaluating pupils' thinking about 'Computers in My World'. It provided an insight into their conceptions of computer technologies. The concept maps were a means of capturing and recording particular facets of pupils' thinking in a way that may not have been possible through talk and certainly would not otherwise have been feasible with such a large amount of data. The positive outcomes achieved in this study suggest that concept mapping is a worthwhile research tool for further development.

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Appendix 1 – ImpaCT2 Methodology

1) Concept mapping

The purposes of concept mapping in the ImpaCT2 study

At a time when networked technologies are having a radical impact on many aspects of our society, it was important to look at the kind of impact they were having and could have in the future, on the lives of pupils. An increasing number of families own a computer and have access to the Internet, digital television, electronic games, video, DVDs, CDs, camcorders, digital cameras and mobile phones. If technologies are becoming an integral part of pupils' experience in the culture of the home, in their peer groups and in schools, this has major implications for how they conceive of their role in everyday life.

In order to understand how pupils thought about technologies, the ImpaCT2 team used 'concept mapping'. Its aim was to gain an insight into pupils' understandings of the role of computers in today's world. Within the project, the concept mapping task was important for three main reasons:

- It provided evidence from each of the pupils involved in the ImpaCT2 study (over 2,000) of their own unique understanding of ICT at that time.
- It was a means of expressing ideas quickly through drawing (or single words) in a way that was neither possible nor measurable in 'traditional' tests.
- By repeating the concept mapping the researchers were able to establish a baseline and then look for changes in pupils' awareness over a year.

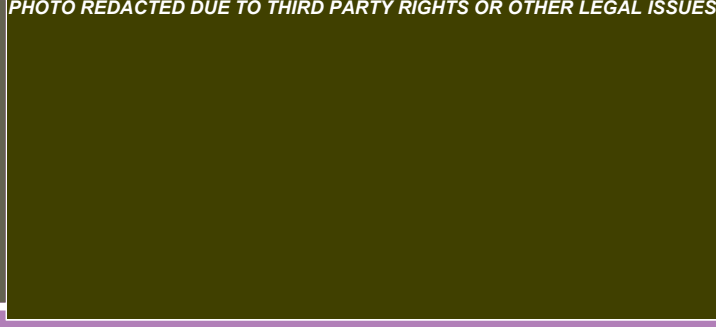
ImpaCT2 therefore set out to explore pupils' mental models of computers in their world using a form of concept mapping that captured their awareness at a particular moment on a particular day. The concept maps were not intended to be an exact measure of individual pupils' understanding. However, the whole sample (over 3,000 maps in total) gave the study team fascinating insights into the thinking of a generation of young people growing up in a networked world.

Why concept mapping?

Traditional concept mapping was first developed as a tool to assist learners in building their own understanding (Novak and Gowin, 1984). It consists of putting words that represent concepts in boxes and linking these by means of words or phrases, so that the connections can be read. In their early work Novak and Gowin found that this approach gave teachers and researchers more accurate insights into pupils' thinking than traditional methods of testing. Concept mapping has also been used as a tool for teachers to debate and define meanings with learners, often using computer-based concept mapping tools (McAleese, 1998; Anderson-Inman and Ditson, 1999). The ImpacT2 concept mapping has been used rather differently, in a manner much closer to Buzan's (1993) notion of a 'mind map' as an 'external mirror' of the 'internal structure and processes' of 'radiant thinking'. It built on the work of Project RÉPRESENTATION (Crawford *et al.*, 1999).

It has long been known that the capabilities of human beings are changed, and often improved, by skilled use of tools. Psychologists such as Wertsch (1998) describe human activity as 'mediated' by tools. Wertsch gives the example of a pole vaulter to illustrate the inter-dependency of an athlete with a tool to achieve something that could not otherwise be achieved. The work of Vygotsky (1978) shows that, in addition to tools like a vaulter's pole, there are large numbers of conceptual tools that transform human capabilities, including spoken and written language, graphs and diagrams, and mental organisers such as numerical tables. Developing skills in the use of both kinds of tools is one of the fundamental purposes of education.

