Part 2 – Strand 1: Impact of ICT at Key Stage 2, Key Stage 3 and Key Stage 4

Section 4 Patterns of use of ICT in English, Mathematics and Science at Key Stage 2

This section analyses pupils' responses to the questions identifying how often and where they used ICT to support their learning in English, mathematics and science. The findings set out below are in line with earlier findings (Harrison et al, 2002) based on evidence from weekly logs of ICT activity, and interviews with other pupils conducted by Pupil Researchers with their peers.

Table 4.1 below shows the average amount of ICT activity reported by pupils for English, mathematics and science at Key Stage 2, in each of the three settings: class, school, and home. These allow the reader to note the amount of ICT experience and to compare the relative prominence of the three settings.

Table 4.1 Frequency of use in core subjects at Key Stage 2 (Drawn from a total of 700 questionnaires administered during 2001)

		Never %	Hardly ever %	Some weeks %	Most weeks %	Every week %
English	Lesson	11.17	27.40	37.52	13.61	10.30
	School	38.72	35.70	17.58	6.57	1.42
	Home	30.80	27.96	24.78	12.39	4.07
Maths	Lesson	15.88	37.35	26.70	10.99	9.08
	School	42.91	34.22	15.43	4.96	2.48
	Home	39.30	24.56	18.95	7.54	9.65
Science	Lesson	31.46	44.29	18.98	4.04	1.23
	School	63.75	25.54	8.39	2.14	0.18
	Home	52.59	27.37	14.49	3.76	1.79

The particular findings for each subject are discussed below.

4.1 Pupils' use of ICT in Key Stage 2 English

The general level of use of ICT in Key Stage 2 English is the highest reported for any subject at any Key Stage. 61% of the pupils report using ICT in their English lessons some weeks or more often and 10% use ICT every week. High levels of home use are also reported, with 41% of pupils using ICT at home to support their English work some weeks or more often. This finding has a significant bearing on the discussion of the impact of pupils' ICT use on attainment which follows. Clearly, any effects identified are likely to be as much a result of home use as of use in lessons. Use in school time outside English lessons is less frequent with 75% using ICT hardly ever or never for studying English.

4.2 Pupils' use of ICT in Key Stage 2 mathematics

The results for Key Stage 2 mathematics indicate a different pattern of use. The general level of use of ICT in mathematics lessons is lower than in English lessons, with over half the sample (52%) reporting never or hardly ever using ICT in their mathematics lessons. This may reflect primary teachers well-

documented[1] higher level of confidence in English than in mathematics or the more general applicability of specific software (such as word-processing) in English. 75% of Key Stage 2 pupils in the sample report never or hardly ever using ICT to support their learning of mathematics in school outside mathematics lessons.

Home use of ICT in mathematics is less than for English, with 39% never using ICT at home for mathematics. This may indicate that the software used in mathematics (including educational software and applications such as spreadsheets) is used less at home. The general lower level of use in mathematics may lead to any observed effects being less marked than in English.

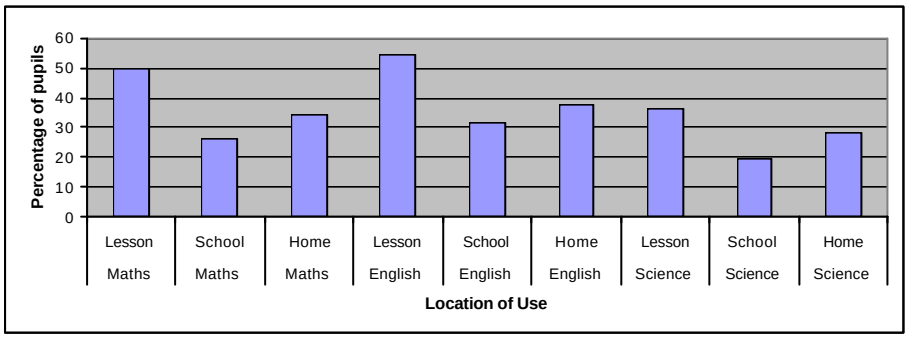
4.3 Pupils' use of ICT in Key Stage 2 science

The results for Key Stage 2 science follow a similar pattern to those for mathematics with a few key differences. The level of use of ICT in science is lower than for English and mathematics, with 76% reporting never or hardly ever using ICT in their science lessons, 89% never or hardly ever using ICT for science related activity elsewhere at school, and 80% never or hardly ever using it to study science at home. These differences in the relative extent of use will clearly have a bearing on the potential for ICT to impact on pupils' achievement.

4.4 Internet use by subject area at Key Stage 2

Figure 4.1 identifies the percentage of pupils who stated they had used the Internet in English, mathematics and science, in the home, the subject lessons, and the school in general. At this stage, what is being reported is whether or not the pupils had used the Internet, rather than data on the level of use. Given the rapid increase in schools' levels of connectivity throughout the period of the study, the analysis that follows is inevitably based on a 'snapshot' in time, rather than an overview of embedded practice. However, some positive messages are beginning to emerge.

Figure 4.1: Percentage Internet usage by subject at Key Stage 2 (Drawn from a total of 700 questionnaires administered during 2001)



[1] Evidence from the recent OFSTED reports shows that the use of ICT in Literacy and Numeracy has improved, however, 'there is an imbalance in the use of ICT resources across the core curriculum. Apart from designated ICT lessons, usually in computer suites, the application of ICT is more common for literacy-based activities than for numeracy. Although mathematics quite often features in ICT work on graphs, data analysis or spreadsheets, this is not directly linked to specific mathematics objectives. Teachers are more comfortable teaching ICT skills to pupils and using literacy and numeracy work to practise and improve these skills rather than applying ICT skills to meet literacy or numeracy objectives... However, teachers are much less clear when and when not to use ICT to support other subjects of the curriculum. Where teachers have good subject knowledge, and there is clear subject leadership and guidance, they are more able to decide on the appropriate use of ICT... Nevertheless, the application of ICT across the curriculum remains an uncertain area for many schools.'

ICT in Schools: Effect of government initiatives. Implementation in Primary Schools and effect on Literacy, June 2002 (HMI712), Ofsted, London. www.ofsted.gov.uk/public/docs02/ictsubject/primary&lit_ict.pdf

While the general level of regular use of ICT to support teaching and learning is low, there was evidence from pupils' responses that use of the Internet in lessons is becoming established. In Key Stage 2, Internet use was more frequent in subject lessons than it was at home. Again, use is more frequent in English lessons, with over 54% of respondents stating they had used the Internet. Almost 50% had used it in mathematics lessons, whilst 36% had used it in science. Internet use in all subjects was further supplemented by subject use on the school premises that did not occur in the specific subject lessons. 20% of respondents stated they used it for science, 26% for mathematics and 31% for English.

> *"A lot use it for homework... for research… they seem to put more effort into it [than with traditional media]… but there are problems where some children download a lot of material without editing or reviewing it, but, on their last topic [an ecological report] the ones with ICT at home were better on presentation of their materials, and produced more [relevant] information."*
>
> Key Stage 2 teacher, Wolsey Court Primary School

Interviews with teachers carried out as part of the other strands of the study indicated that teachers were convinced of the potential of the Internet, but, as with other aspects of ICT, not all were clear about how to develop its effective use or how to integrate it fully into learning activities. Observations of lessons in schools in Strand 3 (see part 4) suggest that where schools have introduced pupils to effective search/research strategies, exploring the Web at home is likely to be more productive. Teachers also often recommended educationally sound web sites for pupils to visit, and downloaded relevant pages onto the school intranet.

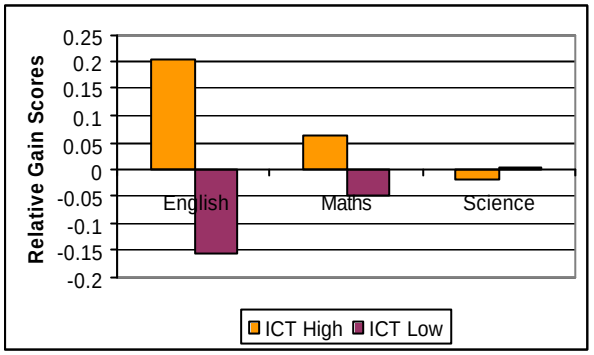
Home Internet use for all three subjects was also notable. 37% had used the Internet at home for English, 35% for mathematics and 28% for science. The significant use of ICT and the Internet for subject specific purposes in the home may suggest that ICT can facilitate the extension of learning in the school to the home environment and vice versa.

The Internet can be used for a variety of purposes, including: searching the World Wide Web for information; communicating with peers and others through e-mail and online chat; and publishing material for others to see. There is evidence that pupils, teachers and schools are beginning to embrace some of these applications. For example, 21% of the Key Stage 2 pupils have used e-mail to support their mathematics learning at home; 19% have used e-mail at home to help them with their English work. However, some uses of the Internet are much rarer. The use of video-conferencing, for example, remains in its infancy with 1% of pupils reporting using it in English and similar levels of use in mathematics and science. It must be stressed, however, that these figures represent a particular point in time, and they will rapidly become out-of-date.

Section 5 Relative gain for high ICT users versus low ICT users of ICT in English, mathematics and science at Key Stage 2

This section begins by exploring the general relationship between pupils' use of ICT and their performance in the Key Stage 2 tests. As described in the introduction, the relationship explored is that between pupils' level of use of ICT in English, mathematics and science, and their relative gain scores in each subject, that is how their actual performance compared with their predicted performance. The following chart (Figure 5.1) shows how the relative gain scores of the group of pupils characterised as high ICT users compared with low ICT users in each of the three subjects.

Figure 5.1: Relative gain at Key Stage 2 (standardised) for high ICT users versus low ICT users (ICT use data drawn from a total of 700 questionnaires administered during 2001)



As Figure 5.1 illustrates, pupils characterised as high ICT users outperformed, on average, low ICT users in English and mathematics (see Appendix 1 for a detailed description of methodology). The numbers on the scale on the left of the graph relate to the mean difference between what the pupils were expected to achieve and what they actually did achieve in National Tests at Key Stage 2, expressed in standard deviations.

In Figure 5.1, the most powerful impact of ICT use can be seen to be in English – a figure of 0.2. This actually represents a statistically significant (and positive) impact for high ICT use in English ($F(1,455) = 14.923$, $p < 0.001$).

In mathematics, there is a positive effect of ICT use but it is not statistically significant. (Again, this does not include use of the Internet). It should be noted that not reaching statistical significance does not mean that a result is unimportant or uninteresting.

These findings were broadly supported by supplementary analyses (Appendix 2). Analysis on a school basis rather than an individual basis suggested that higher ICT usage was more beneficial in all three core subjects and these were all statistically significant. Multilevel modelling revealed a statistically significant impact of higher ICT usage for English.

It is of some interest to examine whether the impact of ICT usage is general across the ability range as indexed by the initial achievement (IA) of each pupil. The sample of pupils was divided into three groups (high, medium and low) based on pupils' initial achievement scores. Although using relative gain scores seeks to create a more level playing field, it remains the case that some pupils will make more progress than others when they reach National Tests or GCSEs. Some of that variation may be attributable to IA effects (if the regression of IA on target score is non-linear or if the sample used in this survey differs somewhat from the much larger population used by the CEM centre). Some may be attributable to ICT experience. By comparing relative gain scores with initial achievement (IA) it was possible to confirm that the advantage of high ICT in English was apparent for all three groups (Table 5.1) and that there were no interaction effects. Those scores that are emboldened are statistically significantly different. The main effect of ICT replicates the finding presented above (Figure 5.1). Note that there are slight differences between the mean relative gains reported in this section as those in

Figure 5.1 have been standardised and those in Table 5.1 have not. High IA scores are associated with lower gain scores in English but not in other subjects – perhaps a sampling error.

Table 5.1: Relative Gains (unstandardised) by ICT and Initial Achievement for English, mathematics and science at Key Stage 2

		English (N)	Maths (N)	Science (N)
ICT High	IA High	.025 (58)	-1.648 (55)	-.370 (49)
	IA Average	3.374 (44)	1.932 (50)	-1.229 (49)
	IA Low	3.622 (46)	-4.744 (53)	-.315 (44)
ICT Low	IA High	-1.690 (76)	-2.294 (79)	-2.301 (85)
	IA Average	0.086 (82)	-2.452 (77)	-.600 (72)
	IA Low	-1.031 (74)	-2.757 (69)	1.628 (78)
All	ICT High	**2.139**	-1.554	-.649
	ICT Low	**-.852**	-2.490	-.476
All	IA High	**-.948**	-2.029	-1.595
	IA Ave	**1.234**	-.726	-.855
	IA Low	**.752**	-3.620	.927
sd (overall)		8.710	14.481	8.619

ANOVA

Effect	***df***	***English***		***Mathematics***		***Science***	
		F	significance	F	Significance	F	Significance
ICT	1	12.66	.000	0.455	0.500	0.055	0.815
Init Ach.	2	3.209	.042	1.755	0.174	1.741	0.177
ICT x Init Ach	2	0.904	.406	1.479	0.229	1.576	0.208

Further, as expected, there are gender effects. These are significant for all core subjects (girls performing better at English ($F(1, 414) = 10.46$, $p<0.001$), boys performing better at mathematics ($F(1, 416) = 8.4$, $p < 0.01$) and science ($F(1, 411) = 4.97$, $p < 0.05$)).

