

Primary Schools of the Future – Achieving Today

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A Report to the DfEE by Becta

Published January 2001

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An introduction by Owen Lynch

This is the second in a series of reports on research being carried out by Becta that investigates the link between ICT and educational standards. Becta obtained and analysed data from a variety of sources, and we would like to thank Ofsted's Research, Analysis and International Division; Analytical Services of the DfEE, and QCA for their help in providing this data. We are also very grateful to all of the schools who took part in the telephone and online surveys. Professor David Reynolds has written the foreword to this report. In it he reviews the position of Becta's research in relation to other ICT research work and reflects on the need for further research into ICT practice.

Owen Lynch
Chief Executive, Becta

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Preface

Countries around the world are investing large sums into ICT in schools and colleges, believing that it can transform both the learning outcomes from classrooms and, indeed, the whole nature of the child's educational experience. Great hopes are held worldwide for ICT, but thus far the research into whether ICT has effects, the appropriate utilisation of it, and 'what works' in terms of the balance between hardware, software and teacher input is an area of more assertion than evidence.

Such research as there has been internationally is of dubious validity, sometimes relying on studies of innovative persons and schools using ICT in which one is unsure of the extent to which any effects are because of the technology or the persons using it. The historic research is often on small samples, rarely controls out the effects of things other than ICT, and is rarely rigorous enough in its methodology or its search for explanations of findings to support the weight that has been put on it.

The research reported in this publication is different and sets new standards of methodological decency in this area of research. It is based on large samples, attempts to control out the effect of things other than ICT, such as the management and leadership quality of the school, and uses appropriate statistical methods. Usefully, it disaggregates schools into subject areas and shows an 'ICT effect' upon individual subjects. It also reports on detailed interview-based work with a large sample of headteachers, and has fascinating descriptions of the characteristics of, and possible effects of, the aptly named 'Schools of the Future' that score highly on their 'quantity' and 'quality' of ICT usage.

This research is not the last word. It is part of an ongoing programme of work that is attempting to unravel the complexities of ICT and its use. It is also intended to move existing research into further 'cutting edge' areas, by undertaking detailed case studies of the exemplary primary schools from this research study, and into the secondary system through looking at the ICT use within particularly effective departments.

Science rarely evolves because of one study in a particular area, of whatever quality it may be. Rather it is the accumulation of studies which point in the same direction that gives confidence to people that there is a 'truth' that has been discovered. When both the research reported here, and the views of large numbers of educational professionals, all point to the same conclusion that ICT can have positive effects on children's learning, it would be very foolish indeed to ignore this, or to ignore the implications of these findings, both educationally and economically, for practitioners, researchers, and policy makers.

**Professor David Reynolds,
University of Exeter**

Introduction

Purpose

Over recent years, there has been a significant expansion in the use of information and communications technology (ICT) in British schools. ICT is increasingly important in supporting the Government's agenda for the education system, and there has been major investment for ICT infrastructure, content development and training. A key aim of this investment is to raise the standards of attainment achieved by school pupils. There is an increasing need to evaluate the impact of ICT in order to both inform government policy, and to provide headteachers and governors in schools with evidence on how to invest their own resources.

This study builds upon Becta's earlier published report 'A preliminary report for the DfEE on the relationship between ICT and primary school standards'. That report highlighted evidence of a positive link between ICT and standards based on data from the Ofsted database for schools inspected in 1998/9. It related data on Ofsted grades about the adequacy of the school ICT resource with Key Stage 2 attainment grades for the school as whole, and established that, in general, primary schools with the highest grades for ICT resource got better Key Stage 2 test results than those with the lowest grades.

This study aims to answer the question 'can a clear link be identified between schools' use of ICT and standards of achievement in those schools?' It analyses the relationship between ICT and KS2 standards from a variety of sources, and identifies whether they combine to provide evidence of a direct linkage between them. It is based on objective, external, measures of schools' use of ICT and the standards achieved in the core subjects of English, mathematics and science. Data was drawn from Ofsted inspections of 2,110 Key Stage 2 schools, QCA data on standards in English, maths and science in those schools, DfEE benchmarking data and the results of the DfEE's ICT in schools survey for 2000.

The approach to the data

Becta's preliminary report to the DfEE on the relationship between ICT and primary school standards demonstrated amongst other results that:

On average schools with better Ofsted grades for 'adequacy of ICT resources' in 1998/9 achieved better grades in English, maths and science in 1999 national tests at Key Stage 2.

Schools with very good ICT resources were found in a similar range of socio-economic contexts as schools with **poor** ICT resources.

Further work was needed in order to establish whether the link discovered was real rather than the result of random variation or some other 'hidden variable' such as the socio-economic background of the school. This report systematically examines possible alternative explanations for the link. It analyses the data in order to eliminate them from the picture and, in doing so, builds up a compelling case for a direct link between ICT and pupils' standards of attainment. Different elements of the causal chain (such as the impact of school management and the quality of ICT teaching) are examined to provide a more detailed explanation of the link between ICT and standards.

In order to achieve this Becta extended the analysis to include further data from:

- Ofsted, which provided further information on the 2,110 schools inspected in 1998/9 that had KS2 results in mathematics, science and English
- QCA, which provided mathematics, science and English standards for 1999 and 2000 for these 2,110 schools
- DfEE, which provided benchmarking data for these schools and data from the 'ICT in schools survey' for 582 primary schools

- the professional judgements of heads taken through a telephone survey of the 242 schools categorised in the very good ICT and poor ICT schools in the study. An 80% response rate was achieved, giving results for 192 schools
- the professional judgements of teachers through an online survey of 315 teachers who have previously involved in DfEE funded projects
- research evidence carried out by academic and research institutes in the UK and internationally.

The approach to the analysis

In order to provide evidence for a link between ICT and standards, this data was analysed against a broad framework of three sections:

- analysing the statistical data collected on schools by Ofsted, DfEE and QCA, in particular data relating to their achievements in mathematics, science and English at Key Stage 2
- analysing the professional judgements of primary teachers and heads gathered by the surveys, in particular their views about ICT's impact on mathematics, science and English
- searching the research literature relating to detailed studies carried out on ICT and achievement in mathematics, science and English.

To establish elements of a possible causal chain between ICT and standards the following research questions were asked of these data-sets.

Statistical data on schools

Do schools with better ICT resources which gained better results in 1999 continue to achieve better grades in the year 2000? How do these compare to national targets, and the rising standards associated with the literacy and numeracy strategies?

If there is a difference in standards between schools with different ICT levels, is this difference still visible when comparing schools of the same type and pupil attainment level? This eliminates a possible secondary relationship that links ICT to 'good' schools which are, in turn, linked to pupil achievement.

If there is a difference in standards between schools of the same type but with different ICT levels, is this difference related to the amount of subject usage? A link between subject usage of ICT and improved standards in that subject would provide strong evidence for a direct impact of ICT on pupil learning.

If there is a link between the amount of usage of ICT and improved standards, is the effect greater if ICT is used well? ICT is a learning tool, and its impact should be dependent on the quality of its usage. If attainment is even higher when good ICT resource grades are combined with good use of ICT by teachers, this indicates a direct rather than an indirect link.

If there is a clear link between ICT resource and standards, is there a linkage with other ICT measures? What is the pattern of the effects of factors such as ICT teaching, pupil ICT attainment and breadth of ICT curriculum?

If there is an identifiable set of characteristics that represent good use of ICT, are these the characteristics of the 'school of the future'? What is the impact of ICT on standards in these schools?

Professional judgements of teachers and heads

Do professionals who have experience of using ICT in their work believe that it has a positive impact on pupil achievement in mathematics, science and English?

From the research literature

Are there identified mechanisms that would explain how ICT causes a rise in standards and could they plausibly contribute to the observed effects in the statistics? Are there experimental studies that have shown a real impact of the use of ICT on improved learning by pupils and improved teaching in similar situations to the schools in the study?

Summary of conclusions

From the statistical data on schools, it was found that:

- schools with good ICT resources tended to have better achievement at Key Stage 2 than schools with unsatisfactory ICT resources, and this improved attainment is seen over more than one year
- schools with good ICT resources tended to have better standards at Key Stage 2 than schools with unsatisfactory ICT resources, even when benchmarked with schools of a similar type
- for schools with the same quality of management, those with good ICT resources tended to attain better standards at Key Stage 2 than those with unsatisfactory ICT
- schools that use ICT to support a subject tended to have better achievement in that subject than schools that do not make such use
- schools that have good ICT resources and use them well tended to have better standards than schools where good ICT resources are not well used
- schools that made good use of ICT to improve standards generally had high-quality teaching of ICT, a favourable school ethos in relation to ICT, good pupil access to ICT resources, high pupil ICT skills, and have developed in their pupils a positive attitude to ICT
- the identified 'schools of the future' had, on average, reached, in 1999, the targets for all schools to achieve by 2002: 81% in English (target 80%) and 79% in maths (target 75%).