Tools are only useful to skilled hands and minds. Evidence from previous research showed that many young people develop a high level of proficiency in their use of computers; they acquire skills quickly and easily (Downes 1997; Furlong *et al*. 2000). This raised the question why. The work of other psychologists, in particular Cole (1999), suggested that there are three crucial factors that facilitate the acquisition of skills. The first is sustained access to use of the tool, and there is much evidence to suggest that pupils are willing to devote a great deal of time to the computer if there is one around. The second is a mental model of the tool that makes it possible to predict its possible uses and plan specific activities using it. Without such a mental model, skills will be acquired more slowly because there is no clear purpose to their use. The third is that children frequently adopt exploratory strategies with computers, for example, 'playing around' with a computer and



software working out what it can do, or how to make it do what they want it to do. This may not have a clear purpose but can be very effective as a learning, or at least problem solving, strategy. Thus, for pupils, exploratory learning strategies can help the development of mental models and skills that develop in tandem and are inextricably linked.

The concept mapping task

After a trial run with their teacher on the topic of 'Holidays', the pupils involved in the ImpaCT2 study were invited to create a concept map on 'Computers in My World' on a sheet of A3 paper. The instructions asked them to think about types of computers, where they can be found, whether they are connected in any way, the people who use them and the reasons why people use them. Key Stage 2 and 3 pupils communicated with the study team through quick drawings, drawing lines between the images they wanted to link. Key Stage 4 pupils were given the option of writing words instead of drawing images, and many of them chose to do so. The concept maps were produced in just 30 minutes. Subsequent interviews with the pupils and feedback from teachers indicated that they enjoyed the experience.

Analysing the concept maps

Altogether 1,738 baseline concept maps were submitted in June 2000 (653 Key Stage 2, 534 Key Stage 3 and 551 Key Stage 4) and 1,482 in June 2001 (619 Key Stage 2, 486 Key Stage 3 and 377 Key Stage 4). Following analysis, the study team selected 12 concept maps, four from each key stage, that seemed representative, gave contrasting data, or showed interesting or unusual features. They interviewed these pupils and analysed each of their maps in depth. This selected rather than representative sample enabled the study team to check the validity of the concept mapping by comparing verbal and paper-based accounts. Every pupil interviewed was able to explain why they had included particular features in their map and why they had linked images or words in particular ways.

The method for coding the maps was developed using the phenomenographic theories developed by Marton (1994) and his group of researchers. The starting point is the way in which human beings focus their awareness differentially on whatever comes to their attention. Some features of the phenomenon (an object or set of ideas) become the focus of attention and others remain as the background field. There is variation between different people in how they first become aware and then develop their conceptual understanding of a phenomenon. Marton and his colleagues developed the theory that these variations fall into distinctive patterns. There will always be a small number – usually five or six – distinctive ways in which humans experience (and learn) any concept or set of ideas. Analysis of the ImpacT2 concept maps focused, therefore, upon looking for patterns across the sample as a whole in pupils' awareness of computers in their world. What knowledge did they have, whether fully comprehended or more peripheral in their thinking? And what were the patterns in the ways that the sample as a whole built up that knowledge?

Quantitative analysis of the concept maps

Quantitative analysis of the concept maps enabled the study team to gain an overview of their content as a whole. Rather than approaching the maps with preconceptions of what should be there, intensive study of a sample of around 40 maps was initially undertaken by two researchers who worked independently and later compared results. Emerging categories were then refined in discussion with three other researchers. Initial disparities were around, for example, what counted as nodes and confusion over labels. As a result of discussions, more detailed procedures were developed and additional items were added to each of the categories in order to make the analysis more sensitive to individual variation. Where it was necessary to make fine judgements these were standardised across all raters, so that for example a picture of the world globe was counted as 'information gathering' and the '@' sign was counted as 'communication'. This ensured that the coding of the maps was consistent, despite some lack of clarity as to the precise intended meanings of individual pupils.