It may be thought that the lack of statistical significance in the analysis of mean relative gain scores implies that pupils' use of ICT in mathematics and science has no effect on their performance in those subjects. However, a number of points are worth considering before adopting that view. A wide variety of practices were identified in the schools in the sample. Evidence from lesson observations pointed to a variety of approaches to integrating ICT within lessons. Section 5.2 begins to explore these differences at an individual school level. Key messages about effective practice are identified on the basis of participating teachers' views.

Key findings at Key Stage 2

- At Key Stage 2, pupils characterised as high ICT users outperformed, on average, low ICT users in English and mathematics.
- In Key Stage 2 English this effect was statistically significant, in mathematics it was not.
- Differences in performance between low and high ICT users in science at Key Stage 2 were marginal and far from statistical significance.
- Gender effects were generally in line with known trends.
- The benefits of high ICT use are the same across all ability groups.

5.1 Relative gain at Key Stage 2 in National Test marks and National Curriculum levels

It is also possible to provide a further interpretation of the relative gain scores by translating them into National Test marks and National Curriculum levels for each subject. National Curriculum levels measure children's progress in each subject. Broadly, one level is thought to relate to around two years in a pupil's development, that is, they are expected to progress by the order of 0.5 of a level per year.[2] This way of presenting relative gains provides estimates of the actual marks associated with the performance of high and low ICT groups after taking into account differences in their initial achievement levels at Key Stage 2.

In Tables 5.2 and 5.3 the mean relative gain scores at Key Stage 2 for high ICT users and low ICT users are expressed in terms of their mark and level equivalents respectively. This can help to express the impact of greater ICT use. Note however that these can only represent approximations, because the number of marks separating levels varies from level to level, and because the clustering of marks can vary from subject to subject.

Table 5.2 Mean relative gain scores in marks equivalents at Key Stage 2 for high ICT users versus low ICT users by subject

	English	Maths	Science
High ICT	2.31	0.34	-0.35
Low ICT	-0.81	-1.35	-0.18
Difference	3.12	1.69	0.17

Table 5.3 Mean relative gain scores in level equivalents at Key Stage 2 for high ICT users versus low ICT users by subject

	English	Maths	Science
High ICT	0.120	0.012	-0.019
Low ICT	-0.04	-0.049	-0.010
Difference	0.16	0.061	-0.009

Given that one level is thought to relate to around two years in a pupil's development, a gain of 0.10 represents 10% of two years' achievement, or 20% of one year's achievement. If the mean relative

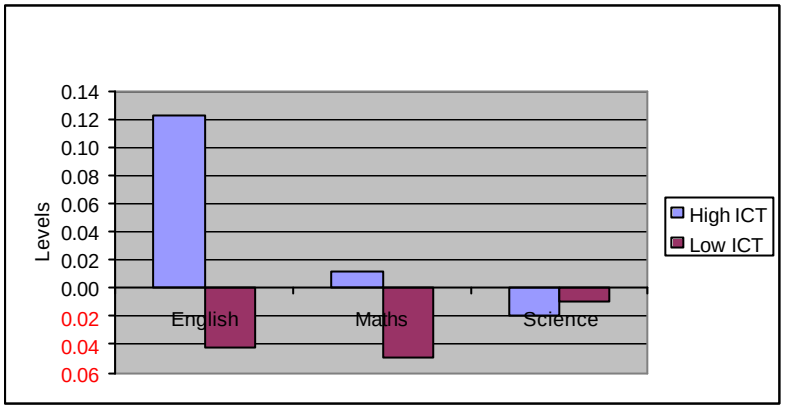
[2] More information regarding Key Stages, National Curriculum levels and National Tests can be found in the DfES publication series Learning Journey, the National Curriculum online web site: www.nc.uk.net and on the DfES Parents web site: www.dfes.gov.uk/parents.

gains identified earlier were translated directly into progress through the National Curriculum levels, high ICT use in Key Stage 2 English in particular can be seen to support a substantial acceleration in progress through these levels equivalent to 16% of two years' achievement.

In Key Stage 2 mathematics the acceleration in progress is equivalent to 6.1% of two years' achievement.

Figure 5.2 illustrates the level equivalents in graphical form.

Figure 5.2 Mean relative gain scores in level equivalents at Key Stage 2 for high ICT users versus low ICT users by subject (ICT use data drawn from a total of 700 questionnaires administered during 2001)



It is important to note however that the preferred way of analysing the impact of high ICT use remains the one presented at the start of section 5 – the graph of relative gain scores. This is because the relative gain data has been standardised, and so allows for comparison between the various Key Stages and subjects included in this study.

5.2 Relationship between ICT use and attainment in Key Stage 2 English

As described in the introduction, the graph below (Figure 5.3) is designed to show the association between mean relative gain and mean ICT experience levels for each subject, at each Key Stage by individual school – in this case for Key Stage 2 English.

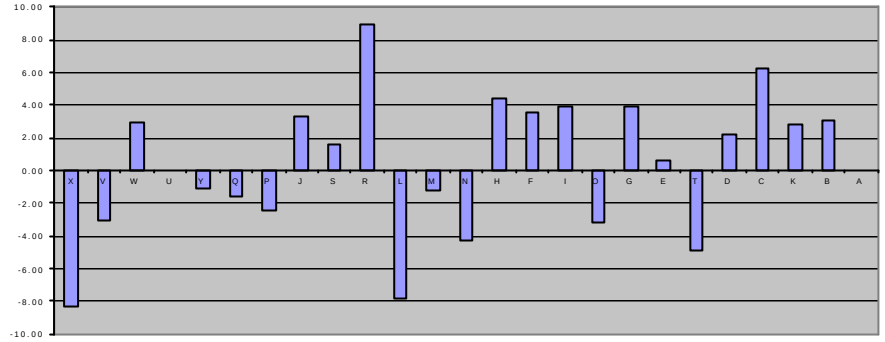
In this type of graph the schools that contributed data have been ranged along the horizontal axis from the lowest average ICT score for use of ICT in the subject (left of each graph) to the highest (right of each graph). The vertical scale shows mean relative gain scores. Each school contributes a single column the height of which corresponds to the mean relative gain for that school in the given subject. Each school in the sample is represented by a single letter (or a double letter for secondary schools in later graphs of this type). The letter used gives an indication of the level of ICT use. In the graph below, (Suffolk Primary School (A) reported the highest level of ICT use in English, Duke Primary School (X) reported the lowest. Where a school has been plotted on the graph but no relative gain score is shown, this is because the study team was not able to obtain the value-added data for this subject.

In an ideal world, in order to establish a highly significant association between the level of ICT use and attainment as measured by National Tests or GCSEs, the pattern of bars in this type of graph would start on the left showing high negative mean gain scores, that is, pointing downwards. As you move to the right, the bars would decline to zero at about half-way along, and then show an increasing positive set of scores for the schools with increasingly higher use of ICT, that is, they would point upwards. So if there were a perfect positive association between ICT use and relative gain, the resulting graph would resemble a 'staircase' ascending from left to right. Where the association is strongest, there would be a concentration of higher columns on the right and lower columns on the left. Exceptions to this would

suggest that other influences were outweighing any impact of ICT. If the association is low, the staircase effect will be virtually absent.

Clearly, in the real world such perfect patterns do not exist. However, if the association between use of ICT and attainment is to be demonstrated, it is reasonable to expect a significantly higher proportion of positive gain scores above the mid-point of zero on the vertical scale to the right-hand side of the graph, and more negative scores on the left-hand side.

Figure 5.3: Mean relative gain (unstandardised) for schools in order of ICT usage for English from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



As can be seen, in general:

- The pattern follows the alphabet, indicating that the level of pupils' use of ICT to learn English is in line with the overall level of ICT use in the schools.
- The statistically significant positive association between pupils' level of use of ICT in English and their performance in the National Test is reflected in the graph with schools to the right of the graph (that is those where pupils used ICT more often in English) more often exhibiting higher mean relative gain scores.

However, a number of schools do not follow this general trend. For example, while Carpenters Primary School (R) and Kingston Primary School (L) have similar levels of ICT use, they have achieved widely differing mean gain scores. These individual differences may reflect differences in factors such as the quality of the ICT use and the general quality of teaching, or may be simple statistical anomalies. Similarly the mean gain score in Branley Wood Primary School (W) is higher than those with similar levels of ICT use and that of Parkstone Primary School (T) is lower.

Interestingly, Parkstone Primary School's position towards the right of the graph (placing it earlier in the alphabetical list) indicates that pupils use ICT in English more often in this school than might be expected from the overall level of ICT in the school, that is the relatively high use of ICT in English by pupils in Parkstone is against a backdrop of a low level of use throughout the school. A possible explanation for Parkstone's 'anomalous' position is that it may be the totality of a pupil's experiences that influences achievement, rather than isolated use in a particular subject. Clearly, given the small number of schools under discussion it would be problematic to do more than offer these observations as worthy of further investigation.

Further analysis of the nature of the ICT use may point to the factors influencing effective use from which others may learn. Further publications in this series will examine the factors that may underlie these differences. Material drawn from interviews carried out as part of the work in the other strands provide insights into how schools in the sample are using ICT in English.

5.3 Links to other strands of the study regarding Key Stage 2 English

The motivating effect of ICT was a common factor in teachers' comments, and while some saw this as an end in itself (inasmuch as it captivated students who were previously hard to engage), it was most often linked to talk of a shift in the attitude of pupils and a greater involvement in learning activities. The

following example is taken from the Literacy Co-ordinator at school C, a school where pupils are using ICT in their English and achieving high relative gain scores.

> *"..the children… are completely committed to doing that work, finishing that task.. you can certainly see the motivation. They will all want to go on the computer and the work they produce is far superior, and not just in terms of presentation… they have more time to consider the consequences of what they are learning"*
>
> Key Stage 2 teacher, Literacy co-ordinator Westbrook Primary School (C)

The following illustration is taken from Shotton Primary School (B), a school where pupils are using ICT in mathematics and achieving high relative gain scores.

> *"..Year 5…, during their Literacy lessons, would have completed a range of tasks throughout the year using: word processing package of word; publishing packages in either [word software] or [publishing software]; internet sites for research and have experience of importing pictures from clip art.*
>
> *"[children] were involved in researching, compiling and producing an information book for our environmental area. The skills developed during this project included; taking digital photographs, importing them into a word document, wrapping the text around the picture, word art, word processing the information researched, glossary, bibliography, acknowledgements, mapping the area."*
>
> Teacher researcher, Shotton Primary School (B)

One school was using the QCA guidelines and finding opportunities to integrate English with the teaching of skills in presentation software and Internet use; two were using ICT "for revision"; one said the main focus was on word processing and another that there had been some use with pupils of the NOF (New Opportunities Fund) training materials. Only three schools said they were not using ICT at all for teaching English. However, when asked to assess the impact of ICT on pupils' attainment in English, only one teacher (in Hope Hill Primary (I), a school achieving positive gain scores with relatively high use of ICT in English) gave an unqualified, positive response:

> *"Software for spelling has increased attainment in my opinion. Again, emphasis on games and fun encourages children to be challenged to learn spelling strategies: and to a less extent story writing and grammar.*
>
> Key Stage 2 teacher, Hope Hill Primary School (I)

Two other teachers felt that the impact of ICT on attainment in English was limited for specific reasons: the first because successful use depended upon the pupils' reading and literacy skills; the second because the computer-based materials were not of sufficient quality.

Issues for teaching and learning at Key Stage 2 English

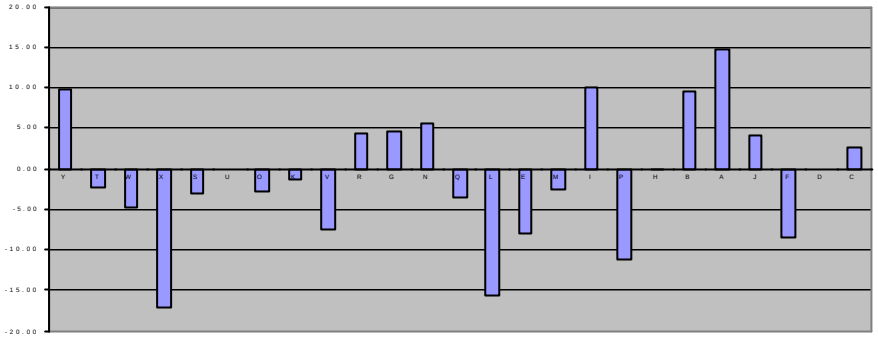
Teachers in schools where pupils used ICT in English and achieved higher mean gain scores identified the following key factors in relation to the use of ICT in English at Key Stage 2:

- Increased motivation and greater involvement in learning.
- Higher quality outcomes encouraging greater commitment to writing tasks.
- Relevant software making the learning of key skills (such as spelling) fun.
- Increased time for reflection.
- Use of ICT to support research skills.
- Use of ICT to develop materials incorporating text and graphics.

5.4 Relationship between ICT use and attainment in Key Stage 2 mathematics

Figure 5.4 (below) is designed to show the association between mean relative gain and mean ICT experience levels – in this case for Key Stage 2 mathematics. As with the graph for English (Figure 5.3, above), in this graph the schools have been ranged along the horizontal axis from the lowest average ICT score for use of ICT in mathematics (left of the graph) to the highest (right of the graph).