Professional judgements of teachers and heads:

- The great majority (86%) of headteachers in 'high ICT' schools believe that ICT has been important in raising standards in the past two years.
- Where very good ICT resources are present in schools, they are extensively used and headteachers report that they impact positively on standards.
- 'High ICT' schools are using ICT to support the core subjects of English, maths and science. Opinions about the impact of ICT on subject standards were positive. The subjects where greatest use was reported were those in which a greater impact was reported to have been made.
- Headteachers of 'high ICT' schools identify ICT as having an impact on those factors which research outside the area of ICT identifies as having a direct impact on learning: motivation 98%; subject knowledge 96%; teaching 93%; pupils' effectiveness 90%; school effectiveness 89%; home-school relations 77%.
- The majority of headteachers of 'high ICT' schools (83%) reported that ICT had a positive impact on the attainment of Key Stage 1 pupils.
- Teachers with personal access to ICT spend significant amounts of time using ICT with their pupils.
- Teachers with personal access to ICT identify it as having an impact on those factors which research outside the area of ICT identifies as having a direct impact on learning: motivation 99%; subject knowledge 91%; teaching 92%; pupils' effectiveness 79%; home-school relations 52%.
- Professionals with experience of ICT are using ICT to support the core subjects of English, maths and science. Opinions about the impact of ICT on subject standards were positive. The subjects where greatest use was reported were those in which a greater impact was reported to have been made.

From the research literature:

- The wider findings from the research evidence support the patterns of effect found both within the statistical analysis of the Ofsted and QCA data and the surveys.

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Section A - statistical data on schools

1. The impact of ICT on standards over two years

Do schools with better ICT resources which gained better results in 1999 continue to achieve better grades in the year 2000? How do these compare to national targets and the rising standards associated with the literacy and numeracy strategies?

Rationale

If ICT resources contribute to improved attainment, then higher attainment grades should be seen for more than one year after a school's assessment as having good resources. Researchers have sometimes identified an 'innovation effect', where the introduction of a new way of working or a new technology creates an initial improvement that fades away in subsequent years. Is this the case with ICT resources?

Methodology

The sample for this procedure consists of all of those schools with Key Stage 2 pupils that were subject to Ofsted inspection in 1999. Exactly as in the first report, the sub-samples of schools were defined according to the grade given by Ofsted for their ICT resources in 1999.

- 153 schools with very good ICT resources (Grades A*-A)
- 89 schools with poor ICT resources (Grades E-E*).

However, to avoid statistical errors due to low sample sizes, the analysis was repeated for the wider bands.

- 736 schools with good and very good¹ ICT resources (Grades A*-B)
- 477 schools with unsatisfactory and poor² ICT resources (Grades D-E*).

The proportion of pupils achieving Level 4 or above in English, maths and science at Key Stage 2 was known for every school in the sample for both 1999 and 2000. These proportions were averaged across the two sub-samples.

Results

The chart in Fig 1.1 (right) shows the average percentages of pupils achieving Level 4 or above at Key Stage 2 in science, maths and English in 1999. Percentages are shown for two groups of schools - those with very good and poor ICT resources. The chart also shows the Government's Key Stage 2 targets, to be reached by 2002, for English and mathematics. It can be seen that schools with very good ICT resources are already achieving, in 1999, the targets for 2002 for mathematics.

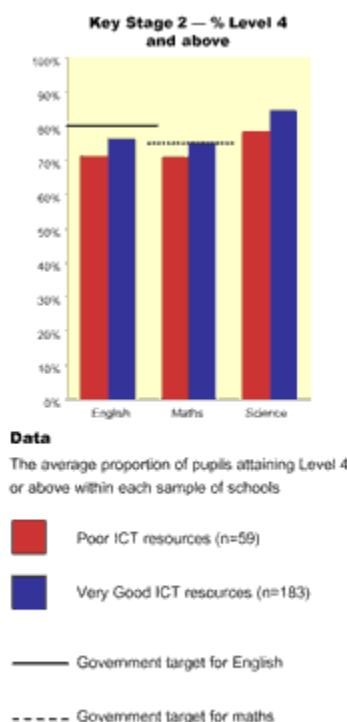


Fig 1.1: Comparing the extremes—Very Good against Poor ICT

As stated above, an analysis was carried out for a wider range of schools, and the results for these schools for 1999 and 2000 were also compared. Fig 1.2 (right) shows the results of these analyses. In both years, the sample of schools with good ICT resources shows higher standards than the sub-sample with unsatisfactory ICT resources. This applies to results in English, maths and science. The results also show a general increase in standards for all subjects and schools across the two years.

The scale of the graphs for Fig 1.2 (right) (and in the rest of the report) have been reduced to identify the 70% to 90% range in particular, since this area relates to the Government's targets

Conclusions

The results of this investigation supports the conclusion that, on average, schools with good ICT resources have better achievement at Key Stage 2 than schools with unsatisfactory ICT resources, and this improved attainment is seen over more than one year. The data also provides confirmation of other research showing the significant effect of the Government's literacy and numeracy strategies on school standards during this time.

Footnotes to BECTA

1 : In the rest of the text and diagrams, this sample is referred to as good

2 : In the rest of the text and diagrams, this sample is referred to as unsatisfactory.

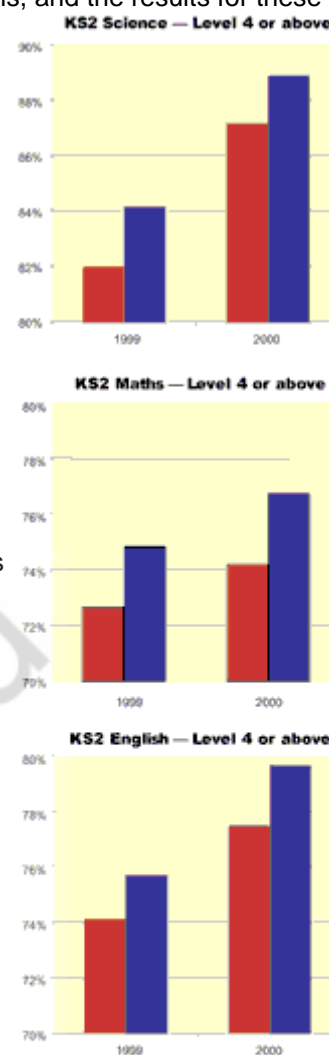


Fig 1.2: Comparing a wider sample for 1999—2000

Data

The average proportion of pupils attaining Level 4 or above within each sample of schools



2. The impact of ICT on schools of a similar type

If there is a difference in standards between schools with different ICT levels, is this difference still visible when comparing schools of the same type and pupil attainment level? This eliminates a possible secondary relationship that links ICT to good schools which are, in turn, linked to pupil achievement.

Rationale

If ICT resources contribute to improved attainment, then higher grades should be seen in all types of school, regardless of social and other factors that also influence pupil attainment.

Two investigations were undertaken to shed light on this hypothesis:

- [comparing attainment within DfEE benchmarking categories](#)
- [comparing attainment within management categories.](#)

2a. The impact of ICT on benchmarked schools

Methodology

The sample for this procedure consists of those schools with Key Stage 2 pupils that were subject to Ofsted inspection in 1999.

The DfEE divides schools into five 'benchmarking' bands. For the assessment of pupils' results in the 1999 Key Stage 2 tests, the bands are defined according to the prior achievement of the same pupils in their Key Stage 1 tests in 1995. Band 1 represents those schools with the lowest pupil attainment, and band 5 represents those schools with the highest attainment. Benchmarking thus controls all factors, such as social class, which when combined serve to determine prior attainment levels of pupils.

The sample was first divided into benchmarking bands. The proportions of pupils achieving Level 4 or above in English, maths and science at Key Stage 2 were then compared between schools with good ICT resources and schools with unsatisfactory ICT resources.

Results

The graphs in Figs 2a.1, 2a.2 and 2a.3 (below) show the average proportion of pupils achieving Level 4 or above at Key Stage 2 in science, maths and English for schools in each benchmark group. Because benchmark groups 1 and 5 included very few schools (fewer than 20 in each sub-sample), these have each been combined with the next-closest group when creating the graphs.

