

Evidence on the impact of technology on learning and educational outcomes

1. Introduction

This paper presents an interim review of evidence from published independent studies and analysis on the relationship between technology and the learning outcomes of school-aged learners. This review will inform a further Becta publication in November 2009 which will draw on additional evidence and offer a more detailed analysis of the implications of key studies for educational practice.

The context of this review is one where children and young people spend much of their time using technology in their own ways to support learning, sometimes independent from specific guidance and support from schools. The rapid changes and developments in technology are signalling an age where constant access to information resources and knowledge networks is increasingly a norm, and children and young people are increasingly bringing that expectation to their learning in school.

How educators respond to this is a critical issue for our times. It is increasingly important to develop a good understanding of the role that technology has played in supporting improved learning. This review does that, drawing from a range of recent studies. As the use of technology develops, both within and outside formal learning, it is also important to keep up to date, which is why this review focuses predominantly on recent research.

In considering 'the impact of technology', what is meant by 'technology'? Current information and communication technologies are diverse, ranging from access to broadband and the internet, to classroom display technologies, networked technologies such as online learning environments, and specific tools and devices such as data loggers and handheld computers. We must not wrongly transfer findings from specific uses of technology to broader judgements about the role of technology in learning.

The often quoted Angrist and Lavy study of 2001 offers an example of this error. It found small negative impacts on learning. It in fact evaluated a very specific programmed learning approach, the outcomes from which can not be generalised to other contexts or uses of technology. Nonetheless it received considerable attention in the press, including false conclusions that technology was bad for learning. In considering any study of the role of technology in learning, it is important to bear in mind which findings can or cannot be generalised to contemporary UK settings.

2. Messages from the evidence

Overall there is a strong body of evidence linking the use of technology to improvements in learning and outcomes for learners. The relationship is not a simple one. Time taken to embed the use of technology, school-level planning and learner competency and focus of use, and link to models of learning are all important in mediating the impact of technology on outcomes.

Schools that take a systematic and planned approach to using technology to support learning achieve better outcomes with technology than other schools. These 'e-mature' schools have a well-developed vision for learning and lead and manage their use of technology in support of this. They develop teacher skills and curriculum support to build habits and competency in using technology effectively in independent learning.

Opportunities provided by technology lead to learning gains when they are linked explicitly to a model or framework for learning. Targeted use of technology to improving (making more efficient or effective) specific aspects of learning based on a systematic understanding or model leads to positive impact. Supporting schools in reflecting on and developing their approaches to and vision for learning is fundamental to embedding learning gains from technology.

Strong patterns of impact are also found from learners' use of technology to support learning at home. However, again, the relationship is not simple. Schools play a key role in promoting and supporting appropriate learning behaviours with technology. Students from schools that use technology across the curriculum are more likely than those from other schools to engage in using technology to support learning outside school, leading to learning gains.

3. Key studies

Since 'Impact 2' was published in 2003 there have been several studies of the relationship between technology and outcomes for learners in England. Many of these have focused on outcomes from specific technology-related interventions and programmes, making comparisons with the 'counterfactual'. That is, the performance or improvement is compared with other schools with similar characteristics, or compared to expected attainment of students based on their prior performance and other factors. Other studies have used robust statistical models to look at the effect of technology across schools and learners, controlling for factors which are known to affect attainment, assessing the extent to which the use of technology predicts outcomes for learners or school performance and improvement.

ImpaCT 2

The 'Impact2' study (Harrison et al, 2003) was a large scale and detailed assessment of the impact of the use of ICT on learning across the curriculum. It studied the time students spent using technology to support subject learning and found statistically significant relationships between students' using technology in a variety of ways to support learning and student-level 'value-add' scores. That is, achievement beyond what would be expected given prior results and social circumstances, thus effectively controlling for other factors which impact on attainment.