Figure 5.4: Mean relative gain (unstandardised) for schools in order of ICT usage for mathematics from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The graph for mathematics shows a smaller trend than that for English indicating that any 'ICT effect' is less well marked. Many of the observations made about the graph for Key Stage 2 English apply here. Again a number of schools (such as Maidenhall Primary School (Y), Aspley Primary School (P) and Beech Grove Primary School (F)) clearly do not follow any underlying trend, and these are worthy of further study. Aspley Primary School's position on the graph is out of line with its alphabetical position, being too far to the right. This indicates that the level of pupils' use of ICT in mathematics is relatively higher than the overall pattern of ICT use in the school. The variation in mean gain scores for high ICT schools appears to be greater than for low ICT schools, with the exception of school Y. While this may be simply the result of random statistical variation, it may point to differences in practice within high ICT schools. These will be explored further in part 3 (Strand 2) and part 4 (Strand 3) below.

5.5 Links to other strands of the study regarding Key Stage 2 mathematics

The following illustration is taken from school B, a school where pupils were using ICT in their mathematics and achieving high relative gain scores.

> *"In numeracy, the computers were used in a supportive way to reinforce learning for the lower attainers through number games. Computers were also used to compile databases through [spreadsheet] software and produce graphs from the [gathered] information …[including] mapping the area."*
>
> Key Stage 2 teacher, Shotton Primary School (B)

The next response is from a school using ICT, but not achieving high mean relative gain scores in mathematics. This teacher felt that the use of ICT was having a positive impact on pupils' learning of mathematics.

> *"The children have used the computers in maths lessons throughout the term. With, normally, 2 computers in the classroom for each lesson, the ICT component …had to reflect the main objectives of the lesson [Numeracy Strategy hour]. This has been achieved by 2 different applications. First, throughout the term, [mathematics software] has been used. 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. Secondly, the children have used [a revision site]. Children have used this program extensively during March/April, in particular when they have had access to the 7 wireless-networked laptops. This program does not allow a very close link to classroom activity but is structured in themes which the children can select and then test themselves against*

particular maths aspects. This self-test proved very popular and gave a good, immediate feedback to the children of their performance."

Key Stage 2 teacher, Claypit Lane Prmary School (E)

Overall, however, very little use was being made of ICT to directly support mathematics teaching in the ImpaCT2 sample of schools. Observations of ICT-focussed sessions confirmed that even with the best-appointed ICT rooms and the most carefully planned lessons, monitoring the activities of twenty or more simultaneous users could be problematic for many teachers. Back in the classroom, where the number of machines was more limited, there could be a different problem - while there were fewer computer-users to 'keep an eye on', the teacher had to organise activities for the remainder of the class who were not using ICT:

"I value ICT and I think its very important, but it's almost like a fringe activity sometimes… when you've got the other twenty or so others doing something else... it's not always easy to home in. As soon as the others are up and running, I can go back to the ICT, but it's hit and miss, and there's no telling whether I get to see all the children that are working."

Key Stage 2 teacher/numeracy co-ordinator, Yew Tree Primary School (M)

Issues for teaching and learning at Key Stage 2 mathematics

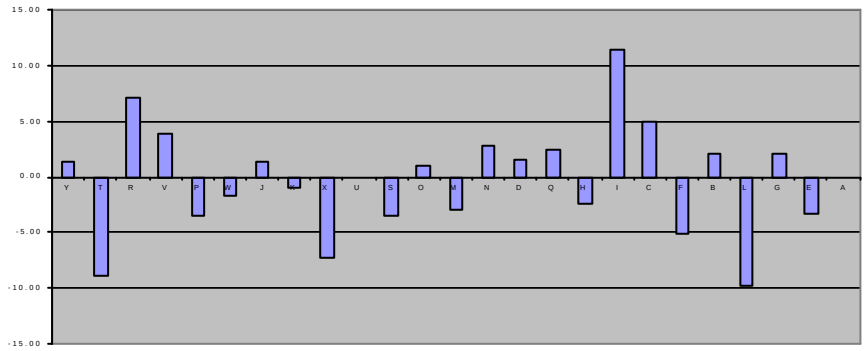
Any conclusions for Key Stage 2 mathematics must be more tentative than those for English because of the lower level of ICT use and lack of statistical significance. However, on the basis of the data gathered a number of key factors may be identified in relation to the use of ICT in mathematics at Key Stage 2:

- The use of number games to reinforce number skills with low attainers.
- Use of standard packages for data handling.
- Linking mathematics teaching to real-world applications.
- Use of interactive software applications for self-testing and immediate feedback.

5.6 Relationship between ICT use and attainment in Key Stage 2 science

The graph below (Figure 5.5) completes the set of graphs illustrating the relationship between for ICT use and attainment on a school-by-school basis for the core subjects at Key Stage 2. As with the graphs for English and mathematics, the schools have been ranged along the horizontal axis from the lowest average ICT score for use of ICT in science (left of the graph) to the highest (right of the graph).

Figure 5.5: Mean relative gain (unstandardised) for schools in order of ICT usage for science from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2000)



The results in science reveal a mixed picture without any clear trend. Similar comments apply to those already stated for English and mathematics. In addition, comparisons of the results for English, mathematics and science reveal some interesting observations. Firstly, Kingston Primary School (L) is out of step with any possible underlying trends in all three subjects, consistently achieving lower mean gain scores than those with similar levels of use. Similarly, Carpenters Primary School (R) achieves consistently higher mean gain scores than those with similar levels of use. Again, while these may reflect statistical anomalies, they (and other schools exhibiting similar patterns) require further analysis of the nature of any ICT use in those schools and other contextual factors.

5.8 Links to other strands of the study regarding Key Stage 2 science

Although use of ICT in science teaching in the schools in the ImpaCT2 sample was not extensive, it was highly focused on supporting pupils in areas of conceptual difficulty which related directly to areas covered in national testing. As the relationship between ICT use and attainment was the least marked in science, failing to reach statistical significance, the examples quoted below are presented as tentative suggestions of how ICT supports learning in science.

When asked if ICT was having an impact on Key Stage 2 attainment in science in their schools, some teachers were explicit about the ways in which ICT could make a direct contribution to pupils' knowledge and conceptual understanding. The following example is drawn from Bank Street Primary School (V), where the use of ICT by pupils is low, but which achieved a positive mean relative gain score. The teacher in that school felt there was a particular value in using ICT in science teaching because of the disciplinary links between ICT and science.

> "*The activity required pupils to search for information related to specific areas for their work on the human body (life processes and living things). ...Ultimately, I wanted the children to be able to identify the internal structure of the ear and how it decodes the sound waves. ICT was used to support the activity because I felt that the children could utilise a wider variety of information areas than were available in the form of books, videos and magazines. It would also allow the children to make decisions about what information was relevant to the work they were doing and their specific research. Although the children had a 3D model of an ear in school for hands-on experience, a site that had a 3D image of the inner ear particularly interested them. It gave them the opportunity to look from an alternative perspective.*
>
> *Amazingly, the activity not only furthered knowledge in the science studies but ICT skills also improved. Children were careful to evaluate material, liking the pictorial representation, but disliking the text because it was inappropriate for their age group. They wanted to change this, so needed support in order to download web pages into word processing or graphics packages in order to amend text or illustration. This became a giant leap in computer capability for some children."*
>
> Key Stage 2 teacher, Bank Street Primary School (V)

A teacher in a school where pupils used ICT more often, and which achieved positive mean relative gain scores, linked any increase in attainment to the use of sensors and the production of tables and graphs:

> *"In Science lessons pupils use sensor equipment such as [Data capture equipment] to monitor temperature, light etc. [Data capture equipment] is attached to a laptop. Tables and graphs are plotted on the laptop. Pupils are encouraged to interpret these tables and graphs. Many Science [National Test] questions involve interpreting graphs, which have been drawn as if the results had been entered on a computer. Therefore previous pupil knowledge and experience of ICT in science is important in the outcome of KS2 [Key Stage 2 National Tests]."*
>
> Key Stage 2 teacher, Braeburn Primary School (N)

Two cited the ability to manipulate data so that changes were modelled visually and had a visual impact on the user:

> *"...Very beneficial because the interactive nature of CD-ROMs means that difficult concepts can be explained and if schools have limited resources, the children can observe practical investigation taking place instead of just reading about it. The Internet can be also used to demonstrate practical investigations. Some software allows children to test their ideas and their outcome and change variables in the activity. Any gaps in the science curriculum are easy to fill like this or it's possible to revisit previous concepts - children enjoy this type of presentation."*
>
> Key Stage 2 teacher, Honeypot Lane Primary School (U)

> *"ICT helps in science because of the visual images, which give a child greater understanding. More able [pupils] can access information much quicker and know where to look."*
>
> Key Stage 2 teacher, Wolsley Court Primary School (S)

Another teacher mentioned the use of interactive CD-ROMs and once again data-handling software, and three others cited the value of being able to access encyclopaedias and other on line information resources.

It would be useful to investigate further a number of the schools that stand out in the above figures – both those that appear to represent a link between high ICT use and relative gain in attainment, and those which do not. More specific investigation of the particular practices and uses of ICT in these schools would be required in order to gain a greater understanding of how the use of ICT in the classroom relates to particular aspects of attainment and achievement.

Issues for teaching and learning at Key Stage 2 science

Any conclusions for Key Stage 2 science must be more tentative than those for English because of the lower level of ICT use and lack of statistical significance. However, on the basis of the data gathered a number of key factors may be identified related to the use of ICT in science at Key Stage 2.

- The use of simulations and visual models for enhancing understanding.
- Exploring effects and testing ideas by varying data in computer models.
- Researching and revising scientific topics independently using on-line resources and CD-ROMs.
- The use of data logging to further understanding of graphs and interpreting data.

5.8 Impacts in other subjects

At Key Stage 2, the study of impacts on attainment focussed on the core subjects. There appears to be some pattern emerging around the level of usage and impact in each subject. This may imply that factors surrounding the ease of which ICT can be utilised and applied effectively into specific subjects may be significant in mediating the impact on the quality of teaching and learning. Results from Key Stages 3 and 4 shed further light on such views.

Section 6 Patterns of use of ICT in English, mathematics and science at Key Stage 3

Pupils' responses to the questions identifying how often and where they used ICT in English, mathematics and science are summarised in table 6.1.

Table 6.1 Frequency of use in subject areas at Key Stage 3 (Drawn from a total of 700 questionnaires administered during 2001)

		Never %	Hardly ever %	Some weeks %	Most weeks %	Every week %
Maths	Lesson	20.69	45.98	21.38	6.90	5.06
	School	51.62	29.86	12.5	3.24	2.78
	Home	43.65	27.48	12.7	5.31	10.85
English	Lesson	21.11	40.14	32.48	3.94	2.32
	School	41.03	30.77	19.35	7.23	1.63
	Home	19.58	24.24	34.03	15.15	6.99
Science	Lesson	31.78	36.68	25.70	4.91	0.93
	School	59.43	24.29	12.03	4.01	0.24
	Home	36.15	34.04	19.48	7.98	2.35

The findings for individual subjects, and the comparisons between Key Stages 2 and 3, are discussed below.

6.1 Pupils' use of ICT in Key Stage 3 English

The majority of pupils surveyed reported using ICT never or hardly ever to support their learning of English, either within their English lessons (61%) or within their wider school experiences (72%). This is markedly less than at Key Stage 2 where 61% used ICT some weeks or more often in their English lessons. Pupils' use of ICT at home to support their English studies is higher than at Key Stage 2 with 34% reporting use some weeks and 22% most or every week. This finding has a significant bearing on the discussion of the impact of pupils' ICT use on attainment with follows. Clearly, any effects identified are likely to be as much a result of home use as of use in lessons.

6.2 Pupils' use of ICT in Key Stage 3 mathematics

Key Stage 3 pupils report using ICT at school less often in mathematics, 67% never or hardly ever using it. Again, this is markedly less than the level of reported use at Key Stage 2 (52% never or hardly ever). 28% reported using ICT at home for mathematics work with 44% never using it at home. Again, the general lack of appropriate software and applications in the home may explain this finding. Such a pattern of home use would mirror the findings reported in *Young People and ICT* (DfES, 2002b) where 82% of the 554 secondary pupils consulted reported using word processing/desk top publishing at home in comparison with 39% using databases/spreadsheets.

6.3 Pupils' use of ICT in Key Stage 3 science

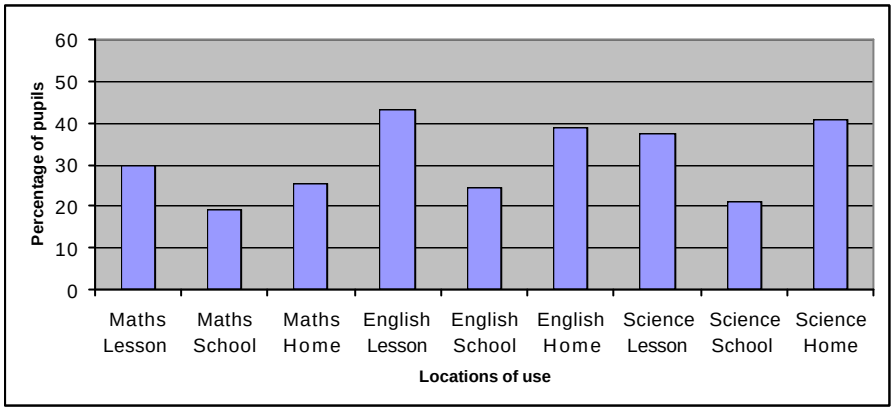
Science is the only subject where Key Stage 3 pupils report a higher level of use than at Key Stage 2, with 31% using it at least some weeks in lessons in comparison with 24% at Key Stage 2. Slightly more pupils report using ICT at home for science work than for mathematics, but they use it less often. Again, the level of use at home is less than for English. This may reflect less overall teaching of science than mathematics and the less specialised nature of the material available at home. For example, CD-ROM encyclopaedias and science-based Internet sites offer many opportunities for out of

school research activities, whereas mathematical applications such as spreadsheets demand a higher level of ICT skill. The variation of use of ICT at home will be discussed in further publications in this series.