Three trends can be seen consistently across all subject areas:

- Schools with higher pupil attainment in 1995 (benchmark groups 4 and 5) also tended to do well in 1999 and 2000, showing the continuing influence of the wide range of factors which tended to improve attainment in these schools.
- There was a general improvement of results in all groups between 1999 and 2000, showing the effect of additional factors impacting across all schools in this year and raising standards across the country. The literacy and numeracy strategies are obvious examples of such positive factors
- The subgroups of schools with better ICT resources tended to do better than the equivalent subgroups of schools with unsatisfactory ICT resources, in both years and across all benchmark groups, which suggests an additional ICT factor that predominantly affects those schools with better resources.

For the lowest benchmarking category (schools with lowest prior pupil attainment), this pattern is not completely consistent in 1999, though between 1999 and 2000 the schools with better ICT show a noticeable improvement in attainment in all three subjects. It may be that, for schools with the lowest levels of pupil attainment, the effects of ICT take longer to manifest. It will be interesting to see the further development of the effects of ICT on low-achieving schools, as shown by 2001 results.

Conclusions

The results of this investigation support the view that, in general, schools with good ICT resources have better achievement at Key Stage 2 than schools with unsatisfactory ICT resources, even when benchmarked with schools of a similar type.

For those schools in the lowest benchmarked groups, there is evidence that ICT had not been used effectively to impact on standards in mathematics and English in 1999 but that this had improved significantly in 2000.

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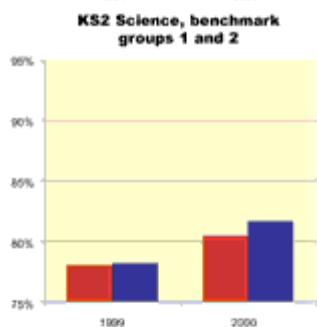
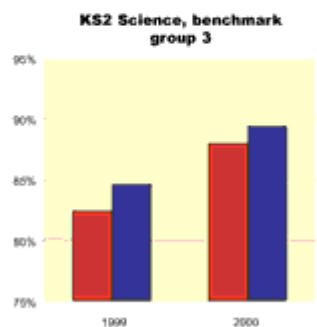
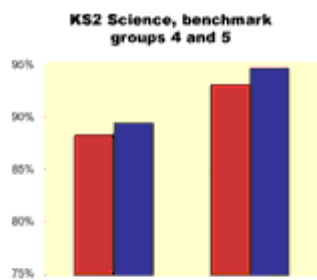


Fig 2a.1: Comparing science attainment within benchmark groups

Data

The average proportion of pupils attaining Level 4 or above in science within each sample of schools

- Unsatisfactory ICT resources
- Good ICT resources

Sample sizes

	Unsatisfactory ICT resources	Good ICT resources
Benchmark groups 1 and 2	93	122
Benchmark group 3	189	284
Benchmark groups 4 and 5	102	160

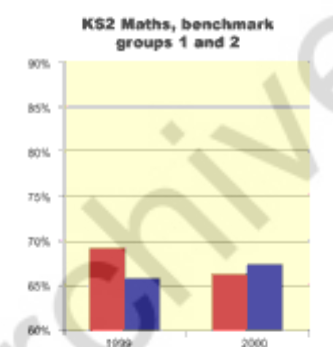
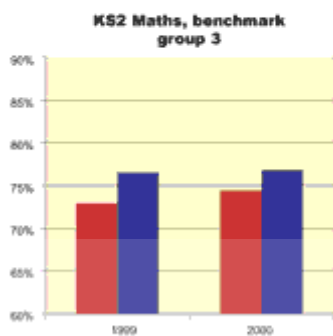
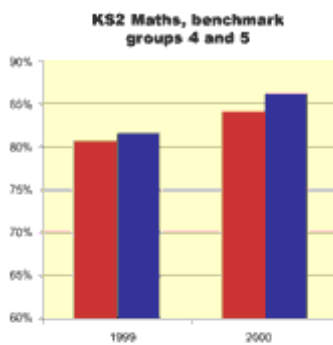


Fig 2a.2: Comparing maths attainment within benchmark groups

Data

The average proportion of pupils attaining Level 4 or above in maths within each sample of schools

- Unsatisfactory ICT resources
- Good ICT resources

Sample sizes

	Unsatisfactory ICT resources	Good ICT resources
Benchmark groups 1 and 2	93	122
Benchmark group 3	189	284
Benchmark groups 4 and 5	102	160

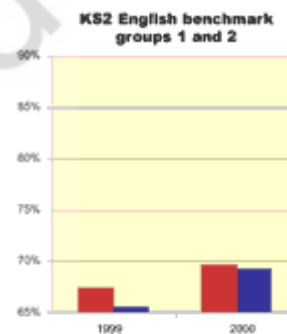
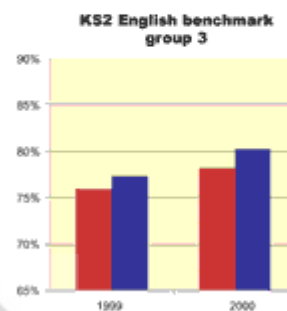
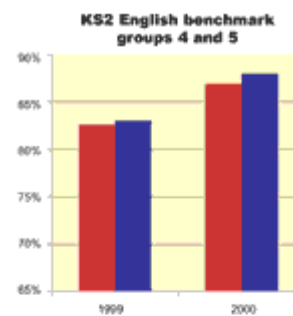


Fig 2a.3: Comparing English attainment within benchmark groups

Data

The average proportion of pupils attaining Level 4 or above in English within each sample of schools

- Unsatisfactory ICT resources
- Good ICT resources

Sample sizes

	Unsatisfactory ICT resources	Good ICT resources
Benchmark groups 1 and 2	93	122
Benchmark groups 3	189	284
Benchmark groups 4 and 5	102	160

2b. The impact of ICT on schools of similar management effectiveness

Rationale

It has been argued by some commentators that the association between ICT resources and improved standards is because 'good managers' both develop ICT resources and promote improved attainment, but that these two effects are unconnected. The suggestion is that management of high standard would be associated with good pupil attainment, regardless of whether ICT resources were present or not. In order to demonstrate the causal connection between ICT and standards, this possibility would have to be considered and eliminated.

Previous research shows that management quality does have a major effect on standards. But can ICT improve standards in schools above and beyond any effect attributable to management quality?

Methodology

The management grade awarded to each school by Ofsted is generated from a range of factors, including leadership and management of staff and resources within the school. Each school is put into one of four categories: very good management; good management; management in need of some improvement; management in need of substantial improvement.

By taking the management grade and the ICT resource grade of every school, four small samples were extracted:

- those with poor management (management in need of improvement) and unsatisfactory ICT resources
- those with poor management and good ICT resources
- those with very good management and unsatisfactory ICT resources
- those with very good management and good ICT resources.

Each group was analysed against Ofsted data which places schools (on the basis of their Key Stage 2 test results) into categories. The proportion assessed as 'above national standards' for pupil achievement at Key Stage 2 was calculated. This provides graphs which are slightly different from the previous diagrams - these used average percentages of pupils reaching Level 4. This different presentation of the data does not affect the results or conclusions.

Results

The charts in Fig 2b.1 (right) show the proportion of schools in each of these four categories assessed as 'above national standards' for English, maths and science. It can be seen that there are two effects in operation:

- schools with better management tend to get better results
- schools in the same management category tend to get better results if they have good ICT resources.

These results apply to all three subject areas. However, it appears that schools in the worst management category are not achieving particularly good results in English, even with good ICT resources.

Conclusions

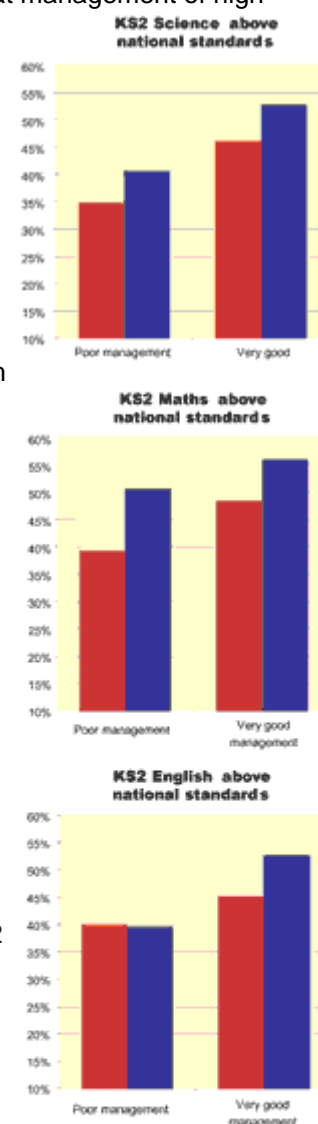


Fig 2b.1: Comparing attainment within management category

Data

The average proportion of pupils attaining 'above national standards' at Key Stage 3

Sample sizes

	Good ICT resources	Unsatisfactory ICT resources
Very good management	343	643
Poor management	91	135



As expected, management does impact on standards. The data also provides evidence that, for schools with the same quality of management, those with good ICT resources tend to attain better standards in science, maths and English than those with unsatisfactory ICT resources.