In all subjects and stages there was a positive relationship between use of technology to support learning and value-add scores. Significant positive impact was found in:

- KS2 English, where the average gain from ICT use was 0.16 of a national curriculum level (equivalent to a term's additional progress)
- KS3 Science, where the average gain from ICT use was 0.21 of a national curriculum level (also equivalent to a term's additional progress)
- GCSE Science, where the average gain from ICT use is 0.56 of a grade (52,484 students moving from grade D to C)
- GCSE D&T the average gain from ICT use is 0.41 of a grade (10,020 students moving from grade D to C).

Interestingly, the study found that schools' use of technology across the curriculum in a variety of ways was a key factor in learning gains. That is, impact was achieved simply from using technology in individual subjects. Use across the curriculum was important in both developing learner skills in using technology to support learning and in promoting an orientation towards independent learning with technology. Some uses of technology, including the use of the internet to support revision at GCSE level, were particularly strongly linked with improved performance.

Evaluation of DfES Primary interactive whiteboard programme

The evaluation of the Primary School Whiteboard Expansion project (SWEEP) (Somekh, Haldane et al., 2007a) concluded that the length of time students were taught with interactive whiteboards was a major factor in student attainment across core subjects at Key Stage 2. The study found positive impacts on standards of literacy and mathematics at Key Stages 1 and 2 once teachers had experienced sustained use and the technology had become embedded in pedagogical practice.

After an embedding stage, improvements in outcomes which could be attributed to the use of the interactive whiteboard included:

- In Key Stage 2 maths (age 11), average and high attaining boys and girls who had been taught extensively with the IWB made the equivalent of an extra 2.5 to 5 months' progress over the course of two years.

- In Key Stage 2 science (age 11), all pupils except high attaining girls made greater progress with more exposure to the IWB, with low attaining boys making as much as 7.5 months' additional progress.
- In Key Stage 2 writing (age 11), boys with low prior attainment made 2.5 months of additional progress.
- In Key Stage 1 maths (age 7), high attaining girls made gains of 4.75 months, enabling them to catch up with high attaining boys.
- In Key Stage 1 science (age 7), there was improved progress for girls of all attainment levels, and for average and high attaining boys.
- In Key Stage 1 English (age 7), average and high attaining pupils benefited from increased exposure to IWBs.

This study is particularly significant in identifying the importance to outcomes of levels of teacher experience and expertise in using technology in teaching and learning. It was only in the second cohort, at least a year into using the technology, that an impact on attainment could be identified. There are strong arguments for longer term studies of impact and those which focus on sustained and embedded use of technology rather than its initial uses.

The Impact of Broadband in Schools

Underwood et al (2005) looked at levels of use of the internet in schools, linking this to school-level outcomes, including GCSE A*-C grades. They found that, relative to other schools, those making good use of connectivity in class demonstrated statistically significant improvement to the percentage of pupils gaining 5+ A*-Cs at GCSE in the year after broadband introduction.

The researchers suggest that broadband to the classroom played a particular role in GCSE learning. It had an impact on GCSE results through providing greater opportunities to support pupil-led research in the classroom, using the internet in real time to support project-based learning. This was likely to be linked to the development of higher-order skills which were reflected in GCSE assessment.

This study supports a view that opportunities provided by technology lead to actual learning gains when they are linked explicitly to a model or framework for learning. In short, targeting the use of technology to improving (making more efficient or effective) specific aspects of learning based on a systematic understanding or model will lead to results.

For example, quality of teaching is a key factor in learning. Technology can support improvement by, for example, enabling development and sharing of lessons and learning resources, and enriched, enlivened and structured delivery through the use of interactive whiteboards. Independent study and research can be made more effective through constant access to the right resources (as is the case with GCSE project work and

revision cited above). School-based approaches like the Cramlington learning cycle¹, which has led to significant improvement in learning outcomes, identifies the overall learning approach and ethos, and uses technology in specific ways to enable and enhance activities as part of this, with the aim of building a community of learners and thinkers.