6.4 Internet use by subject area at Key Stage 3

Figure 6.1 identifies the percentage of pupils who stated they had used the Internet in English, mathematics and science, in the home, the subject lessons, and the school in general.

Figure 6.1: Percentage Internet usage by subject at Key Stage 3 (Drawn from a total of 700 questionnaires administered during 2001)



Internet use was less frequent at Key Stage 3 than at Key Stage 2 in English and mathematics. For example, 43% report having used the Internet in English lessons at Key Stage 3 in comparison with over 54% at Key Stage 2. Use was more frequent in English and mathematics subject lessons than it was at home. However, 41% report using the Internet at home as part of their science work, higher than for any other subject at Key Stage 3 or 2.

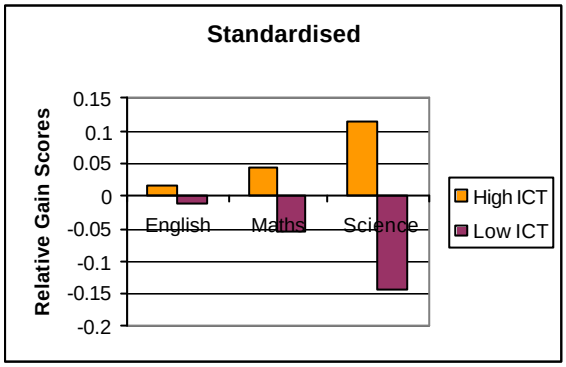
Use of e-mail at home to support school learning was also less marked than at Key Stage 2: 15% of the Key Stage 3 pupils have used e-mail to support their mathematics learning at home (21% at KS2); 12% have used e-mail at home to help them with their English work (19% KS2). Again, it must be stressed that these figures represent a particular point in time, and they will rapidly become out-of-date.

Section 7 Relative gain for high ICT users versus low ICT users of ICT in English, mathematics and science at Key Stage 3

This section begins by exploring the general relationship between pupils' use of ICT and their performance in the Key Stage 3 tests. As described in the introduction, the relationship explored is that between pupils' level of use of ICT in English, mathematics and science, and their relative gain scores in each subject, that is how their actual performance compared with their predicted performance.

The following chart (Figure 7.1) shows how the relative gain scores of the group of Key Stage 3 pupils characterised as high ICT users compare with low ICT users in each of the three subjects. The effects are less striking than at Key Stage 2.

Figure 7.1: Relative gain at Key Stage 3 (standardised) for high ICT users versus low ICT users (ICT use data drawn from a total of 700 questionnaires administered during 2001)



As Figure 7.1 illustrates, in all three subjects the pupils characterised as high ICT users outperformed, on average, low ICT users. As with the equivalent graph for Key Stage 2, the numbers on the scale on the left of the graph relate to the average advantage gained by each group, that is, the average difference between how the pupils were expected to achieve and what they actually did achieve in National Tests at Key Stage 3. Again, these differences are expressed in 'standard deviations'. In Figure 7.1, the most powerful impact of ICT use can be seen to be in science. This actually represents a statistically significant (and positive) impact for high ICT use in science ($F(1,268) = 4.549$, $p < 0.05$). (Again, this does not include use of the Internet). In mathematics and English, there is a positive association but it is not statistically significant. It should be noted that not reaching statistical significance does not mean that a result is unimportant or uninteresting. The positive nature of the effects gives further credence to the view that the observed impacts of ICT are not random fluctuations in the data.

As at Key Stage 2, it may be that considerations of differences in practice (that is how ICT is applied in addition to how often) are needed to more fully understand these findings. Section 7.2 begins to explore these differences at an individual school level.

As in section 5 above, the following analysis investigates the impact of ICT usage on relative gain scores by initial achievement (IA) or ability levels (Table 7.1)

Table 7.1: Relative Gains (unstandardised) by ICT and Initial Achievement for English, Mathematics and Science at Key Stage 3

		English (N)	Maths (N)	Science (N)
ICT High	IA High	.105 (54)	.353 (39)	.316 (47)

	IA Average	.053 (79)	.114 (78)	.178 (90)
	IA Low	-.173 (21)	-.341 (30)	-.158 (14)
ICT Low	IA High	-.022 (42)	.191 (37)	.171 (28)
	IA Average	.0026 (63)	.011 (60)	-.236 (71)
	IA Low	.129 (21)	-.187 (21)	-.173 (19)
All	ICT High	.040	.085	.190
	ICT Low	.016	.032	-.129
All	IA High	.049	**.274**	.262
	IA Ave	.031	**.069**	-.0043
	IA Low	-.022	**-.277**	-.167
Sd (overall)		.957	.913	1.001

ANOVA

Effect	***df***	***English***		***Mathematics***		***Science***	
		F	significance	F	Significance	F	Significance
ICT	1	0.102	0.750	0.095	0.758	1.644	0.201
Init Ach.	2	0.064	0.938	5.300	0.006	2.565	0.079
ICT x Init Ach	2	0.752	0.472	0.505	0.604	0.816	0.443

In English, differences between mean relative gains are negligible for all three effects. In mathematics there is a non-significant advantage to the higher ICT group. More interestingly, there is a significant and linear trend showing an association between IA and relative gain; that is those with the greatest IA scores do better than expected whilst those with the lowest IA scores tend to do worse that anticipated. The trend is apparent for both ICT groups. In science there is an advantage to High ICT at all ability levels although this does not reach statistical significance. There were no interaction effects.

For Key Stage 3, the only gender effect is that girls outperform boys in English but this is irrespective of the amount of ICT usage and is a common finding ($F(1, 214) = 10.46$, $p < 0.001$).

Key findings at Key Stage 3

- At Key Stage 3, pupils characterised as high ICT users outperformed, on average, low ICT users in all three subjects; however, the effects were much less well marked than at Key Stage 2.
- A statistically significant positive association between ICT and attainment in National Tests for science was found at Key Stage 3, but there were no other clear-cut associations at Key Stage 3.
- Where there were positive effects of high ICT usage, the benefits were the same across all ability groups.

7.1 Relative gain at Key Stage 3 in National Test marks and National Curriculum levels

It is also possible to provide a further interpretation of the relative gain scores by translating them into National Curriculum levels for each subject. National Curriculum levels measure children's progress in each subject. Broadly, one level is thought to relate to around two years in a pupil's development, that

is, they are expected to progress by the order of 0.5 of a level per year. This way of presenting relative gains provides estimates of the actual marks associated with the performance of high and low ICT groups after taking into account differences in their initial achievement levels at Key Stage 3.

In Table 7.2 the mean relative gain scores at Key Stage 3 for high ICT users and low ICT users are expressed in terms of their level equivalents. This can help to express the impact of greater ICT use. Note however that these can only represent approximations, because the number of marks separating levels varies from level to level, and because the clustering of marks can vary from subject to subject.

Table 7.2 Mean relative gain scores in level equivalents at Key Stage 3 for high ICT users versus low ICT users by subject

	English	Maths	Science
High ICT	0.009	0.037	0.094
Low ICT	-0.008	-0.046	-0.120
Difference	0.017	0.083	0.214

Given that one level is thought to relate to around two years in a pupil's development, a gain of 0.10 represents 10% of two years' achievement, or 20% of one year's achievement. If the mean relative gains identified earlier were translated directly into progress through the National Curriculum levels, high ICT use in Key Stage 3 science in particular can be seen to support a substantial acceleration in progress through these levels equivalent to 21.4% of two years' achievement.

In Key Stage 3 mathematics the acceleration in progress is equivalent to 8.3 % of two years' achievement.

Figure 7.2 Mean relative gain scores in level equivalents at KS3 for high ICT users versus low ICT users by subject

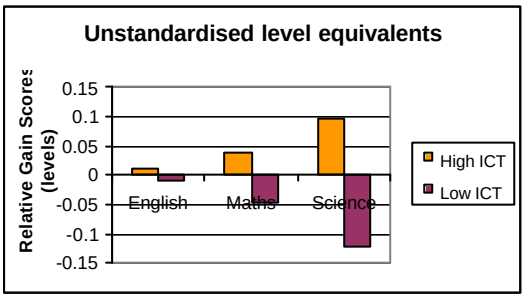
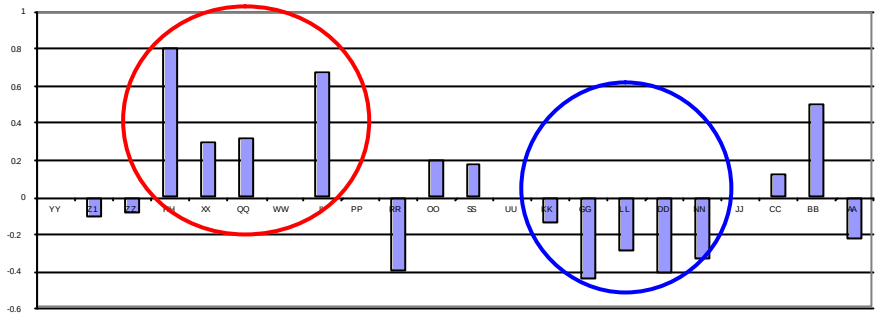


Figure 7.2 illustrates the level equivalents in graphical form. It is important to note however that the preferred way of analysing the impact of high ICT use remains the one presented at the start of section 7 – the graph of relative gain scores. This is because this data has been standardised, and so allows for comparison between the various Key Stages and subjects included in this study.

7.2 Relationship between ICT use and attainment in Key Stage 3 English

As in the previous part of the report concerning Key Stage 2, the following set of graphs illustrate the relationship between ICT use and attainment on a school-by-school basis for the core subjects at Key Stage 3. The schools have been ranged along the horizontal axis from the lowest average ICT score for use of ICT in the subject concerned (left of the graph) to the highest (right of the graph). The vertical scale shows mean relative gain scores. Each school contributes a single column the height of which corresponds to the mean relative gain for that school in that subject at Key Stage 3. We start with Key Stage 3 English.

Figure 7.3: Mean relative gain for schools (unstandardised) in order of ICT usage for English from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The marginal difference in performance between those pupils using ICT a lot and those using it a little is reflected in the small variation in relative gain scores and the lack of any clear trend from left (low use of ICT) to right (high use of ICT). Again, the vertical axis has been stretched to make what differences there are more apparent. As can be seen, some schools (circled red) achieve better relative gain scores than would be expected if the level of pupil's use of ICT were a significant influence on their achievement. Similarly in some schools (circled blue) the effect is reversed.

This is in line with the findings reported in Becta's *Secondary Schools of the Future* (Becta, 2001) where a small negative correlation was found between schools reporting high use of ICT in English and pupils' performance in the Key Stage 3 English tests.

7.3 Links to other strands of the study regarding Key Stage 3 English

In Sedgewick Secondary School (QQ), where pupils were using ICT less often, but where the mean relative gain score was positive, ICT was being used to support a wide range of curriculum activities:

> *"All staff use WP [word processing] software for newspaper article work and media work Y8 and Y9 [Year 8 and Year 9]. Y7 [Year 7] use WP for stories, poems etc. Some Internet based research of authors' work. Most staff [are] comfortable with web page design to present work and Internet research Y9 [Year 9]. E-mail is used for collaborative work in Y9."*
>
> Key Stage 3 English teacher, Sedgewick Secondary School (QQ)

In two other schools use was only partial, depending on the interest and skills of members of the English department. For example, across the 13 reports on ICT in subject areas from teacher researchers in secondary schools the following uses of ICT for English at Key Stage 3 were described: revision (four), word processing/course work (three), remedial skills building (two), research (three), Shakespeare CD-ROM (three) and e-mail for communicating with children in other schools (one).

Cheapside Secondary School (CC), which had the third highest level of pupil use, and, again, where the mean relative gain score was positive provided an example of how pupils were using ICT to help them prepare speeches on contemporary issues in English in Year 9:

> "*Pupils in Year 9 are completing a 'Contemporary Issues' module. Their task is to write a speech about any contemporary issue and to argue a particular viewpoint connected with the issue... To gather information for their speeches the pupils spent one lesson working on the Internet looking at appropriate web sites connected with their issue.*
>
> *I chose ICT to support this activity because the Internet provides a wealth of resources and knowledge. It is also a good motivational tool for pupils especially boys who tend to have less enthusiasm for research. Pupils used their own user areas to access [Internet browser]. They then used search engines to find appropriate web sites. Once they found useful information/ pictures to use in their speeches, they were encouraged to*

either note down information, transfer into [word processing software] or down load certain pages. They used [word processing software] in writing up their material."