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3. The impact of ICT usage on standards in subjects

If there is a difference in standards between schools of the same type but with different ICT levels, is this difference related to amount of subject usage? A link between subject usage of ICT and improved standards in that subject would provide strong evidence for a direct impact of ICT on pupil learning.

Two different investigations were employed:

- an analysis of subject use as reported by Ofsted inspectors.
- headteachers' own assessment of subject use in their schools.

3a. From Ofsted inspection reports

Rationale

If ICT resources contribute to higher attainment, then higher grades should be seen in subjects that are directly supported by the use of ICT. Using the text of inspection reports for schools provides a method of identifying schools where Ofsted reports ICT usage within a subject area. The texts of school reports were searched for comments by inspectors on ICT use in mathematics, science and English.

Methodology

The sample took those schools with Key Stage 2 pupils inspected in 1999 which were assessed as having either very good or poor ICT resources. The inspection reports for these schools were read by independent inspectors. All mentions of ICT being used to positively support subject teaching in English, maths and science were noted. Attainment grades in each subject for 1999 were compared between schools for which a positive mention was noted and those where it was not.

In this investigation, the proportion of schools assessed by Ofsted as 'above national standards' for each subject is used as an index of attainment.

Results

The chart in Fig 3a.1 (right) shows how frequently ICT inspectors mentioned the use of ICT to support the three subject areas.

It can be seen that in most schools in the sample ICT was used to support English; three-quarters of schools used ICT to support maths, while only one-third of schools used ICT to support science. The charts in Fig 3a.2 (right) show attainment for each subject area. Attainment is compared between schools in which ICT support for a subject was, and was not, mentioned.

It can be seen that, for both science and maths, attainment was higher for schools in which support for the subject was specifically and positively mentioned by Ofsted inspectors. For English, this pattern was not seen. However, it is worth noting that there were only 16 schools with very good ICT resources in which English was

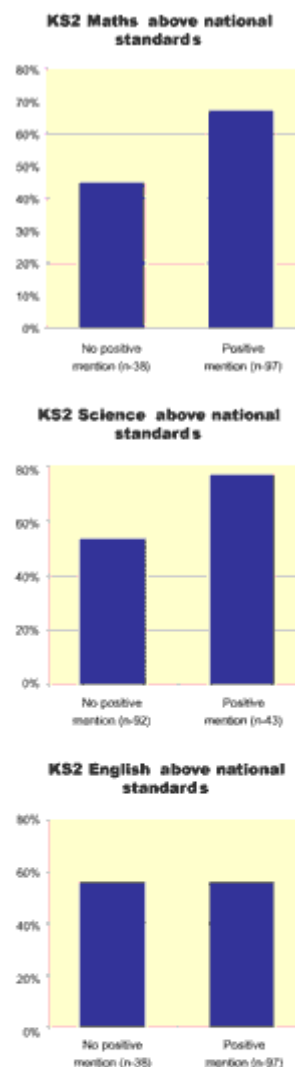
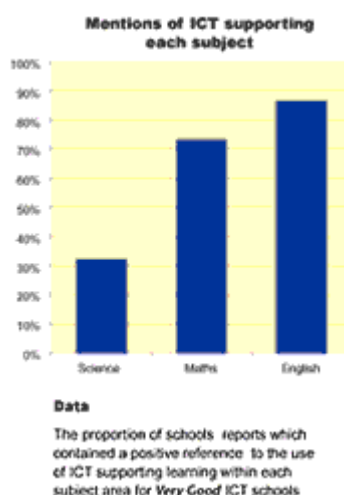


Fig 3a.2: Standards in subjects supported by ICT



Data
The proportion of schools assessed as being 'above national standards' in science, maths and English in 1999

Proportions are compared between

- Schools with Very Good ICT resources, in which ICT support for a subject was not mentioned
- Schools with Very Good ICT resources, in which ICT support for the subject was mentioned

Sample sizes

	Science	Maths	English
No mention of ICT supporting the subject	92	38	16
ICT mentioned as supporting the subject	43	97	119

not specifically mentioned, giving a very small sample size for this comparison.

Conclusions

Schools with very good ICT resources, that use ICT to support a subject, generally have better achievement in that subject than schools that do not make such use.

3b. From the DfEE survey

Rationale

If ICT resources contribute to higher attainment, then, generally, higher grades should be seen in subjects that headteachers report as supported by the use of ICT. Using the DfEE's data from the 'ICT in Schools Survey 2000' provides a random sample of schools and a method of identifying schools where headteachers report on ICT subject usage. By looking at the key stage test results for these schools, a comparison can be made between the sample of schools which report usage of ICT in that subject and those which do not.

Methodology

The sample for this investigation constitutes those schools with Key Stage 2 pupils which replied to the DfEE's 'ICT in Schools Survey 2000'. The results from this sample were weighted by DfEE analytical services to reflect the characteristics of the population of all schools, and this weighting system has been retained in the analysis of findings.

The survey results include assessment by headteachers of those subjects in which ICT was used 'substantially' and those in which it was used 'little'.

The proportion of pupils achieving Level 4 or above in each subject in 1999 was compared between schools which made 'substantial' use of ICT to support that subject and those that did not.

Results

The charts in Fig 3b.1 (right) compare the attainment rates in science, maths and English between schools which reported 'substantial' use of ICT to support each subject and those which did not. It can be seen that, for each subject, average attainment was higher for schools claiming that ICT was used to support that subject.

Conclusions

The results of this investigation support the view that schools which use ICT resources to support a subject have, on average, better achievement in that subject than schools which do not make such use.

Fig 3b.1: Attainment for schools claiming substantial use of ICT

Data

The average proportion of pupils achieving Level 4 or above at Key Stage 2, in science maths and English, in 1999

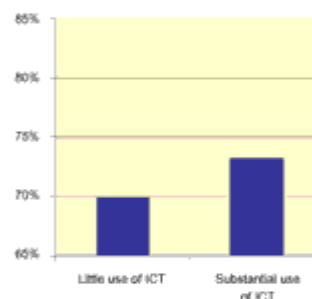
Proportions are compared between

- Schools which claimed ICT was used 'substantially' to support a subject
- Schools which did not claim substantial use of ICT to support a subject (little use or no comment on use)

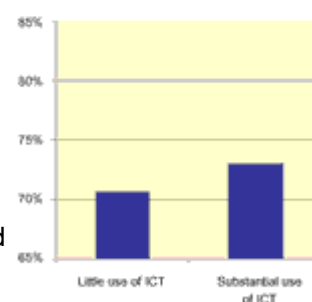
Sample sizes

	Science	Maths	English
Substantial use of ICT	219	376	504
Little use or no comment on use	263	206	78

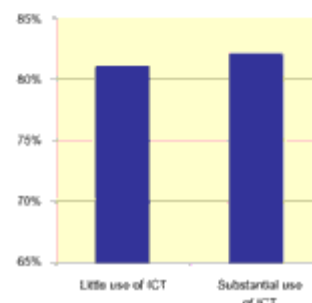
KS2 English



KS2 Maths



KS2 Science



4. The impact of good ICT resources combined with good ICT teaching

If there is a link between the amount of usage of ICT and improved standards, is the effect greater if ICT is used well? ICT is a learning tool, and its impact should be dependent on the quality of its usage. If attainment is even higher when good ICT resource grades are combined with good use of ICT by teachers, this indicates a direct rather than an indirect link.

Rationale

It is known that there is an association between **good** ICT resources and better pupil attainment in schools.

If this association is because the use of ICT to support learning does impact on standards, then when **very good** ICT resources are well used the impact will be greater and standards will therefore be even higher.

If the use of ICT resources to support learning does not impact on standards (for example, if the association was merely a coincidence), it would make no difference to pupil attainment whether or not those resources were well used. This therefore provides a good test of the causal connection between ICT and standards. If schools that combine **good** ICT resources with good use of those resources by teachers achieve better Key Stage 2 results than schools which do not use them so effectively, this is a strong indication that there is a direct link between ICT and standards.

Methodology

The sample of schools with **good** ICT resources (A*-B) was divided according to the Ofsted judgements on the quality of ICT teaching into those with **very good** (A-A*), **good** (B), **satisfactory** (C), **unsatisfactory** (D) and **poor** (E-E*). Attainment, measured as the proportion of schools assessed as 'above national standards' in science, maths and English, was compared between these groups of schools.