1) Firstly, the number of images (nodes) in the maps was counted. No account was taken, at this stage, of what these images might be and no judgements were made as to their appropriateness or 'correctness'. It was clear from preliminary qualitative analysis, however, that maps with a large number of images generally indicated understanding of a wider range of computer equipment and electronically related human interactions and activities than maps with a small number of images.

2) Secondly, the number of links between the objects in the maps was counted. Again, the study team did not

make judgements about the appropriateness or 'correctness' of the links. Once again, it was clear from preliminary qualitative analysis that maps with a large number of links generally indicated understanding of the technical linkage between computer systems and the ways in which they enable connectivity between people. The counting of links became difficult when there was a large number, so they were counted in two stages: firstly the number of links from each node was counted and written beside it; secondly these numbers were totalled to give the number for all nodes across the map. Each link was, therefore, counted twice because it linked two nodes. Occasionally complicated by 'branching' links, the study team decided to count the branches to different nodes as separate links.

3) A third category of analysis developed by the evaluators was a 'connectivity' score consisting of a simple ratio of the number of nodes to the number of links. This was derived by computerised calculation. There was considerable variation across the sample, with simpler maps based on a central object linked to a number of surrounding objects having a 'connectivity' score of around 2:1 and some maps with large numbers of links achieving connectivity scores of 5:1 or higher. (There was, however, some effect whereby maps with a very large number of nodes were less likely to achieve high connectivity scores, probably because those pupils ran out of time.)

4) The fourth category was labelled 'spheres of thinking', and as originally defined, consisted of awareness – as indicated by the drawn images – of one or more of the following: for example, information gathering, communication, computer games, music/sound, images/photos and advanced control mechanisms. Each sphere of thinking identified in the map counted as one even if represented by two images, so that, for example, two drawings of a digital camera and a scanner counted as one 'images' sphere of thinking.

5) The fifth category related to the locations or virtual locations for computer-related activities depicted in the maps. This overarching category was labelled 'zones of use', and as originally defined consisted of awareness – as indicated by the drawn images – that computer-related activities take place in one or more of the following places: for example, home, school, workplace, transport and hospitals (ambulances); or provide a virtual location for activities such as shopping.

A score sheet was devised, a spreadsheet was prepared and each concept map was photocopied. The full sample of maps was then coded on the basis of judgements by an individual 'rater'. On the score sheet, the researchers recorded the number of nodes and links, and ticked the occurrences of spheres of thinking and zones of use that could be identified in the concept map, the number for each then being tallied. The same methods of analysis were used for the second sample of concept maps produced in June 2001.

Qualitative analysis of the concept maps

A fuller phenomenographic analysis was also possible as patterns of pupils' ways of experiencing computers in their world began to emerge. In follow-up one-to-one interviews with a sub-sample of 34 pupils (approximately nine months after concept map production) it was possible to begin to explore the dominant groupings of items. This indicated that despite the uniqueness of the perceptions of each individuals, the group as a whole provided examples of four or five typical patterns of awareness.

Pupils also undertook a writing task approximately a week after the baseline concept mapping. Those in Key Stages 2 and 3 gave an explanation of how computers are used in our world to a visitor from another planet and the Key Stage 4 pupils explained the most important uses of computer systems in present-day society, their advantages and disadvantages and what changes to everyday life they imagined in the future. The aim of the writing was to ensure that those whose preferred mode of communication was continuous writing should not be disadvantaged. However, the analysis showed no evidence that pupils could not express themselves in concept mapping at least as well as in writing, and in many cases they conveyed much more information; hence, the written task was not repeated a year later.

2) The pupil instruments

Strand 2 of the ImpaCT2 research design focused on educational learning at home and more informal learning beyond school. The former might be in the form of homework, such as use of networked technologies to research a homework topic. The latter recognised that the wider learning context also includes use of networked technologies for personal interests, communicating in chat rooms or playing on-line games, which involve learning

but may or may not be reflected in improved attainment. Whilst the computer could be used to do the same thing more efficiently, the study team also sought evidence of how ICT might change what and how pupils learn, looking at learning in its broadest sense and going beyond the school curriculum. In these out-of-school contexts pupils themselves were clearly the best-placed informants.