Key Stage 3 English teacher, Cheapside Secondary School (CC)

Issues for teaching and learning at Key Stage 3 English

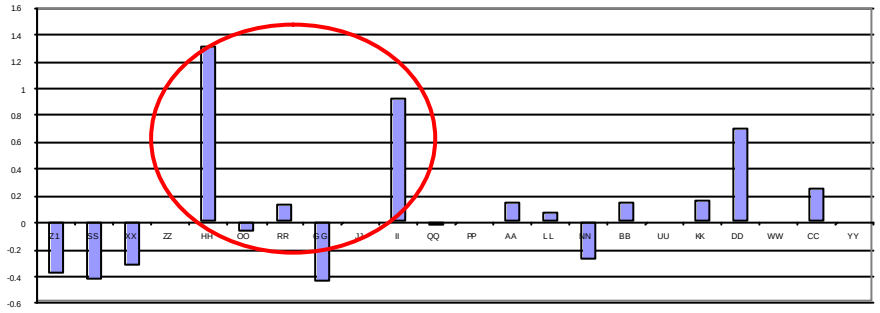
Teachers in schools where pupils used ICT in English and achieved higher mean gain scores identified the following key factors in relation to the use of ICT in English at Key Stage 3:

- Higher quality outcomes encouraging greater commitment to writing tasks.
- Use of e-mail to support collaborative writing.
- Increased time for reflection.
- Use of the Internet to locate relevant material linked to real tasks.
- Use of ICT to develop materials found on the Internet.

7.4 Relationship between ICT use and attainment in Key Stage 3 mathematics

As with the previous graph for English, this graph (Figure 7.4) illustrates the relationship between for ICT use and attainment on a school-by-school basis for Key Stage 3 mathematics.

Figure 7.4: Mean relative gain for schools (unstandardised) in order of ICT usage for mathematics from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



While the underlying trend is stronger than for English, the marginal difference in performance between those pupils using ICT a lot and those using it a little is reflected in the small variation in relative gain scores amongst the majority of schools. Spartan Secondary School (HH) and Northumberland Secondary School (II) show marked differences from any underlying trend, both achieving the highest mean relative gain scores with less use of ICT than those at the right hand end of the graph. Interestingly, these same two schools exhibit similar patters in English (see earlier). Northumberland Secondary School (II) also performs similarly in science. Given the high weighting the results in these schools contribute to the overall statistics, further investigation is needed into of the practice in these schools.

7.5 Links to other strands of the study regarding Key Stage 3 mathematics

As at Key Stage 2, ICT was used very little for teaching mathematics at Key Stage 3. Only two of the secondary teachers said that they thought ICT had a positive impact on National Tests/GCSE results in

mathematics in their school. One teacher at a school achieving a positive mean relative gain score with average ICT use in mathematics said:

> *"Coursework can be more presentable for some pupils. The use of spreadsheets helps find number patterns and can improve pupil grades. The use of software such as [a revision site] allows pupils to concentrate their efforts on weak topics and provides instant feedback on individual progress. Confidence can be boosted. Pupils use this type of revision software extensively at home and it allows those with Internet availability to improve their potential grades. An improvement of one grade is achievable."*
>
> Key Stage 3 mathematics teacher, Pilgrim Secondary School (LL)

At Lode Hall Secondary School (RR), with a lower reported level of ICT use in mathematics, but, again, with a positive mean relative gain score there was evidence of a greater commitment to incorporating ICT into subject work at Key Stage 3, including mathematics.

> *"..students work with spreadsheets for mathematical activities of optimising, and trial and improvement; in one case spreadsheets are used to investigate which of two mobile phone purchase packages is better given differing initial payments for calls and on-going charges. With the advent of the new National Strategy for Key Stage 3 the department is moving towards greater use of ICT as "a tool when appropriate" and looks forward to building on, for instance, students' experience of using spreadsheets in Year 6. The Head of Maths has written a set of Web pages for Year 11 "to think about when they're going to plan their revision" with hints, tips, sources of information, and another to support students in undertaking a GCSE statistics project with links to sources of statistics. These pages are available from home over the World Wide Web. Local statistical research by students then 'validated' using national information which is searched for on the Web."*
>
> Key Stage 3 mathematics teacher, Lode Hall Secondary School (RR)

Issues for teaching and learning at Key Stage 3 mathematics

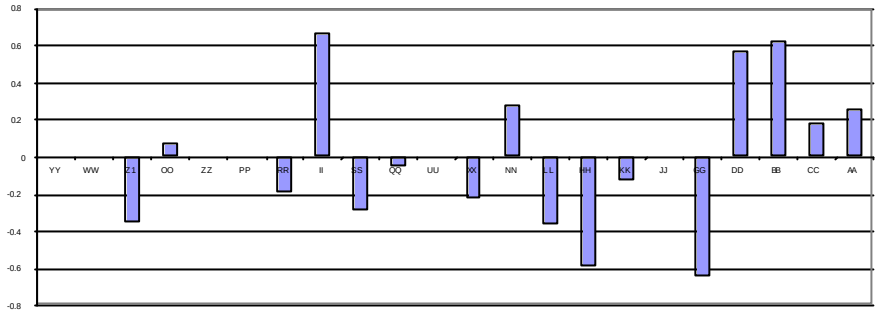
Teachers in schools where pupils used ICT in mathematics and achieved higher mean gain scores identified the following key factors in relation to the use of ICT in mathematics at Key Stage 3:

- Higher quality outcomes encouraging greater commitment to coursework tasks.
- Immediate feedback identifying strengths and weaknesses.
- The use of revision sites out of school hours to reinforce topics and address weaknesses.
- Using spreadsheets to support work on number patterns, optimising and modelling.
- Use of Web-based material to structure out of school learning.

7.6 Relationship between ICT use and attainment in Key Stage 3 science

As with the previous graphs for English and mathematics, this graph (Figure 7.5) illustrates the relationship between for ICT use and attainment on a school-by-school basis for Key Stage 3 science.

Figure 7.5: Mean relative gain for schools (unstandardised) in order of ICT usage for science from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The statistically significant association between pupils' level of use of ICT in science and achievement is reflected in the general trend towards higher relative mean gain scores as one moves towards the right hand end of the graph. Again, there is variation around this general trend. Mallard Secondary School (GG) achieved a low mean relative gain score in science, as it did in English and mathematics, suggesting that other factors may be influencing results in the school. Similarly, Northumberland Secondary School (II) achieved high relative mean gain scores in all three subjects. As before, an investigation of the practice in the schools is needed.

7.8 Links to other strands of the study regarding Key Stage 3 science

The following, taken from Northumberland Secondary School (II) (with the largest mean relative gain score in science) reveals that, while the level of use of ICT in that school is not as high as in some, the teacher had a clear sense of when and why ICT use was effective.

> *"They were so highly motivated that those who would have attained anyway attained better I felt, but there were one or two students who normally wouldn't have even engaged in the lesson [who] were extremely well motivated... Those students got [good] marks in that lesson when I had struggled with them all year to get anything out of them at all. They were coming up with their own ideas and generating planning and evaluating what they were doing in a way they had never done before."*
>
> Key Stage 3 science teacher, Northumberland Secondary School (II)

Two teachers described wide-ranging use of ICT for science in their schools, one of whom was able to use laptops for data-logging in a science lab rather than moving the pupils to the ICT suite. One teacher was enthusiastic about the use of software for modelling and testing electrical circuits (Tudor Secondary School, KK), and another mentioned using spreadsheets for manipulating data and producing charts. Three others described small-scale use of ICT, by pupils for revision, research and extension work. The following is taken from Dalton Secondary School (BB), where pupils are high users of ICT in science and the mean relative gain score is high.

> *"The department has set the target of introducing at least one investigation into every year involving some aspect of ICT. I have used data-logging, spreadsheets and word processing."*
>
> Key Stage 3 science teacher, Dalton Secondary School (BB)

The remaining three appeared to make little use of ICT in science teaching at Key Stage 3. It was clear that in some cases teachers felt hindered in what they could do by lack of equipment and two of those who reported low usage went on to describe the new equipment that would soon be installed.

Issues for teaching and learning at Key Stage 3 science

Teachers in schools where pupils used ICT in science and achieved higher mean gain scores identified the following key factors in relation to the use of ICT in science at Key Stage 3:

- Increased motivation and greater involvement in learning.
- Higher quality outcomes encouraging greater commitment to writing tasks.
- The use of simulations and modelling software to explore specific concepts.
- The use of data-handling software for analysing, manipulating and presenting data.
- The use of laptops to allow data-logging in the science lab.
- Use of ICT to support research skills.

Section 8 Patterns of use of ICT at Key Stage 4

Pupils' responses to the questionnaire administered in 2001 identifying how often and where they used ICT in English, mathematics and science are summarised in the following table.

Table 8.1 Frequency of use in core subjects at Key Stage 4 (Drawn from a total of 700 questionnaires administered during 2001)

		Never %	Hardly ever %	Some weeks %	Most weeks %	Every week %
Mathematics	Lesson	27.49	54.45	14.82	1.08	2.16
	School	68.72	23.18	6.70	0.84	0.56
	Home	58.15	29.78	8.15	3.37	0.56
English	Lesson	32.18	38.83	22.07	6.12	0.80
	School	45.68	28.13	17.83	7.24	1.11
	Home	22.69	23.81	34.45	15.13	3.92
Science	Lesson	26.81	42.77	27.71	2.11	0.60
	School	53.61	25.08	17.55	3.45	0.31
	Home	35.20	26.48	31.15	6.23	0.93

8.1 Pupils' use of ICT in Key Stage 4 English

ICT is little used in English at Key Stage 4. The majority of pupils surveyed reported using ICT never or hardly ever to support their learning of English, either within their English lessons (71%) or within their wider school experiences (72%). This contrasts with the finding that approximately half the sample used ICT at home to support their English studies with one third reporting use some weeks and 20% most or every week.

8.2 Pupils' use of ICT in Key Stage 4 mathematics

The results for Key Stage 4 mathematics indicate a different pattern of use. While fewer pupils report never using ICT in mathematics (27%) compared to English (32%), the general level of use of ICT in mathematics is lower. Nearly 70% report never or hardly ever using ICT to support their learning of mathematics in school outside mathematics lessons. This contrasts with the position in English and is in line with Key Stage 4 pupils' general school experiences. Writing tasks (for example) are far more likely to be found outside English lessons than mathematical tasks outside mathematics lessons. The level of use at home is markedly less with well over half of the sample never using ICT in their mathematics at home. This may indicate that the software used in mathematics (including educational software and applications such as spreadsheets) is used less at home, in contrast with word-processing, the major application used to support English. The general lower level of use in mathematics may lead to any observed effects being less marked than in English.

8.3 Pupils' use of ICT in Key Stage 4 science

The level of use in science-related work at home (38.31% reporting use at least some weeks or more) is larger than for mathematics (12.08%) and less than for English (53.5%), possibly reflecting the use of ICT to write up scientific investigations and to search information sources such as CD-ROMs and encyclopaedias, both of which have made significant inroads into the home software market. Evidence from pupil diaries points to the extensive use of online revision sites. Further case study work is needed to clarify whether this is the case.

Key findings at Key Stage 4

- At Key Stage 4, ICT use is rare in schools, but more common at home in English and science.
- ICT is used somewhat more frequently for English than it is for science at Key Stage 4, while usage in mathematics is considerably rarer.

Pupils' responses to the questions identifying how often and where they used ICT in non-core subjects are summarised in the following table.

Table 8.2 Frequency of use in non-core subjects at Key Stage 4 (*Drawn from a total of 700 questionnaires administered during 2001)*

		Never %	Hardly ever %	Some weeks %	Most weeks %	Every week %
History	Lesson	49.00	29.00	16.50	3.50	2.00
	School	55.05	22.73	18.69	3.03	0.51
	Home	29.84	28.80	34.03	5.76	1.57
Geography	Lesson	33.80	39.91	23.00	2.82	0.47
	School	47.34	35.75	13.04	3.38	0.48
	Home	20.69	33.99	34.98	7.39	2.96
MFL	Lesson	40.00	31.67	22.50	5.00	0.83
	School	68.83	20.35	9.52	1.30	0.00
	Home	48.48	34.63	13.42	3.46	0.00
D&T	Lesson	16.59	24.42	35.25	17.97	5.76
	School	40.98	26.00	20.61	9.60	2.81
	Home	29.55	18.91	29.08	17.49	4.96

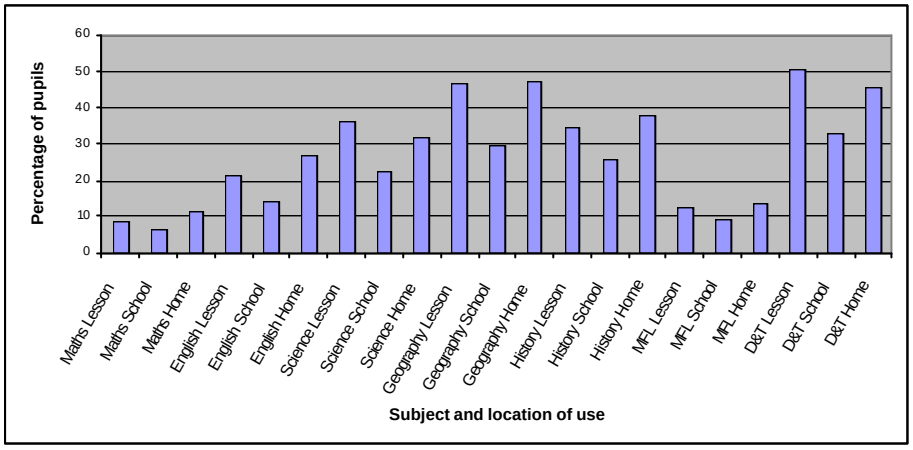
The overall pattern of usage is similar for history and geography; with about 30% of pupils reporting use at home some weeks and some reporting most weeks. ICT usage in modern languages is considerably lower, both at home and at school. By contrast, teachers of design and technology use ICT quite extensively, in their lesson work (with 59% of pupils using ICT some weeks or more often), and they encourage pupils to use ICT in their homework (57% using ICT some weeks or more often). While many teachers identified technical and access issues which they felt prevented them from using ICT, some teachers also identified difficulties in adapting their teaching to incorporate the use of ICT.