Results

Across the whole sample of schools, roughly a third have **good** ICT teaching, roughly a third have **satisfactory** ICT teaching, and roughly a third have **unsatisfactory** ICT teaching. Among schools with **very good** ICT, the division was quite different: more than half of these schools have **good** ICT teaching. However, for a small proportion of these schools, teaching is **unsatisfactory**, despite the presence of good resources. One in ten schools with good ICT resources have **poor** ICT teaching.

In the charts in Fig 4.1 (right), attainment is compared between schools in which **good** ICT resources are combined with **very good** ICT teaching and those in which **good** ICT resources are combined with **poor** teaching. The attainment grades for science, maths and English are shown.

It can be seen that, for all subjects, attainment is higher when good ICT resources are combined with high-quality ICT teaching.

The pattern is consistent: ICT resources are associated with better results when they are well used.

Conclusions

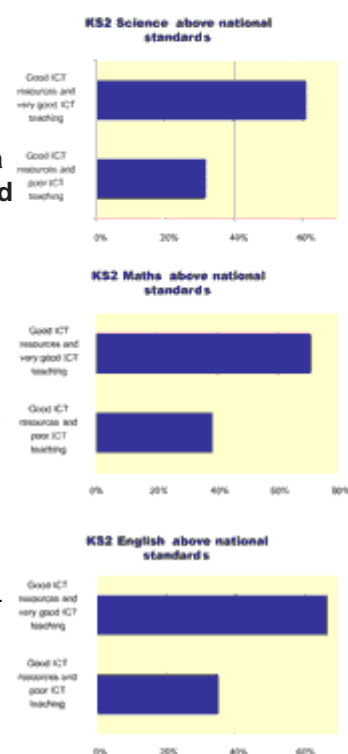
Fig 4.1: The combined effect of good ICT resources and good ICT teaching

Data
The proportion of schools assessed as 'above national standards' for science, maths and English

Proportions are compared between:

- Schools with Good ICT resources and Very Good ICT teaching
- Schools with Good ICT resources and Poor ICT teaching

Sample sizes	Number of schools
Good ICT resources and very good teaching	51
Good ICT resources and poor ICT teaching	77



The results of this investigation support the hypothesis that schools that have **good** ICT resources and use them well have better standards on average than schools where **good** ICT resources are not well used.

Archived

5. Consideration of other ICT factors influencing standards

If there is a clear link between ICT resource and standards, is there a linkage with other ICT measures? What is the pattern of the effects of factors such as ICT teaching, pupil ICT attainment and breadth of ICT curriculum?

Rationale

The previous section indicated that the link between ICT and standards was strengthened if the ICT was supported by good ICT teaching. To identify further key characteristics, the correlation between standards and a range of ICT factors based on Ofsted judgements of the school was carried out.

Methodology

The sample for this investigation was all schools with Key Stage 2 pupils which were inspected by Ofsted in 1999. The full set of ICT measures was obtained for these schools. Some attainment grades were given for ICT provision at Key Stage 2, while others were given for ICT provision for the school as a whole. Correlation was then calculated between each ICT measure and each attainment grade. As grades are ordinal rather than continuous measurements, Spearman's Rank Correlation was used.

Results

The correlation observed in the previous study between ICT resources and pupil attainment was 0.05. Most measures of ICT provision at key stage and school level are more highly correlated with attainment than this, as shown in Fig 5.1 (below).

There are high correlations with measures of:

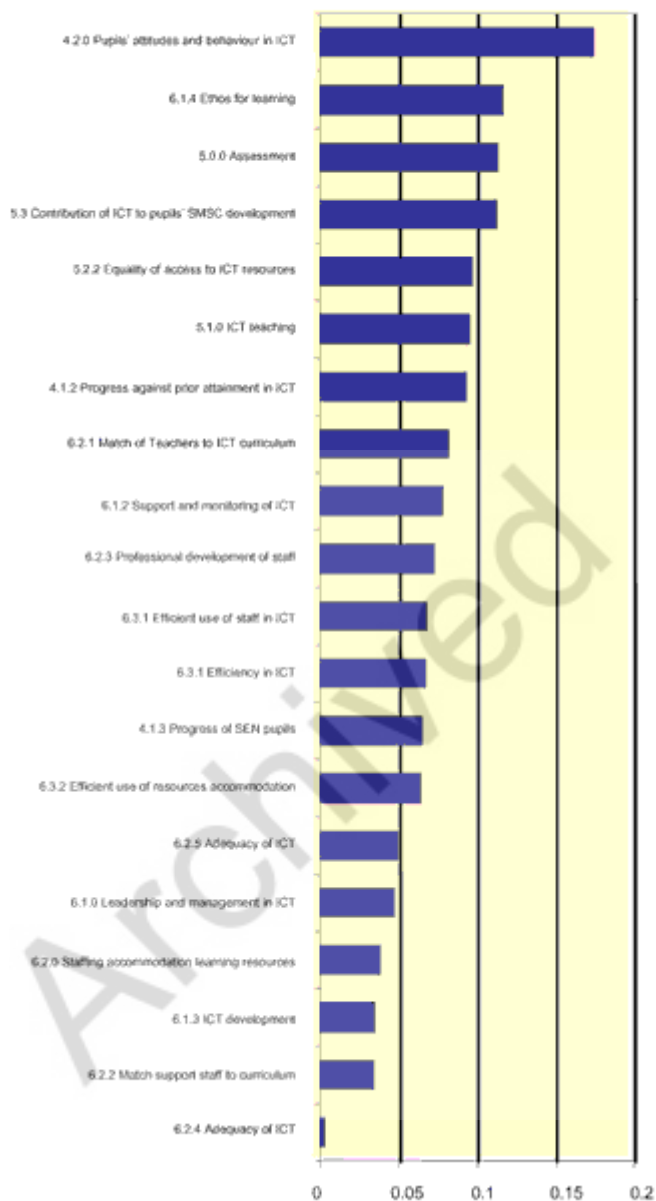
- pupil interest in ICT and pupils' ICT skills
- enthusiasm and support for ICT at the whole-school level
- a broad ICT subject curriculum and high teacher expectations of ICT
- teacher skill, training and confidence in ICT.

For example, the correlation between pupils' attitudes to ICT throughout the school and English attainment grade at Key Stage 2 is 0.17. The correlation between teachers' expectations of ICT at Key Stage 2 and pupils' maths grades is 0.12.

It is also interesting to note that not all features show correlation. For example, the correlation between the grade given for ICT accommodation (that is, the size and condition of the classroom where the ICT equipment is held) and English grade is 0. This supports the idea that it is the actual use of ICT resources to support learning that impacts on attainment. General measures which do not relate to this active use are much weaker predictors of pupil attainment.

Fig 5.1

Correlations between ICT factors and English standards



Conclusions

There is a varying link between different characteristics of ICT use with higher standards. These results link in to the school effectiveness research outlined in Section C. Five overarching factors indicate good use of ICT resources. Schools that made good use of ICT to improve standards have:

- high-quality teaching of ICT
- a favourable school ethos in relation to ICT
- given pupils good access to ICT resources
- developed their pupils' ICT skills
- developed in their pupils a positive attitude to ICT.

6. The school of the future

If there is an identifiable set of characteristics that represent good use of ICT, are these the characteristics of the 'school of the future'? What is the impact of ICT on standards in these schools?

Rationale

The previous section identified the characteristics of ICT use most linked to improved standards. For example, they are characterised by:

- high levels of ICT
- a positive ethos for learning with ICT
- high-quality ICT teaching
- good pupil attitudes to ICT
- high standards of pupil attainment against the ICT curriculum.

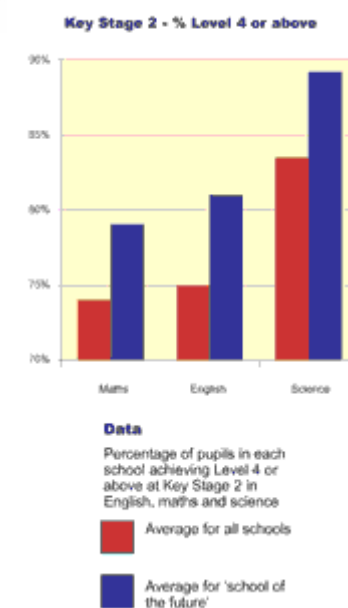
What is the likely impact of combining these factors, and are there schools which exemplify all of them?

Results

Among those schools inspected by Ofsted in 1998-99, 77 were defined as combining very good assessment of ICT resources with positive assessment of each of the other features listed above. Obviously, there will be many other schools that have these features but were not inspected in that year, or that have developed these features since 1998. Thus, this sub-sample represents a group of schools that give an early indication of the effects of positive features that are likely to become increasingly common as the use of ICT in education continues to expand.