The evidence therefore tells us that approaches to using technology in schools should start with an understanding of learning, leading to a vision and framework for learning. Schools should then plan on the basis of how technology, with all the opportunities it provides, will enable and support this. This reflects the approach taken through Becta's self-review framework and BSF (Building Schools of the Future) planning.

Evaluation of the DfES Secondary interactive whiteboard programme

Unlike the primary whiteboard evaluation, cited above, this study (Moss et al, 2007) was unable to take a long-term approach, assessing impact on outcomes from early use. However, an assessment was made of the link between the introduction of interactive whiteboards and student perceptions of the quality of learning and teaching. These indicate a positive effect from the introduction of the technology on the learners' experience of classroom teaching. The table below reflects secondary pupil's views on their learning when teachers use an interactive whiteboard.

Statements about use of interactive whiteboards in class (Secondary students)	Agree / strongly agree
IWB's make it easier for the teacher to repeat and summarise	87
I think teachers lessons are more prepared and organised when they use an IWB	85
IWBs make learning more exciting and interesting	81
It is easier to understand the work when the teacher uses an IWB	77
I think IWBs make teachers' drawings and diagrams easier to see	76
I prefer lessons which are taught with an IWB	74
I learn more when the teacher uses an IWB	70
We get to join in lessons more when my teacher uses an IWB	64

¹ <http://www.cchsonline.co.uk/school/transformation/cramlearncycle>

School-level e-maturity and school improvement

Drawing from a nationally representative sample of schools in England, Butt and Cebulla (2006) analysed the relationship between school outcomes and indicators of 'e-maturity', controlling for known factors in school performance. 'E-maturity' is the extent of provision, management and use of technology to support learning across the curriculum.

The relationship between technology provision and outcomes was not a simple one. However, the study found that secondary schools exhibiting strong development in e-maturity over the previous four years demonstrated a statistically significant decrease in absence rates compared to other schools. They displayed statistically significant improvements in KS3 average points scores and GCSE point scores and the percentage of A* – C grades at GCSE, as well as better KS3-KS4 value add scores.

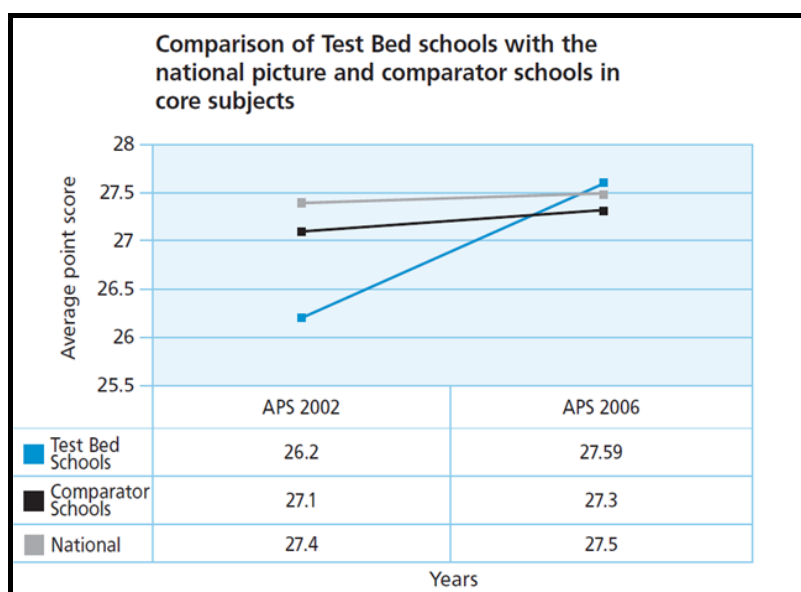
The researchers concluded that the results suggest there is a link between performance and e-maturity, albeit this may not be a simple one. Mediating and contextual factors such as school ethos and general leadership approach are likely to be important. This analysis does, however, indicate that e-maturity is an important part of the mix in school improvement strategies.