Drawing on the pupil hypotheses identified in Preliminary Study 2 (Lewin *et al.*, 2000), key research questions were formulated and then, through a process of experimentation, consultation and piloting, transformed into four pupil activities:

- The pupil log
- The special report
- The Internet questionnaire
- The pupil-pupil interview.

These instruments used quantitative and qualitative measures to find out about the processes, nature and content of learning through asking for facts, descriptions, analysis, opinions and values.

The pupil log

The pupil log was designed to monitor use of technologies including on-line resources both at school and at home over the period of one week, including a weekend. The structure of the logs differed for primary and secondary phases. The Key Stage 2 version asked pupils to describe their use of ICT at school and at home on a day-by-day basis, indicating which resources they used and how much time they spent. They were then asked how much time they had spent on three aspects of computer use during that week: 1) for educational learning, both non-networked (for example, word processing, art packages, spelling games) and networked (for example, e-mail, web sites); 2) for leisure purposes (for example, games consoles, television, mobile phones); and 3) general information about their use of computers at home (for example, ranking their top five most used technologies for schoolwork and leisure). The secondary version was similar but with additional detail for some aspects (for example, computer use at school in subject lessons, computer use for homework by subject, use of electronic devices such as diaries, digital cameras, interactive whiteboards and so on).

As the primary and secondary pupil logs differed in their level of detail, analysis of each phase was undertaken separately. Due to discrepancies within the data, measurement of timing was analysed quantitatively and other entries were used for cross-checking. As pupils recorded time periods differently (for example, 7.15 to 8.00, one and a half hours), all responses were converted to minutes. Where responses were given as ticks rather than specific amounts of time, these were represented by the modal response (the most common number of minutes specified for that item in the pupil log). Other data (for example, the ranking of favourite resources) was coded. Descriptive statistics were collated for all responses. Inferential statistics were conducted on the total amounts of time reported using ICT at home and at school. In addition, differences in responses by gender were analysed for both phases, for all variables. The analysis of this data was primarily quantitative. However, atypical individual cases were described in the form of vignettes to illustrate the diversity of reports that were received.

The study team received 276 logs from 20 primary schools, 64 Key Stage 3 logs from 11 secondary schools, 51 Key Stage 4 logs from 14 secondary schools and four primary logs from one special school (280 primary and 115 secondary logs, a total of 395). Although not all primary schools responded, logs were completed by whole classes in some cases rather than just ten pupils so that the total number of responses received met expectations. In the case of secondary schools, only 16 of 28 schools responded and often only with one or two logs from each key stage. Therefore the number of responses received from secondary schools was much lower than expected.

The special report

The special reports were structured but they gave free choice so that the picture is likely to be more positive than the average. Pupils were asked to choose a time when using the computer had been helpful to them in their schoolwork. The format of the special report gave an insight into how each pupil at least tacitly envisaged, carried out and judged the results of a learning activity. Given that developing a capacity for self-directed learning is important for pupils, this gave an opportunity for pupils to reflect in their own learning processes and outcomes. The structure of the special report entailed the following:

- Planning the task (how they acquired the prior knowledge needed for the task, who decided whether they use a computer and, if they themselves decided, why).

- Carrying out the task (where the task was undertaken, choices around how long to spend, where to work, with whom they worked, whether they needed any help and the nature of that help).
- Outcomes of the task (what they discovered, any new understanding, and (for secondary only) specific kinds of learning).
- Pupil evaluation of the task (self-evaluation, the relative merits of computer based and conventional resources, what they were or were not pleased with, what changes, if any, they would make if they did the activity again).

166 pupils completed a special report with 123 returns from ten primary schools (including one special school) and 43 returns from 12 different secondary schools (22 from Key Stage 3 and 21 from Key Stage 4 pupils). The analysis of this data was qualitative.