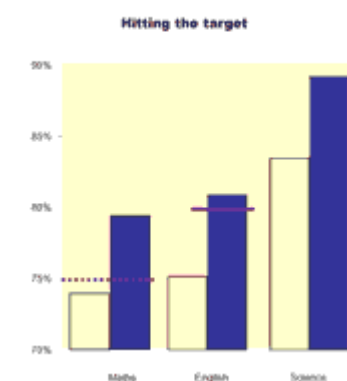
The chart in Fig 6.1 (right) shows the percentage of pupils achieving Level 4 or above in Key Stage 2 tests in 1999. The results for the entire sample of inspected schools are contrasted with results for 'schools of the future' (note that the results for 'all schools' are slightly better than published DfEE figures, as we have not included certain categories of school - for example, special schools - in the base for averages). It can be seen that attainment rates were consistently higher among the vanguard schools of the future.

Fig 6.1: Attainment in the schools of the future



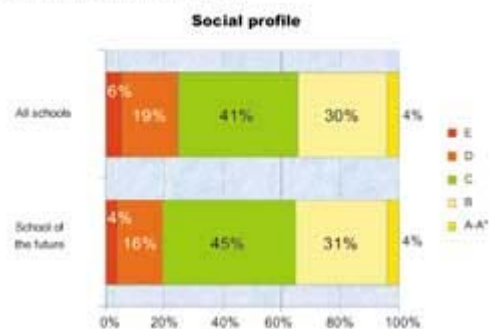
The chart in Fig 6.2 (right) shows the same data; the Government's targets for 2002 are also shown. On average, the identified 'schools of the future' had reached, in 1999, the attainment levels set as targets for all schools to achieve by 2002: 80% in English and 75% in maths. It may be thought that these high-achieving 'schools of the future' are particularly socially privileged and that this is why they are already reaching future targets.

Fig 6.2: Government targets for English and maths



However, the chart in Fig 6.3 (right) shows that this is not the case. The proportion of 'schools of the future' falling into each social category is very similar to the proportions in the population as a whole.

Fig 6.3: Social background of schools



Conclusion

On average, the identified 'schools of the future' had reached, in 1999, the attainment levels set as targets for all schools to achieve by 2002: 81% in English (target 80%) and 79% in maths (target 75%).

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Section B - Professional judgements of teachers and heads

7. Surveys of Schools

Do professionals who have experience of using ICT in their work believe that it is having a positive impact on pupil achievement in mathematics, science and English?

Rationale

If ICT is a pedagogical tool that enhances the learning process, then those professionals who have experience of using ICT in their work will tend to believe that it is having a positive impact on pupil achievement.

Two surveys were carried out to collect the opinions of professionals within education about the impact of ICT on their work and the success of their schools:

- [telephone survey of schools with very good ICT resources \('high ICT' schools\)](#)
- ['Teachers Online' survey.](#)

The results of both surveys are given in this report.

7a. Telephone survey of schools

Methodology

This section sets out the findings of a telephone survey of headteachers. The sample was drawn from those schools with Key Stage 2 pupils which were subject to Ofsted inspection in 1999, and which were identified by Ofsted inspectors as having **very good** ICT resources (A-A*). A small number of schools with poorer resources were also contacted. By interviewing the same schools where a statistical relationship has been found between ICT and standards, it should be possible to gather further evidence that the relationship is real and not due to sampling variation or further 'hidden' variables. The head, deputy head, or ICT co-ordinator of the school was interviewed. The telephone survey was 'double blind', in that neither the interviewers nor the headteachers were made aware of how schools had been chosen for participation. Schools received prior notice of the survey by post. A total of 191 schools were contacted, of which 162 had **very good** ICT resources. The results that follow are based on the responses of these 'high ICT' schools.

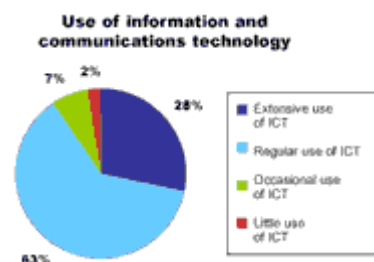
These schools form a useful sample, representative of the 'school of the future', if policy initiatives continue to improve ICT resources across all schools.

The focus of the survey was on the support of Key Stages 1 and 2, in particular the ways in which ICT supported pupil learning and school effectiveness. Interviews were supervised and carried out against a fixed schedule consisting of 25 closed and 2 open-ended questions. Each interview lasted approximately 20 minutes.

The analysis of the survey findings summarises the schools' own reports on their use of ICT and the impact ICT has on standards.

Results

More than a quarter (28%) reported that ICT was used 'extensively' in their school, while nine out of ten (90%) reported it was used 'regularly' or 'extensively'. Thus, there is a very high degree of reported use.



Use of ICT as reported in the telephone survey

A similar range of responses is seen when headteachers were asked about the number of hours that pupils might spend working at the computer. One quarter (26%) reported that pupils would spend two hours or more at the computer. In total, eight out of ten schools (81%) reported that pupils would typically spend at least one hour a week working at the computer.

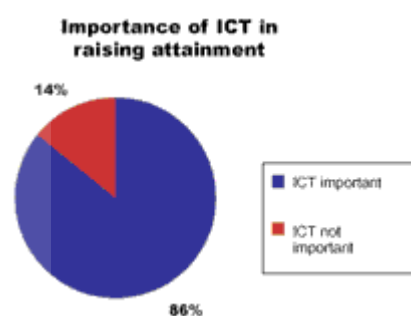


The significant time spent by pupils in 'high ICT' schools using computers provides further evidence that the effects observed are real for two reasons. Firstly, it is unlikely that high-performing schools would devote this amount of time to an activity if it were not achieving results. Secondly, it is unlikely that any school could devote this amount of time to any activity without some effect being observed. Given the pressure on time in primary schools and the challenging targets set, any time wasted on unproductive activity would likely be reflected in under-performance, which the Ofsted data demonstrates is not the case with these schools.

Conclusion

Overall, the great majority (86%) of headteachers in 'high ICT' schools believe that ICT has been important in raising standards in ICT in the past two years.

Overall, this survey reports extensive use of ICT in the sampled schools, and headteachers reported that this use was rewarded by a positive effect on standards. The conclusion is that, where **very good** ICT resources are present in schools, they are extensively used, and headteachers report that they impact positively on standards.

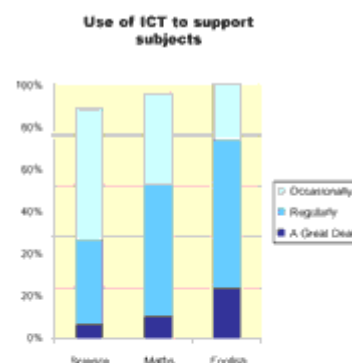


At this stage, it is not possible to say whether schools are using ICT regularly because they believe it has a positive impact on standards, or whether the increased use is encouraging these positive attitudes. However, in either case the evidence supports the notion that ICT is impacting on standards in these schools.

The impact of ICT on Key Stage 2 subjects

Headteachers were asked whether they used ICT to support English, maths and science. For each subject, the following choices were available:

- a great deal
- regularly
- occasionally
- not at all.



Data

Telephone interviews with headteachers of schools with 'Very Good' ICT resources

- Was ICT used in the last two years to support (subject)?

Sample

125 school

The charts that follow show the responses to these questions in schools that had **very good** ICT resources. ICT was used most extensively in English,

where 78% used it 'extensively' or 'a great deal' to support pupil learning. ICT was used 'extensively' or 'regularly' to support maths in 61% of schools, while 38% used ICT extensively or regularly to support science.

Headteachers were also asked whether ICT had a positive impact on standards in each subject.

Eight out of ten headteachers (79%) reported that ICT had a positive impact on standards in English. A similar proportion (80%) reported ICT had a positive impact on maths, while two-thirds reported that ICT raised standards in science.

Conclusion

'High ICT' schools are using ICT to support the core subjects of English, maths and science. Opinions about the impact of ICT on subject standards were positive. The subjects where greatest use was reported were those in which a greater impact was reported to have been made.

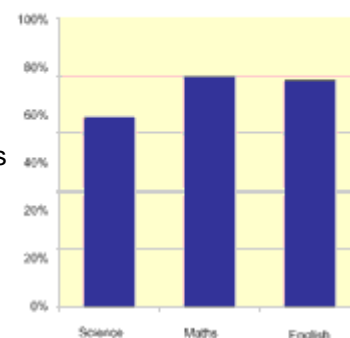
How ICT supports learning - unpacking the causal chain

Previous sections of this report use independent measures to demonstrate correlations between the level of ICT resource in a school and standards in English, maths and science. The first part of the telephone survey shows that headteachers, particularly in those schools which use ICT regularly or more often, believe that ICT has a positive impact on standards in those subjects. The latter part of the survey aims to identify how ICT may be impacting on standards. If it is possible to identify likely mechanisms for linking ICT with improved standards, this would reinforce the view that the links identified are real, represent the impact of ICT, and are not the result of some other 'hidden variable'.