> *"When we started [using ICT] there was much resistance from teachers [to the more independent approach] - I always want to stand in front of class and see what they are doing… but once we started seeing how much kids learned by using ICT, they were more happy to let them come into the computer rooms. It took some time for teachers here to accept that kids would be chatting and walking round the computer room, which would not be acceptable in a normal classroom. But that is how kids learn in IT and teachers now manage that situation well. They know when it is focused chat and when just socialising."*
>
> Key Stage 4 classroom teacher, Sedgewick Secondary School (QQ)

The need to focus on preparation for examinations (in which ICT is not used) was also cited as another reason for not using ICT at Key Stage 4.

8.4 Internet use by subject area at Key Stage 4

Figure 8.1 Frequency of Internet use at Key Stage 4 (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The pattern for Internet use largely matches that for ICT in general at this Key Stage, with most use in D&T and least in mathematics and MFL. In addition, there appears to be less use of the Internet in core subjects at Key Stage 4 than at Key Stages 2 or 3. Use of applications such as e-mail appears to be equally low.

It is interesting to note the relatively high frequencies of 'Yes' responses for Internet use in geography, history and design and technology, which suggests that a significant number of teachers and pupils have found the Internet useful in these subjects. Reasons for the relatively low level of use include the disparity in pupils' home access to the Internet. This has restricted the way in which some teachers direct pupils to use computers to support their homework – so computer use becomes optional:

> *"I do set homework but cannot insist on use of Internet because not all children have a computer at home. Those who do bring in examples then give the sites to children to look up at school."*
>
> Key Stage 4 classroom teacher, Maddison Secondary School (UU)

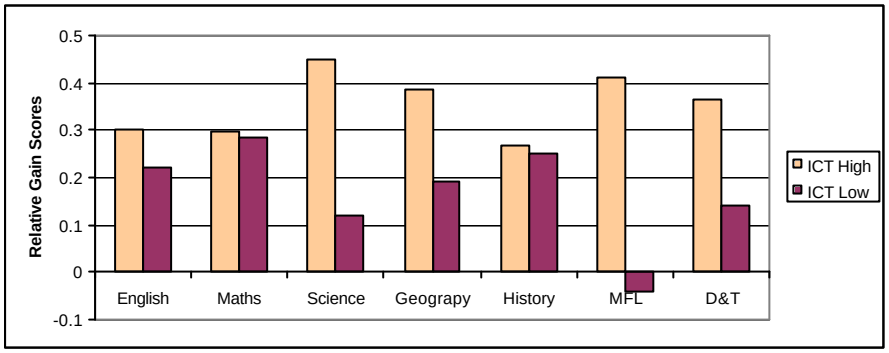
These issues are explored in the discussions of use in individual subjects later on in this report.

Section 9 Relative gain for high ICT users versus low ICT users of ICT in English, mathematics, science, geography, history, modern foreign languages, and design and technology at Key Stage 4

This section begins by exploring the general relationship between pupils' use of ICT and their performance at GCSE. As described in the introduction the relationship explored is that between pupils' level of use of ICT and their relative gain scores in each subject, that is how their actual performance compared with their predicted performance.

The following graph (Figure 9.1) shows how the relative gain scores of the group of Key Stage 4 pupils characterised as high ICT users compare with low ICT users in each of the GCSE subjects investigated. The effects are less striking than at Key Stage 2 and more striking than at Key Stage 3.

Figure 9.1: Relative gain (standardised) at Key Stage 4 (GCSE) for high ICT users versus low ICT users (ICT use data drawn from a total of 700 questionnaires administered during 2001)



As Figure 9.1 illustrates, in all of the subjects investigated the pupils characterised as high ICT users outperformed, on average, low ICT users.

As with the equivalent graphs for Key Stage 2 and Key Stage 3, the numbers on the scale on the left of the graph relate to the average advantage gained by each group, that is, the average difference between how the pupils were expected to achieve and what they actually did achieve in National Tests (GCSEs) at Key Stage 4. Again, these differences are expressed in 'standard deviations'. Remember that it is highly unlikely that the relative gain scores on the graphs would reach the figure of one.

In Figure 9.1, the differences are slight and not statistically significant for English, mathematics and history. The differences in performance are much more considerable for science and for geography. The difference is statistically significant for science ($F(1, 341) = 10.877$, $p < 0.001$) but the difference for geography just failed to reach statistical significance, the number of pupils involved being less for non-core subjects than it is for core subjects.

The greatest difference in mean relative gain between high ICT and low ICT pupils is found in modern foreign languages in favour of high ICT usage, despite the fact that overall usage in this subject was quite low. This was statistically significant ($F(1, 368) = 16.259$, $p < 0.001$).

In the case of design and technology, the subject with the highest reported level of use of ICT, differences in favour of higher ICT levels were found to be approaching statistical significance in all analyses ($F(1, 282) = 3.767$, $p = 0.053$).

These findings were broadly supported by supplementary analyses (appendix 2). Analysis on a school basis rather than an individual basis suggested that higher ICT usage was more beneficial in science, modern foreign languages and design & technology and these were all statistically significant. Multilevel modelling revealed a statistically significant impact of higher ICT usage for science and modern foreign languages.

Again, it may be thought that the lack of statistical significance in some subjects implies that pupils' use of ICT in mathematics and English has no effect on their performance in those subjects. However, the non-statistically significant effects are all positive giving some credence to the view that the positive effects observed are not random fluctuations in the data.

That the most significant associations were found in science at Key Stage 4 may well be a reflection of the fact that science teachers in general have been developing materials and procedures longer than in other curriculum areas and have found ways of capitalising on the potential of the medium. Again, in science, there is a clear alignment between the content of the ICT and the content of the examination. The same is true of design and technology and of modern foreign languages. In some other subjects, and especially in English in the secondary school, there is no such correspondence between the content of the ICT used in English (which was often related to the presentation or publication of work) and the content of the examination. The skills that pupils are learning in becoming more expert at presenting their work effectively on the computer are not tested in Key Stage 3 National Tests, or at GCSE.

Evidence from lesson observations pointed to a variety of approaches to integrating ICT within subject teaching. There were many examples of lessons observed in which ICT featured as integral to a subject-based session so that, in one way or another, ICT served to enhance the learning process. In contrast to these, there were other lessons that were purportedly curriculum focussed, but where most of the ICT use could be described as skill-oriented. That is, while pupils' ICT skill base may have been extended (and in some cases pupils were simply rehearsing already well practised abilities) it did not further those pupils' subject knowledge or understanding. Section 9.2 onwards begins to explore differences in practice at an individual school level in a way that may illuminate the findings.

A consideration of the overall and individual subject relative gain scores (see the graphs in Figure 9.1 above and in Figures 9.3 to 9.9 that follow), indicates that students generally performed well at GCSE as indicated by the high proportion of positive relative gain scores, with the possible exception of science. This contrasts with the patterns and results for Key Stages 2 and 3 where a more even balance of positive and negative scores occur. In the case of Key Stage 4 English and mathematics, only three of the twenty school scores are negative, four in the case of geography, and design and technology. In the case of science the significant finding in favour of high ICT use schools was between two sets of positive scores.

Key Stage 4 performance has been assessed using YELLIS, while PIPs was used at Key Stage 2, and attainment predicted from Key Stage 2 results in the case of Key Stage 3 (PIPs and YELLIS are part of a family of information systems offered by the Curriculum, Evaluation and Management Centre at the University of Durham - see the glossary in appendix 2 for further explanation). There is evidence to support the view that a high proportion of students in the schools in the Key Stage 4 ImpaCT2 sample appear to be achieving above average standards for YELLIS pupils – hence the reason for the generally positive scores. This is an aspect of the nature of the ImpaCT2 sample as a whole, and may have been the result of teachers avoiding giving questionnaires to some of their weaker pupils. Across the ImpaCT2 secondary school sample as a whole, mean school achievement on the YELLIS 'baseline' tests was very close to the national average.

Deleted: – that is,

As in sections 5 and 7 above, it is helpful to explore whether or not the advantage of ICT usage in subject levels is apparent for all Initial Achievement (IA) levels or ability levels.

Table 9.1: Relative Gains by ICT and Initial Achievement (unstandardised) for English, Mathematics and Science

		English (N)	Maths (N)	Science (N)
ICT High	IA High	.239 (69)	.119 (76)	.453 (67)
	IA Average	.313 (61)	.393 (75)	.482 (74)
	IA Low	.359 (65)	.407 (54)	.315 (40)
ICT Low	IA High	.131 (74)	.022 (60)	.097 (47)
	IA Average	.235 (78)	.310 (57)	.108 (52)
	IA Low	.312 (53)	.556 (61)	.141 (63)

All	ICT High	.303	.295	**.434**
	ICT Low	.220	.283	**.118**
All	IA High	.184	**.057**	.306
	IA Ave	.270	**.357**	.327
	IA Low	.342	**.486**	.209
Sd (overall)		.853	.824	.901

ANOVA KS4

Effect	***df***	***English***		***Mathematics***		***Science***	
		F	significance	F	Significance	F	Significance
ICT	1	0.751	0.387	0.090	0.765	9.360	0.002
Init Ach.	2	1.080	0.340	9.588	0.000	0.155	0.856
ICT x Init Ach	2	0.054	0.947	1.084	0.339	0.398	0.672

None of the effects is significant for English. In mathematics, one notes exactly the reverse trend to that which was found at KS 3: independently of ICT usage the higher the IA level the lower the gain, a finding which, though somewhat surprising, is clearly beyond the scope of this investigation. In science there is no significant IA effect and the ICT effect is significant and positive, as it was the analysis of mean relative gain scores (standardised) described above. The benefit of high ICT usage in science occurs at every level of IA. Again, none of the interactions is significant.

Table 9.2: Relative Gains (unstandardised) by ICT and Initial Achievement for Geography, History, Modern Languages, D&T

	Initial Ability	Geography (N)	History (N)	Modern Languages (N)	Design & Tech. (N)
ICT High	IA High	.289 (39)	.128 (43)	.327 (60)	.376 (55)
	IA Average	.481 (37)	.371 (33)	.409 (61)	.383 (64)
	IA Low	.400 (25)	.473 (12)	.549 (37)	.333 (48)
ICT Low	IA High	.059 (30)	.213 (28)	.053 (76)	.078 (37)
	IA Average	.302 (18)	.315 (26)	.050 (69)	.350 (42)
	IA Low	.326 (15)	.211 (16)	.022 (67)	.037 (38)
All	ICT High	.387	.266	**.411**	**.366**
	ICT Low	.192	.250	**.042**	**.138**
All	IA High	.189	.162	.174	.256
	IA Ave	.423	.346	.219	.370
	IA Low	.372	.323	.210	.169

Sd (overall)		.848	.717	.888	.978

ANOVA

Effect	*df*	*Geography*		*History*		*Mod. Lang.*		*Design & Tech.*	
		F	Signif.	F	Signif.	F	Signif.	F	Signif.
ICT	1	1.300	.256	.383	.537	17.229	.000	3.917	.049
Init Ach.	2	1.119	.329	1.079	.343	.333	.717	1.209	.300
ICT x Init Ach	2	.101	.904	.586	.558	.594	.553	.782	.458

IA effects for geography are slight and non-linear. The overall ICT effect is positive but fails to reach significance, as was found in the analysis of mean relative gain scores (standardised) described above. However, one notes that there is a non-significant positive ICT effect at every IA level. History shows no interesting effects. In modern foreign languages as in design & technology, the ICT effect is significant replicating the analysis of mean relative gain scores (standardised) described above, and the high ICT group achieves higher mean gains than do their counterparts at every level of IA. None of the interactions is significant. ICT effects wherever found were independent of ability as measured by initial achievement. Where there was an ICT effect, it was apparent and positive at each of the three IA levels.

Gender effects were apparent in all subjects but mathematics and science, girls performing better than boys in all cases (English: $F(1, 398) = 32.1$, $p < 0.001$; geography: $F(1, 163) = 5.93$, $p < 0.05$; History: $F(1, 157) = 9.89$, $p < 0.01$; modern foreign languages: $F(1, 369) = 45.08$, $p < 0.001$; design & technology: $F(1, 283) = 44.3$, $p < 0.001$). However, there were no interaction effects when gains by gender and ICT usage were analysed.

Key findings at Key Stage 4

- At Key Stage 4, pupils characterised as high ICT users outperformed, on average, low ICT users in all subjects.
- The effects at Key Stage 4 were less well marked than at Key Stage 2 and more marked than at Key Stage 3.
- At Key Stage 4, there was a statistically significant positive association between ICT and GCSE science, and ICT and GCSE design and technology;
- There were also strong indications of a positive association in GCSE modern foreign languages (MFL) at Key Stage 4, and some indications of a positive association in GCSE geography, although neither reached statistical significance.
- In English, mathematics and history at Key Stage 4 the small positive differences found were not statistically significant.
- Where there were positive effects of high ICT usage, the benefits were the same across all ability groups.