The Internet questionnaire

The Internet questionnaire focused on how and why pupils use the Internet both in and out of school for their own interests and schoolwork. Teacher-researchers were asked to ensure that pupils undertaking this task had experience of using the Internet. The study team anticipated that this would include both use for schoolwork and personal interests.

In the Internet questionnaire, pupils (both primary and secondary) were asked about the following:

- Their favourite web sites and frequency of use
- The kinds of things that they do when visiting web sites (for example, downloading files, following hyperlinks)
- How they find out about web sites (for example, family, friends, teachers, television, magazines, food packaging)
- How often they use search engines
- Whether they use the Internet most in school or out of school
- How they decide which web sites are good
- Whether they use text-based search engines
- Specific examples of Internet use for leisure
- Specific examples of Internet use to support school work (in specific subject areas for secondary pupils)
- Specific examples of e-mail use.

The study team received a total of 227 Internet questionnaires: 35 from Key Stage 2 pupils, 59 questionnaires from Key Stage 3 pupils, 77 questionnaires from Key Stage 4 pupils, and 56 questionnaires from special school pupils (mainly from a single school). Although not a numerically large sample it was drawn from 29 of the 60 participating schools and the findings are not necessarily unrepresentative of the wider population. The questionnaires were subjected to quantitative and qualitative analysis.

The pupil-pupil interview

Pupils volunteering to participate in this aspect of the research were asked to select and recruit their interviewees, to develop an interview schedule, and to write a report. All pupil interviewers were required to attend a briefing session and they also received written guidance (separate primary and secondary versions) that raised issues about interviewing, gave tips on planning and setting up the interview, and set out detailed instructions about how to write and submit the report and cassette recording. In placing such demands on pupils to design their own interview schedules, carry out tape-recorded interviews, report on and interpret the resulting data, it was believed that data would be generated on:

- how pupils are using networked technologies outside school for their own interests
- she ways in which they communicate and handle information for leisure and entertainment as well as for schoolwork
- their perceptions, concerns and values with regard to networked technologies.

The interview reports were diverse. Since what pupil interviewers chose to ask was as interesting as how interviewees replied, the team decided to analyse both questions and responses. It was hoped that this would provide indicators of young people's interests, priorities and views, although in follow-up interviews conducted by the link researchers, it was sometimes difficult to determine whether pupils had asked the questions they thought they should ask on behalf of the adult study team or whether their interviewing reflected their own concerns. Similarly, this raised questions about the extent to which interviewees might have given the kinds of responses they thought appropriate to a national research project.

Qualitative analysis was undertaken on three levels. Firstly, a broad-brush analysis was structured around the topics defined in the guidelines (electronic games, the Internet and mobile phones, and rules about using ICT at home). Secondly, a more fine-grained examination of a set of interviews produced by one primary and one secondary school provided an insight into the style and content of the interviews and reports. Lastly, a detailed analysis of one interview was undertaken. This was chosen because of the apparent enjoyment of the participants, the meticulous transcription undertaken by the eleven-year-old pupil and its key themes.

In total 52 reports and tapes were received from ten schools (seven secondary and three primary). It would be fair to say that fewer schools chose this instrument because of the demands made upon both teachers and pupils.

The case study reports

Six schools were chosen as case study schools. These exemplified at least one key innovative practice with regard to their use of ICT. The case studies drew on data arising from school visits but also related to key themes identified in the Invitation to Tender. Each case study report followed a common structure:

- Introduction (reasons for selecting the case)
- Context
- Resources
- Teaching and learning
- Home use of ICT
- Teacher perspectives on ICT and attainment
- Internet safety/security
- Staff development
- Professional use of ICT.

Each case study report drew on different 'slices of data' including:

- Teacher-researcher monthly reports
- School visits where link researchers observed a range of lessons, collected curriculum materials, carried out group interviews with pupils, and interviewed both individual and groups of staff, head teachers, ICT co-ordinators and specialist teachers using ICT innovatively
- Pupil instruments
- Concept mapping
- Pupil questionnaires 1 and 2 (Strand 1).