Well-established research outside the ICT area identifies a number of factors that can improve learning.

- In the cognitive domain, learners can be encouraged to improve their subject knowledge and understanding by engaging with information, modelling and constructing meaning.
- In the affective domain, attribution theory describes the role of motivation in a person's success or failure in school situations.
- The learner's effectiveness (such as the learner's time on task and time taken for the learner to see the outcomes of learning) can affect performance.
- Direct teaching and intervention by the teacher have been demonstrated to raise standards.
- Wider contextual issues have an impact. Learning in school is more effective if it is supported by the home.
- The ability of teachers and the school to manage and interpret data on pupils' performance so as to set appropriate tasks and targets and modify approaches has been demonstrated to raise standards.
- The telephone survey sought to identify whether headteachers identified that ICT was making a contribution to each of these factors in their schools:
 - subject knowledge
 - pupils' motivation and enthusiasm
 - pupils' effectiveness in completing classroom work
 - teaching standards
 - home-school relations

Positive impact on Key Stage 2 attainment



Data

Telephone interviews with headteachers of schools with 'Very Good' ICT resources

- Do you think that pupils' use of ICT helped to raise standards in (subject)?

- Proportion saying 'yes'

Sample

125 school

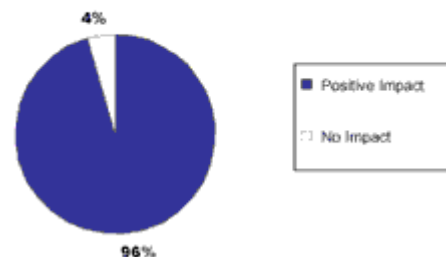
- school effectiveness.

Headteachers in the 'high ICT' schools were asked whether they reported ICT had had a positive impact on each of these. The analysis of the responses follows.

Impact of ICT on subject knowledge

Nearly all headteachers of high ICT schools reported that ICT had impacted on subject knowledge (96%).

Subject knowledge



Impact of ICT on pupils' motivation and enthusiasm

Similarly, nearly all reported positive impact on pupils' motivation (98%).

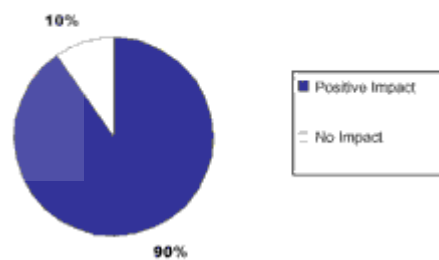
Pupils motivation



Impact of ICT on pupils' effectiveness in completing classroom work

A large majority (90%) reported that ICT had improved the effectiveness of their pupils in completing work in the classroom.

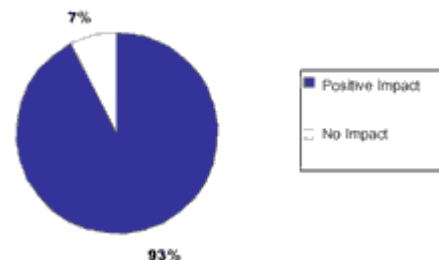
Pupils work effectiveness



Impact of ICT on teaching standards

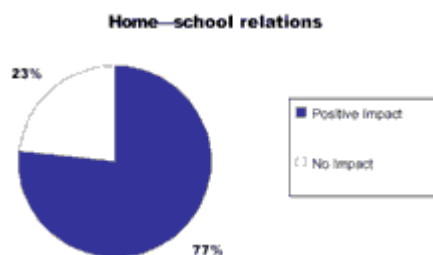
More than nine out of ten (93%) reported that ICT had made teachers more effective.

Teaching



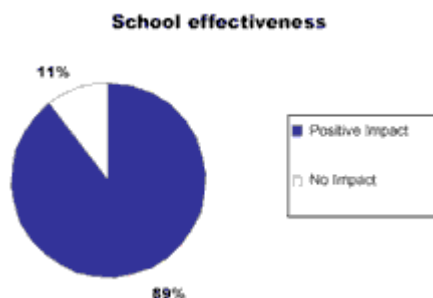
Impact of ICT on home-school relations

On home-school relations, opinion was rather more divided, though more than three-quarters (77%) reported that ICT had had a positive effect.



Impact of ICT on school effectiveness

Almost nine out of ten (89%) reported that the very good ICT resources of their schools had improved the administrative effectiveness of the school as an institution.



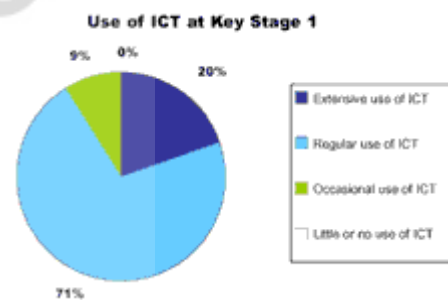
Conclusion

Headteachers of 'high ICT' schools identify ICT as having an impact on those factors which research outside the area of ICT identifies as having a direct impact on learning: motivation 98%; subject knowledge 96%; teaching 93%; pupils' effectiveness 90%; school effectiveness 89%; home-school relations 77%. This provides further supporting evidence that the link between ICT and standards is real.

Key Stage 1

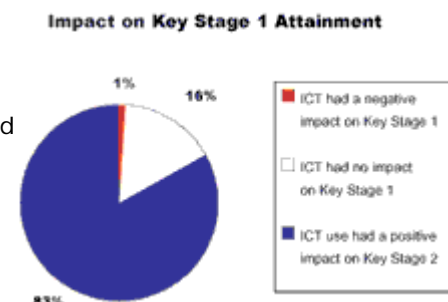
Headteachers were also asked how much ICT was used at Key Stage 1 and whether they reported that ICT supported pupils at Key Stage 1. The answers given are summarised below.

In 20% of schools, ICT was used extensively to support Key Stage 1 pupils. In total, 91% of schools said they used ICT regularly or extensively at Key Stage 1. No schools (which had Key Stage 1 pupils) said ICT was not used at Key Stage 1.



Conclusion

In line with this widespread use of ICT, the majority of headteachers of 'high ICT' schools (83%) reported that ICT had a positive impact on the attainment of Key Stage 1 pupils.



7b. 'Teachers Online' survey

Methodology

Becta maintains email relations with a group of education professionals called 'Teachers Online'. These were originally recruited from teachers who were provided with free portable computers by the DfEE, and contact was maintained after this project came to an end. The members of 'Teachers Online' who worked in primary schools were invited to give their opinions about the use of ICT to support learning, using an online questionnaire. All members of 'Teachers Online' have email and Internet access via the equipment provided for them. The focus of this survey was their experience of the classroom use of ICT.

The 'Teachers Online' sample is drawn from a wider range of schools than the telephone survey, in that, while they as individuals may use ICT, they are taken from a wide variety of Key Stage 2 schools rather than those identified as having 'high ICT' by Ofsted.

Results

As would be expected, these teachers spend significant amounts of time using ICT with their pupils.

Conclusion

Teachers with personal access to ICT spend significant amounts of time using ICT with their pupils.

Impact of ICT on English, maths and science

The following charts show a sample of opinions given by 'Teachers Online' members. The first chart shows the frequency with which teachers made use of ICT. The majority of teachers used ICT at least occasionally in each subject. More than half used ICT regularly in English, four out of ten used ICT regularly in maths, and two out of ten used ICT regularly to support science. The opinions of this group of teachers are, thus, the opinions of those who have experience of using ICT with their pupils.

The second chart shows the proportion of teachers who believed that ICT had had a positive impact on standards in these three subjects. It can be seen that three-quarters believed that ICT had raised standards in English, two-thirds reported ICT had raised standards in maths, and more than half believed ICT had raised standards in science.

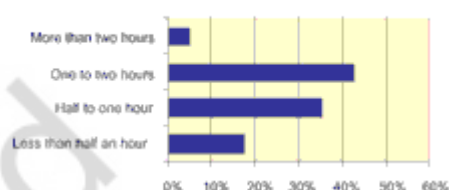
So the majority of teachers who have experience of using ICT feel that it has a positive impact on standards at Key Stage 2.