9.1 Relative gain at Key Stage 4 in GCSE grades

It is also possible to provide a further interpretation of the relative gain scores by translating them into GCSE grades for each subject. These provide estimates of the actual grades associated with the performance of high and low ICT groups after taking into account differences in their initial achievement levels at Key Stage 4.

In Table 9.3 the mean relative gain scores at Key Stage 4 for high ICT users and low ICT users are expressed in terms of their grade equivalents. This can help to express the impact of greater ICT use.

In Table 9.3 the numbers represent grades in the following way:

8 = Grade A*

7 = Grade A

6 = Grade B

5 = Grade C

4 = Grade D, and so on.

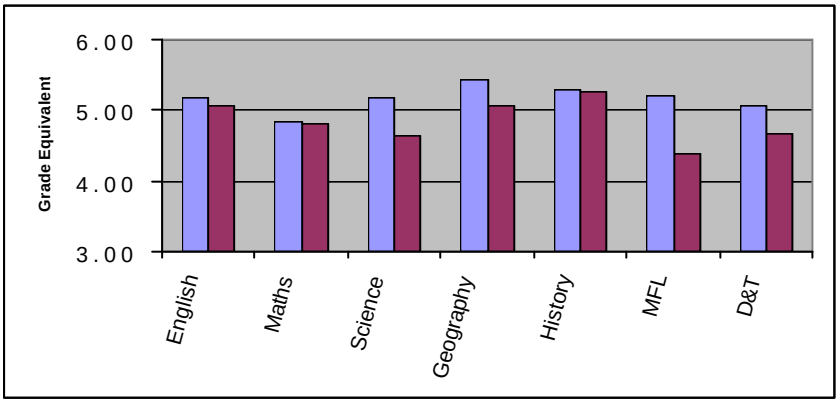
Table 9.3 Mean relative gain scores in grade equivalents at Key Stage 4 for high ICT users versus low ICT users by subject

	English	Maths	Science	Geography	History	MFL	D&T
High ICT	5.19	4.84	5.19	5.42	5.30	5.21	5.07
Low ICT	5.06	4.82	4.63	5.05	5.27	4.39	4.66
Difference	0.13	0.02	0.56	0.37	0.03	0.82	0.41

As noted before, in all subjects investigated the pupils characterised as high ICT users outperformed, on average, the low ICT users.

Figure 9.2 illustrates these grade equivalents in graphical form.

Figure 9.2 Mean relative gain scores in grade equivalents at Key Stage 4 for high ICT users versus low ICT users by subject (ICT use data drawn from a total of 700 questionnaires administered during 2001)



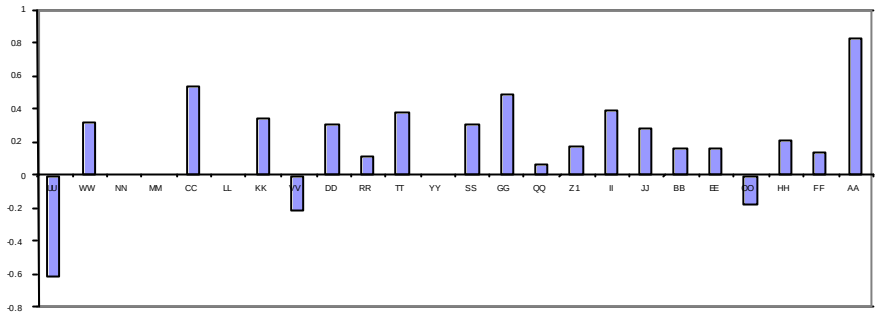
It is important to note however that the preferred way of analysing the impact of high ICT use remains the one presented at the start of section 9 – the graph of relative gain scores. This is because this data has been standardised, and so allows for comparison between the various Key Stages and subjects included in this study.

9.2 Relationship between ICT use and attainment in Key Stage 4 English

As in the previous parts of the report concerning Key Stages 2 and 3, the following set of graphs illustrate the relationship between for ICT use and attainment on a school-by-school basis for subjects

at Key Stage 4. The schools have been ranged along the horizontal axis from the lowest average ICT score for use of ICT in the subject concerned (left of the graph) to the highest (right of the graph). The vertical scale shows mean relative gain scores. Each school contributes a single column the height of which corresponds to the mean relative gain for that school in that subject at Key Stage 4. We start with Key Stage 4 English.

Figure 9.3: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 English from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The lack of any clear association between the levels of pupils' use of ICT in English and performance at GCSE can be seen in the graph, where (except in the extreme cases of the schools where pupils used ICT the least and most) the 'staircase effect' is absent. However, all bar one of the top twelve schools for ICT use in English achieved positive mean relative gain scores. In many schools the reported level of pupil use of ICT appears to be out of step with the overall reported level of use of ICT in the school. Cheapside Secondary School (CC), for example, which achieved the second highest mean relative gain score is further towards the left of the graph than might be expected given the overall high level of ICT use in the school. Similarly, the John Elliot Secondary School (OO) (which had a negative mean relative gain score) is further towards the right than might be expected. The 'anomalous' position of these schools may simply indicate a lack of connection between pupils' use of ICT in English and their results at GCSE. However, it may point towards the need to consider the overall contributions of pupils' experiences to their GCSE results, especially in a subject such as English.

9.3 Links to other strands of the study regarding Key Stage 4 English

Overall, there appeared to be a considerable reduction in the use of ICT for English teaching at Key Stage 4. The reports indicated that there was a range of uses in two schools and that it was either non-existent or limited in all the others. In Cow Lane Secondary School (AA) (which reported the highest level of pupil use in English and achieved the largest mean relative gain score) the following was reported.

> *"The school has lots of awards such as Beacon status and the school achievement status for excellence so I think part of it is down to ethos, teaching, etc. Prior to Year 11 the English department spent one lesson with each class focussing on how to use the Internet for research. In Year 11 they use ICT to research a topic give a presentation and answer questions on it (speaking and listening assessment), research authors (critical work), create …presentations on particular authors, etc."*
>
> Study research team field notes, Cow Lane Secondary School (AA)

In Whitehaven Secondary School (WW) (where pupils report little use of ICT in English, but which achieved a positive mean relative gain score in GCSE English), a Key Stage 4 teacher described practice at an early stage of development.

"Used for coursework – word processing allows students to redraft text. They tend to do this at home. We have just bought an interactive CD-ROM for poetry teaching."

Key Stage 4 English teacher, Whitehaven Secondary School (WW)

From the group as a whole, four teachers said that CD-ROMs were used for the study of set texts including poetry and Shakespeare, six said ICT was used for the production of course work, two said that there was some use of the Internet by "some groups", and four said that pupils made personal use of ICT for revision. Three teachers said their schools made little use of ICT for English at Key Stage 4, two of whom specified that this was because of examination preparation. When asked if they felt that ICT had an impact on attainment at Key Stage 4, only one gave an enthusiastic and positive "yes", two were unable to say, six said it had no or "little" impact, and four said that it improved the presentation of course work. It was clear that covering the syllabus and preparing for the examination was a very significant constraint on use of ICT in English. Only one teacher, who had already said the school made limited use of ICT for English, noted increased use during preparation for examinations. The other teachers all said that there was no time to use ICT, it did not directly contribute to teaching for the exam and was only used by pupils for coursework, in their own time, often at home.

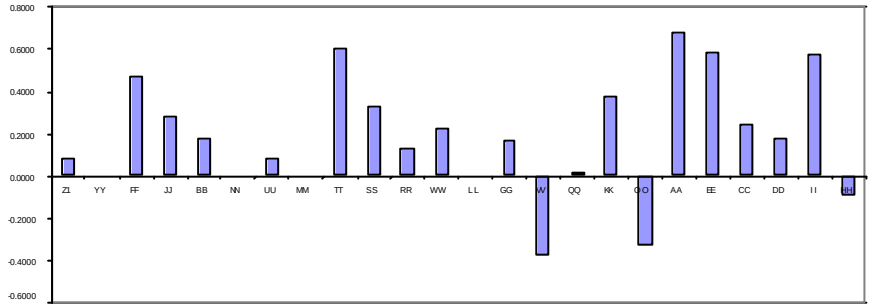
Issues for teaching and learning at Key Stage 4 English

Any conclusions for Key Stage 4 English must be tentative because of the lower level of ICT use and lack of statistical significance in the ImpaCT2 findings.

- Focussed teaching of the use of the Internet for research.
- Use of ICT at home for coursework.

9.4 Relationship between ICT use and attainment in Key Stage 4 mathematics

Figure 9.4: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 mathematics from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



As with English, the lack of any clear-cut link between pupils' use of ICT and performance in GCSE mathematics is reflected in the above graph. The principal difference is between mean gains for the highest ICT levels at the right of the diagram and the remaining schools, with less to discriminate between moderate levels at the centre and lower levels at the left, possibly indicating a threshold effect. Again, the pattern of level of use in mathematics does not always reflect the overall levels of use in the schools.

9.5 Links to other strands of the study regarding Key Stage 4 mathematics

At Key Stage 4, three of the secondary schools said that the use of ICT for course work and to access revision sites was an integral and important part of pupils' work. However, the overwhelming response

was that, adding to the disappointing picture of little use lower down the school, preparations for GCSE often constrained the use of ICT for teaching and learning in mathematics. One possible reason for this, given by at least one school, was levels of equipment. Rosehill Secondary School (EE) (which achieved positive mean relative gain scores and where pupils used ICT relatively often in mathematics) had moved towards clustered resources to provide sufficient access for pupils.

> *"The Maths department has a suite of 10 networked machines; the Maths department also has a digital whiteboard and projector, and a portable laptop with projector. The students are encouraged to use ICT in these areas and support is given by the ICT department in organisation and delivery. All students across the school are encouraged to use Internet resource during revision, advice and links are given on the Intranet which is run by the Head of ICT."*
>
> Secondary mathematics teacher, Rosehill Secondary School (EE)

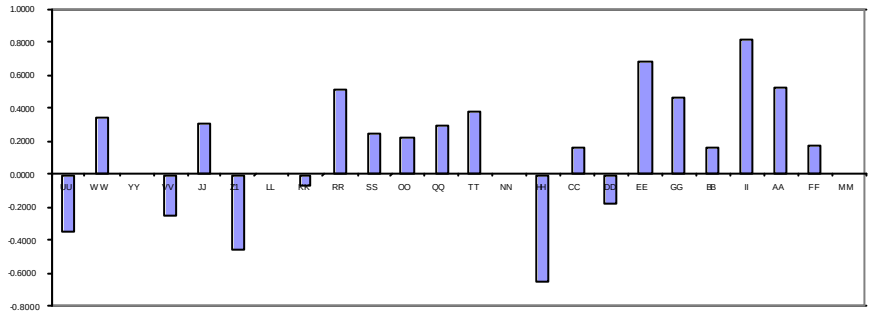
Issues for teaching and learning at Key Stage 4 mathematics

As with English, any conclusions for Key Stage 4 mathematics must be tentative because of the lower level of ICT use and lack of statistical significance in the ImpaCT2 findings.

- Use of the Internet for revision.
- Resources located in subject departments.
- The use of presentation technologies such as digital projectors and whiteboards.

9.6 Relationship between ICT use and attainment in Key Stage 4 science

Figure 9.5: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 science from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The statistical significance of the association between pupils' use of ICT in science and performance at GCSE is apparent in the stepwise trend in the graph, with a concentration of high mean gains to the right of the diagram. Cow Lane Secondary School (AA) and Northumberland Secondary School (II) show relatively high levels of ICT use and mean relative gain scores in all three subjects, and the practice in these two schools in particular is worthy of further investigation.

9.7 Links to other strands of the study regarding Key Stage 4 science

At Key Stage 4, three teachers described wide-ranging uses of ICT for teaching science in their schools. One continued to be enthusiastic about using focussed simulations in dedicated lessons, and three teachers said ICT was a valuable resource for pupils' independent study for research, revision and/or course work:

"Good for researching topics for health studies GCSE which needs up-to-date information in year 10."

Key Stage 4 science teacher, Cheapside Secondary School (CC)

In response to the more specific question about whether or not ICT had an impact on pupils' attainment in science at Key Stage 4 in their schools, three responded positively, one saying:

"Coursework can be more presentable for some pupils. The use of software such as [revision site] allows pupils to concentrate their efforts on weak topics and provides instant feedback on individual progress. Confidence can be boosted. Pupils use this type of revision software extensively at home and that allows those with Internet availability to improve their potential grades. An improvement of one grade is achievable."

Key Stage 4 science teacher, Pilgrim Secondary School (LL)

Three schools said ICT helped to improve course work. One felt that the most able benefited significantly more than other pupils, although another said that "instant feed-back" with interactive software and revision materials was a strong motivator. Four said that ICT in science had little or no impact on attainment at Key Stage 4, although one added that this "varies greatly between staff", and another believed that ICT would have much greater impact on pupils' attainment once the school's new equipment arrived and they were equipped with "satellite" access facilities.