More recent research which looks at the role of technology within strategies for school improvement backs this up. A recent study found that, for 181 sampled schools which had been removed from Special Measures and Notice to Improve, 82 per cent reported that technology had played a key role in improvement. Strategies for using technology in these schools included greater use of information systems for monitoring and analysing learner achievement and progress; IT systems for managing and monitoring attendance and behaviour (lesson registration, parental alerting); greater use of technology to engage under-achieving pupils, especially creative and applied learning using technology; and supporting learner voice through online polls and forums (Hollingworth *et al.*, 2008).

Evaluation of the ICT Test Bed

The ICT Test Bed was a DfES-funded intervention to build e-maturity in three clusters of schools in three local authority areas. Over the period of the four year programme, 2002-2006, schools in these areas of socioeconomic disadvantage were offered investment and support to build their provision and use of technology. By 2005 the progress of primary schools in embedding the use of technology was greater than that in secondary schools, reflecting the greater change management challenge in the secondary sector.

The ICT Test Bed evaluation (Somekh *et al.*, 2007b) compared improvement to school average point scores and outcomes at KS2 to matched comparator schools and the national average. School performance at Key Stage 2 improved faster than comparator schools (those with similar characteristics, including size and socioeconomic makeup). They also improved faster than the national picture during that period (see graph, below).



Somekh et al (2007b)

The ICT test bed evaluation is an important study in identifying key elements which need to be in place to build effective practice with technology. These have been taken forward as part of Becta's Self Review Framework for schools. The study reinforces other evidence relating to the importance of whole-school approaches to technology planning and deployment, and the central role of leadership of learning as part of this process.

Home use of technology to support learning

Valentine et al (2005) conducted a survey of the use of technology at home by secondary-aged students. They used a multiple linear regression to assess the influence on Key Stage 3 and GCSE outcomes of ICT-related behaviours, including in the model other indicators of social capital and attitude to school. Relative performance was obtained by comparing each student's actual achievement with predicted achievement, derived from 'baseline' scores.

The researchers found a statistically significant positive association between pupils' home use of ICT for educational purposes and improved attainment in national tests for:

- Maths KS 2 (PIPS added value 6.00)
- Maths KS 3 (YELLIS added value 0.30)
- Maths GCSE (YELLIS added value 0.38)
- English GCSE (YELLIS added value 0.29).

The study found that use of ICT to support learning at home delivered a range of benefits including motivational and self-confidence effects, particularly for under-achieving learners.

Importantly, the study demonstrated the role of the school in guiding and building learning-oriented behaviours with technology. Students from schools where the use of technology was more common were more likely to use technology to support learning. Given that the study also demonstrated some negative relationships between using technology at home for leisure purposes and GCSE attainment, building learning-oriented behaviours with technology in school is likely to be critical important in enabling learners to achieve educational success.

Student ownership and use of computers

A recent analysis from the Institute of Fiscal Studies has analysed data from the DCSF Longitudinal Survey of Young People in England (LSYPE), looking at both attainment and behaviour differences between socioeconomic groups. The model used data from 15,000 teenagers born in 1989 and 1990.

The analysis found that computer and internet access at home is important in explaining the achievement gap, and plays a role in some behaviour outcomes. Findings include:

- After controlling for KS3 results, the availability of a computer at home is significantly positively associated with Key Stage 4 test scores. This association amounts to around 14 GCSE points (equivalent to 2 GCSE grades).
- Young people with a computer at home are less likely to play truant at ages 14 and 16 than those without computer access. For example, having access to a computer at home is associated with a 5.8% reduction in the likelihood of playing truant at age 16.
- Losing access to a computer is associated with a reduction of 20 GCSE points, even after controlling for prior attainment.
- Gaining access to the internet is associated with 10 GCSE points, again controlling for achievement at KS3.
- Gaining access to a computer is associated with a 4.3% reduction in the probability of playing truant at age 16, while losing computer access is associated with a 5.3% increase in the probability of playing truant at age 16.

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