Conclusion

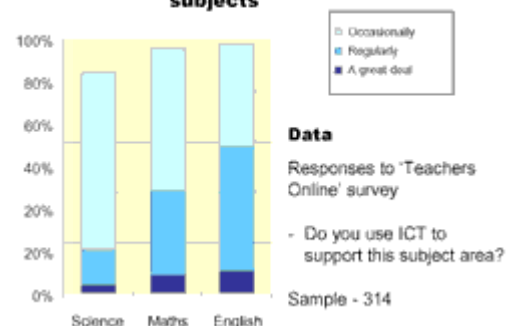
Professionals with experience of ICT are using ICT to support the core subjects of English, maths and science. Opinions about the impact of ICT on subject standards were positive. The subjects where greatest use was reported were those in which a greater impact was reported to have been made. This lends further support to the other evidence accumulated in this research which shows that the impact of ICT on standards is real.

How ICT supports learning - unpacking the causal chain

How many hours a week on the computer?



Use of ICT to support subjects



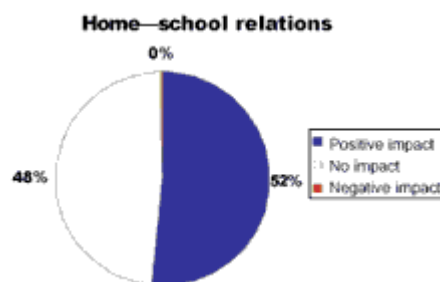
ICT has a positive impact on standards



Data
Responses to 'Teachers Online' survey
- Do you think that pupils' use of ICT helped to raise standards in (subject)?
Sample - 314

As with the telephone survey, the questionnaire aimed at the 'Teachers Online' sample sought to identify whether those teachers identified that ICT was making a contribution to each of the following factors in their schools:

- subject knowledge
- pupils' motivation and enthusiasm
- pupils' effectiveness in completing classroom work
- teaching standards
- home-school relations.



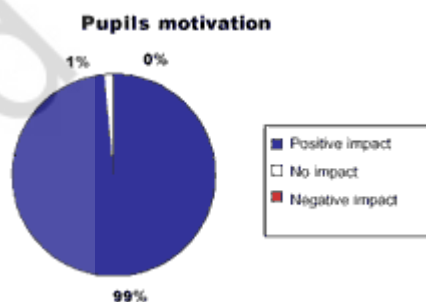
Impact of ICT on subject knowledge

The majority reported that ICT had impacted on subject knowledge (91%).



Impact of ICT on pupils' motivation and enthusiasm

Virtually all reported positive impact on pupils' motivation (99%).



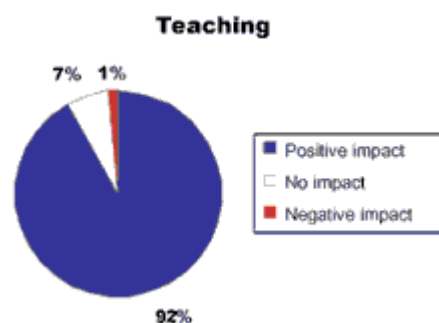
Impact of ICT on pupils' effectiveness in completing classroom work

Approximately three-quarters (79%) reported that ICT had improved the effectiveness of their pupils in completing work in the classroom.



Impact of ICT on teaching standards

More than nine out of ten (92%) reported that ICT had made teachers more effective.



Impact of ICT on home-school relations

On home-school relations, opinion was rather more divided, though more than half (52%) reported

that ICT had had a positive effect.

Conclusion

Teachers with personal access to ICT identify it as having an impact on those factors which research outside the area of ICT identifies as having a direct impact on learning: motivation 99%; subject knowledge 91%; teaching 92%; pupils' effectiveness 79%; home-school relations 52%. This provides further supporting evidence that the link between ICT and standards is real. Where comparisons are made between these results and those of the telephone survey, it can be seen that the findings from the survey of the teachers complement those from the telephone survey of the headteachers in the 'high ICT' schools. However, headteachers in 'high ICT' schools are more positive than the teachers in the particular areas of pupil effectiveness and home-school relations. This may well reflect the fact that the 'Teachers Online' community were provided with personal rather than school access to ICT, and that the sample of teachers draws on a wider range of schools.

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Section C - Research Evidence

8. Causal mechanisms - the evidence from wider research

Are there identified mechanisms that would explain how ICT causes a rise in standards, and could they plausibly contribute to the observed effects in the statistics? Are there experimental studies that have shown a real impact of the use of ICT on improved learning by pupils and improved teaching in similar situations to the schools in the study?

Rationale

Investigation reported earlier in this report has identified:

- a statistical relationship between ICT and standards as measured by Ofsted, DfEE, and QCA data
- headteachers' and teachers' professional judgement that ICT is raising standards in schools.

Research carried out elsewhere has identified causal mechanisms by which ICT may enhance teaching and learning. If ICT has a positive effect on pupil attainment, then research into the learning process will uncover the mechanisms that underpin this causation. In particular, studies of how ICT is used by teachers and by learners will show possible specific ways that ICT helps to enhance pupil attainment in English, maths and science.

Methodology

A wide range of research findings relating to the impact of ICT on attainment was investigated. The main points of this body of research were summarised and related to the impact of ICT on standards. The full report on this research is available.

The analysis of the research sought to:

- relate the analysis of the Ofsted data and ICT literature review to the wider school effectiveness literature
- describe the main findings of the UK research literature on ICT that relate to Key Stage 2 maths, English and science, covering both the positive and negative findings
- review the various environmental and contextual factors that may be important in assisting or hindering the impact of ICT on aspects of learning in the three subject areas.

A search of the literature has identified 36 studies that describe research into the use of ICT to support the teaching of aspects of English, maths and science at Key Stage 2. Of the 36 studies, 16 reported findings for maths, 19 for English and 3 for science. Three ILS studies and the series of studies in the Newcastle report, Moseley and Higgins (1999), relate to multiple findings in both English and maths.

Results

ICT was identified as enhancing attainment in the following aspects of mathematics:

- numeracy skills: Moseley (1999) and Moseley and Higgins (1999)
- graphing: Pratt (1997)
- use of variables: Thwaites and Jared (1997)
- dynamic geometry: Gardiner (2000)
- estimation and extrapolation from graphs: Stradling (1994)
- measuring time and working to two decimal places: Moseley and Higgins (1999).

ICT was identified as enhancing attainment in the following aspects of English:

- positive attitudes to spelling and writing: Taylor (1999), Moseley et al. (1999)
- reading, including reading comprehension and sound recognition of words: Lester (1998)
- phonic skills: Lester (1998)
- use of dictionaries: Lester (1998), Moseley et al. (1999)
- vocabulary and visual memory: Lester (1998)
- writing skills, particularly revising and redrafting: Moseley et al. (1999)
- punctuation, including the use of omissive apostrophes: Moseley et al. (1999)

The various documents from which these findings have been gathered are summarised in tables to be found in Section 2 of the 'Background Research Report', giving details of the methodology sample size and positive/negative findings. The literature review identified a number of findings relating to the factors set out in the section unpacking the causal chain. For example, the motivational power of ICT that can assist improvements in attainment, by improving pupil attitudes to learning, building confidence and self-esteem.

The literature indicates that a range of technologies and software packages/systems can help to raise aspects of attainment, but that positive impact depends on those other factors identified in Section A:5 of this report. It is important to consider aspects of the research design, sample size, duration and method of analysis when considering the robustness of each individual finding.

A consideration of the various environmental/contextual factors help to convey the complex pattern of variables that can help or hinder the effective use of ICT in both the classroom and in the school as a whole. These include:

- level and type of pupil and teacher ICT training and skills
- pedagogical awareness among staff
- staff attitude towards ICT
- the integration into classroom practice and existing teacher interventions
- pre-use and planning
- school ethos
- technical support, resources management and infrastructure
- establishing clear learning and curriculum objectives.

These line up with those further factors identified earlier in the report.

Learning gains using ICT appear to be more likely when supported by effective pedagogical approaches and effective teaching strategies. Research would suggest that a number of these factors need to be in place in order to reach a threshold above which ICT is more likely to have a significant impact and to support education and learning effectively. However, it is unclear at this stage which ones are the most significant and how many are required in order to reach the threshold. This would be a fruitful issue for further investigation.

Conclusion

The wider findings from the research evidence support aspects of the impact of ICT in English, mathematics and science found both within the statistical analysis of the Ofsted and QCA data and the surveys. This provides further supporting evidence that the links between ICT and standards are real and not the result of sampling variation or hidden effects.

Footnote to BECTA/DfEe Report

Becta is aware that schools can and do use ICT in a range of ways not always reported in the academic research literature, as may be seen from the case study material and practical examples of

effective practice in various Becta publications. They illustrate the additional and wider learning potential that the technology can offer.

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