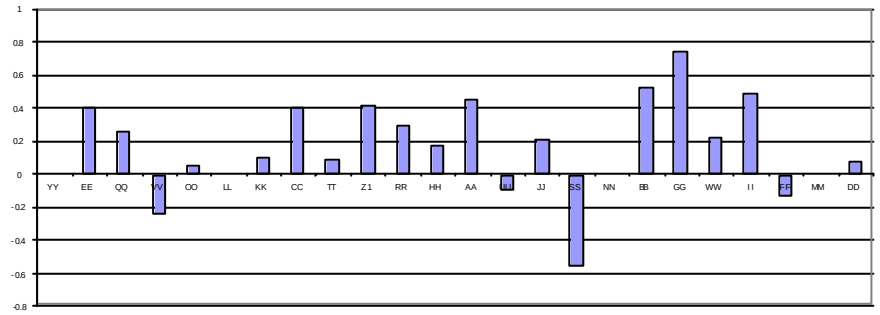
Issues for teaching and learning at Key Stage 4 science

Teachers identified the following key factors for teaching and learning using ICT in science at Key Stage 4.

- Use of the Internet for revision and research where topics require up-to-date information.
- ICT providing instant feedback on strengths and weaknesses.
- Use of simulations.
- Resources located in subject departments.

9.8 Relationship between ICT use and attainment in Key Stage 4 geography

Figure 9.6: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 geography from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The overall positive trend from left to right indicates the strength of the association between level of ICT use and performance in GCSE geography, which just falls short of statistical significance, possibly because of the smaller sample size. (Fewer pupils take GCSEs in the Foundation as opposed to the Core subjects). Again, the patterns of use do not follow the overall levels of use in the school. Cow

Lane Secondary School (AA) and Dalton Secondary School (BB) achieve positive mean gain scores while their positions on the graph indicate that the level of use in geography was relatively less than the overall level of use in those schools.

9.9 Links to other strands of the study regarding Key Stage 4 geography

Mallard Secondary School (GG) (where the pupils' reported level of use of ICT in geography was high and which achieved the highest mean relative gain score) identified a number of specific uses for ICT in geography. These included:

- the preparation for the decision making exercise exam.
- the research and presentation of the coursework units.
- revision for the final exam paper.

"To prepare for the decision making exercise on national parks students used a number of web sites for research. Many of the students word-processed part, if not all, of the work presented for their coursework units. Some produced graphs of the data they collected using ICT. In preparation for the Land Use in [local town] unit the city web site was used. Last year we used the [online] revision course. Many of the students logged on to the web site and worked through the revision exercises. [A number of web sites aimed at tourists are used]."

Geography teacher, Mallard Secondary School (GG)

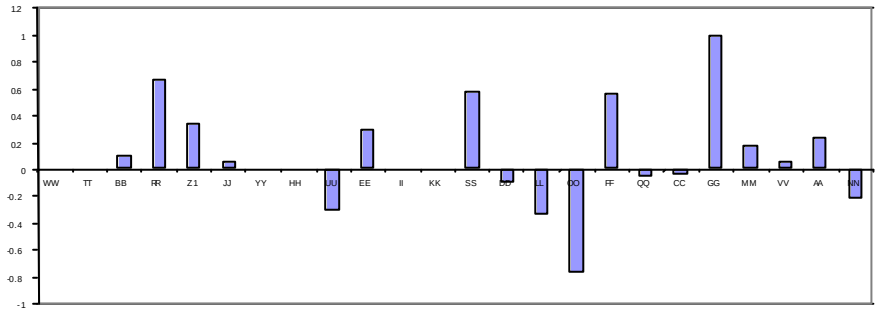
Issues for teaching and learning at Key Stage 4 geography

Teachers identified the following key factors for teaching and learning using ICT in geography at Key Stage 4.

- Use of the Internet for research where topics require access to authentic online resources.
- Use of word processing, data handling and graphing packages in coursework.
- The use of revision sites for examination preparation.

9.10 Relationship between ICT use and attainment in Key Stage 4 history

Figure 9.7: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 history from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The weakness of any relationship between level of ICT use and performance in GCSE history is reflected in the lack of any clear trend from left to right. Again, the levels of use in history teaching are not in line with the overall levels of use in the schools in the sample. For example, pupils in Castlefield

Secondary School (NN) reported making the highest level of use of ICT in their history work. Again, Cow Lane Secondary School (AA) (where pupils' reported use of ICT was the highest overall, and where use in history was the second highest) achieved a positive mean relative gain score.

9.11 Links to other strands of the study regarding Key Stage 4 history

Practice varied in history teaching. For example, presentation software was being used in a history lesson, where students' understanding of a 'presentation' clearly referred to the software itself, rather than to the process of researching for and developing curriculum material which would form the basis of an exposition to the rest of the class – the stated purpose of the lesson. Again, Mallard Secondary School (GG) (where the pupils' reported level of use of ICT in history was high and which achieved the highest mean relative gain score) identified a number of specific uses for ICT in history. These included:

- Sharing lesson ideas and resources with other teachers in other schools.
- Lesson preparation.
- Revision lessons using online resources or specialist revision sites.
- Contribution to wider variety of lessons.

"Only fair to say last year seems a bit like the Dark Ages compared to what we have been able to do this year."

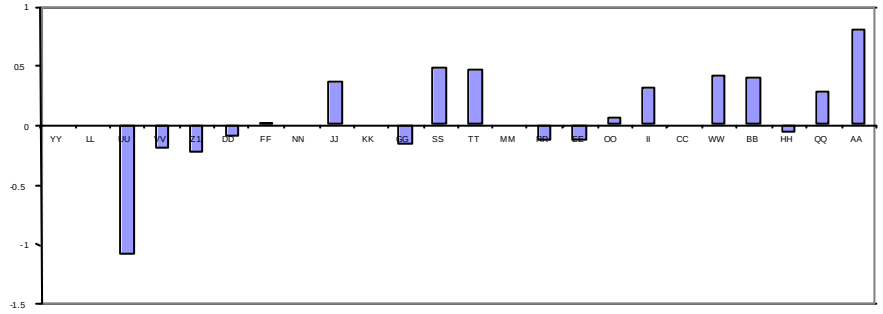
Key Stage 4 History Teacher, Mallard Secondary School (GG)

Issues for teaching and learning at Key Stage 4 history

Any conclusions for Key Stage 4 history must be tentative because of the lower level of ICT use, lack of statistical significance, and lack of teacher comment.

9.12 Relationship between ICT use and attainment in Key Stage 4 modern foreign languages

Figure 9.8: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 modern foreign languages from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The greatest differences in mean performance between high ICT using pupils and low ICT using pupils is found in MFL, despite the fact that overall levels of use were low. A clear trend from low ICT to high ICT can be seen in the graph. Cow Lane Secondary School (AA), where reported levels of use in MFL and more generally has the highest mean relative gain scores and the general difference in performance between high and low ICT schools is apparent. Given the relative size of the mean difference, and the difficulty of drawing clear conclusions because of the small sample and low level of use, it is suggested that teachers' and pupils' use of ICT in MFL in particular warrants further exploration.

9.13 Links to other strands of the study regarding Key Stage 4 modern foreign languages

Evidence from case study visits and interviews with teachers identified a number of teachers who had established a link with a school abroad, and it seems likely that this proved a particularly effective strategy. A secondary MFL teacher spoke of the 'authentic' nature of contact with students in other parts of the world, especially as this involved communicating directly with native speakers of the language being learned.

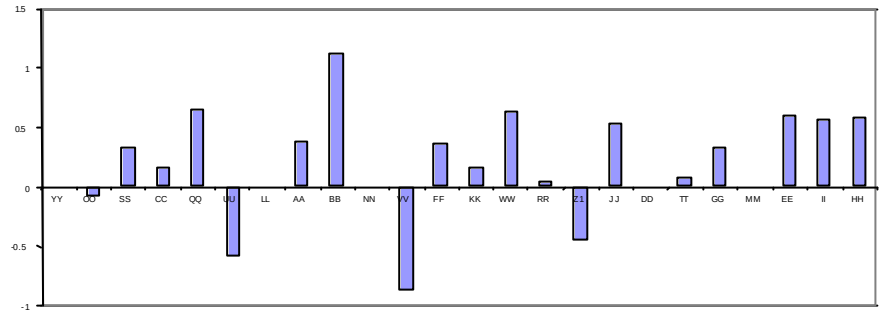
Issues for teaching and learning at Key Stage 4 modern foreign languages

Teachers identified the following key factors for teaching and learning using ICT in MFL at Key Stage 4.

- Use of electronic communications to support direct links with schools abroad.

9.14 Relationship between ICT use and attainment in Key Stage 4 design and technology

Figure 9.9: Mean relative gain for schools (unstandardised) in order of ICT usage for Key Stage 4 D&T from low (left) to high (right) (ICT use data drawn from a total of 700 questionnaires administered during 2001)



The statistically significant association between pupils' use of ICT in D&T and their performance at GCSE is reflected in increased mean relative gain scores in schools towards the right-hand end of the graph. As with other subjects, a number of schools appear to be out of line with any underlying trend. Interestingly, Cow Lane Secondary School (AA), Dalton Secondary School (BB) and Cheapside Secondary School (CC) (where their positions on the graph indicate that pupils' use of ICT in D&T is less than might be expected given the overall level of ICT use) all achieved positive mean relative gain scores, with Dalton Secondary School (BB) achieving the highest in the sample. Similarly, Harrison Secondary School (Z1) (where the overall use of ICT was low, but where ICT was being used in D&T) achieved a negative relative gain score. This suggests a subtle interplay between whole-school ICT use and use in individual subjects such as D&T. However, further analysis would be needed to determine whether this is truly the case.

9.15 Links to other strands of the study regarding Key Stage 4 design and technology

A D&T teacher in Spartan Secondary School (HH) (with the highest level of pupil use of ICT in D&T and a positive mean relative gain score at GCSE described a variety of uses for ICT in D&T.

> *"ICT was used mainly in Electronics, Graphics and Product Design. In electronics the main use was a program which allows pupils to design and test electronic circuits in a very visual way. This is not only of great benefit to weaker pupils who find the subject very hard, but also stronger pupils who can experiment to their hearts content without spending a penny on components.*

In graphics and product design we have used the programs [CAD package] and [CAD package] as well as the more usual generic software. There are 2 quite new teachers in the department who have a very strong background in graphics and design and they have developed many schemes of work as well as one of them becoming a trained user of Pro-desktop (a national scheme) and using it extensively to introduce 3D design work."

Key Stage 4 design and technology teacher, Spartan Secondary School (HH)

A teacher in Dalton Secondary School (BB) (which achieved the highest mean relative gain score at GCSE D&T) described the contribution of ICT to the various stages of a GCSE design and technology project in which the students were required to plan and build a three dimensional model. The use of the Internet was said to 'bring a new dimension' to the research phase of the process, extending the relatively limited and dated reference materials available in the school. By using software that allowed them to test out various aspects of their design, the students managed to reduce the time typically given to this aspect of the process. At the same time, they could test out their ideas in a flexible way, all of which would otherwise have been beyond them because of limitations in skills or shortage of materials, or would have been impractical in a busy GCSE timetable.

"…they are not limited by their own manipulative skills… they can play around with different things, like finish, texture, that they couldn't do [in a real situation]. So not only does this reduce workload, but it enhances their ability to come up with an answer to that particular problem."

Key Stage 4 design and technology teacher, Dalton Secondary School (BB)

This account from Rosehill Secondary School (EE) (another high user of ICT achieving positive mean relative gain scores) describes the advantages of a dedicated ICT provision and close links with the head of ICT.

"The D&T department has a suite of 15 networked machines. The students are encouraged to use ICT in these areas and support is given by the ICT department in organisation and delivery. All students across the school are encouraged to use Internet resource during revision, advice and links are given on the Intranet which is run by the Head of ICT."

Key Stage 4 design and technology teacher, Rosehill Secondary School (EE)

Issues for teaching and learning at Key Stage 4 design and technology

Teachers identified the following key factors for teaching and learning using ICT in geography at Key Stage 4.

- Use of the computer models to aid exploration and visualisation.
- The use of CAD packages for designing. to model outcomes and save time.
- The use of the Internet to research using authentic material.
- The value of a dedicated network and cross-departmental working.
- The use of revision sites for examination preparation.

Summary for Key Stage 4 geography, history, modern foreign languages, and design and technology

The graphs for all four subjects provide some indication of higher gains columns concentrated at the right of these graphs, indicating something of a positive 'ICT effect'. However, the differences are least marked for history. In the case of design and technology, differences in favour of higher ICT levels were found to be statistically significant in all analyses and just short of significance for geography and modern foreign languages.

Some schools differ from this general trend, and more specific investigation of the particular practices and uses of ICT in these schools would be necessary in order to understand more clearly how the use of ICT in the classroom relates to specific aspects of attainment and achievement.

3 ICT themes and key concepts in mathematics. Using data and information sources Organising and investigating Analysing and automating processes Models and modelling. 18 18 19 20 21. 4 ICT capability: Moving forward in mathematics.Â There are two statutory responsibilities within the National Curriculum for teaching ICT in schools at Key Stage 3. Schools need to ensure that all pupils are: s taught the programme of study, at each key stage, as set out in the National Curriculum for Information and communication technology â€“ the attainment target, ICT capability, sets out the expected standard of pupilsâ€™ performance required at each level; s given opportunities to apply and develop their ICT capability through the use of ICT tools to support their learning in all subjects. Launched at the Naace Conference 2012, the proposals for a Key Stage 1 and Key Stage 2 ICT curriculum were discussed at the Curriculum Symposium held at the Naace Conference on 9 March 2012. These have now been developed and form part of the ICT Framework. Read more. Free. Loading Save for later. Preview and details. Files included (3).