Appendix 2 – Glossary

E-mail (electronic mail) – text messages and computer files exchanged through computer communication, via Internet or intranet networks.

Information and Communications Technologies (ICT) – computing and communications facilities and features that support teaching, learning and a range of activities in education (such as administration). The focus is on the subject being taught or studied, or the organisation being administered, rather than developing pupils' skills with and knowledge of the technologies themselves. (Information Technology – IT – comprises the knowledge, skills and understanding needed to use ICT appropriately and effectively).

Internet – the connection of a very large number of computer networks, using a wide range of telecommunications (such as telephone lines) to provide a means of the exchange of information across the globe. For an individual user to access the Internet (or be 'on-line'), their computer must be connected to a local network which in turn has a connection to the Internet. The Internet is not the same as the World Wide Web (though the terms are frequently and erroneously used interchangeably). The World Wide Web (WWW, or just 'the Web') is one of the main types of service available via the Internet (other well-known services include e-mail, bulletin boards and file transfer). It refers to the collection of information held in multimedia form on the Internet. Most Internet resources are accessed using the web, by providers making their information available as a Web site.

Intranet – a communications network, based on the same technologies used for the Internet (for example, the pages look like Web sites), but only available to authorised users within an organisation or company. It is used to share information, resources and services within the organisation.

Modem – a communications device that allows data to be sent over standard telephone lines by converting binary signals from a computer into analogue sound signals.

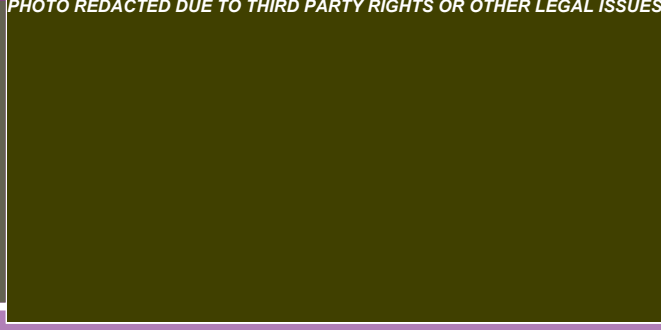
Networked technologies – the hardware and systems necessary for computer users to access networked and on-line applications as found on the Internet and intranets.

New Opportunities Fund (NOF) training – The New Opportunities Fund provides National Lottery funding for

education, health and environment projects. The aims of the Fund's ICT training programme are to raise the standards of pupils' achievements by increasing the expertise of serving teachers in the use of ICT in subject teaching to the level of Newly Qualified Teachers (NQTs), and to improve the competence and confidence of school librarians in their use of ICT.

Socio-economic status (SES) groups – These are based on a widely used classification system of the adult population according to occupation. The classification system as used during this study has now been replaced by an updated version. Sometimes called SEG – Socio-Economic Groups.

Thin client – Thin client networking allows applications (for example office and curriculum software) and data (for example, files) to be hosted centrally on a server, rather than on each individual computer (client) on the network. Each computer (thin client) connects to the server via a network to run applications, access files and locate information, but does not store information locally. A thin client is normally configured with only the essential equipment such as a central processing unit (CPU), limited memory, keyboard and monitor. It is most often devoid of a hard drive, CD-ROM player, disk drive and expansion slots. The software is therefore delivered, configured and controlled from the server. The purpose is to limit the capabilities of these computers to essential applications, hence the term *thin*. This ensures that users do not have redundant computing power on their desks and that administration is centralised.



The ICT in Schools programme (formerly the NGfL programme) is the Government's key initiative for improving ICT provision in schools, developing a wide range of digital resources for teaching and learning and equipping teachers to be effective users of ICT. The programme underpins the Government's vision for transforming education. Evaluation is being undertaken using a variety of techniques, both qualitative and quantitative, and at both national and local level.

Below you can find a list of the reports published so far in the ICT in Schools Research and Evaluation series, produced by Becta for the Department for Education and Skills (DfES).

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