

Interpreting the evidence base for the impact of digital technologies on learning: Report for BECTA

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Interpreting the evidence base for the impact of digital technologies on learning

Overview

The aim of this paper is to present a synthesis of recent evidence of the impact of ICT on learning. It is divided up into three main sections. The first sets out a general analysis of the impact of technology on learning to set a broad historical context. The next section reviews evidence from recent Becta projects (summarised in Appendix 1) and includes a synthesis of some methodological issues relating to this research. Further sections consider wider research on digital technologies in the UK and internationally, again to provide further context for the recommendations which follow.

The purpose of this review is therefore to identify potential gaps in the evidence base for further research. It is intentionally provocative and speculative, but aims to stimulate debate about research into the impact of digital technologies on learning. Such technologies are here to stay in society and the focus needs to shift from *whether* to use them in teaching and learning, to investigating a more precise set of questions about *which* technologies to use for *what* educational purposes and then to investigate *how* best to use and embed these across the range of educational settings with diverse learners.

Summary of key points

Overall the research into the impact of digital technologies on learning tends to identify modest positive benefits for learning. The range of technologies and settings in which the research has been conducted and the challenges in effective synthesis of evidence from different methodologies makes it difficult to identify clear messages for policy and practice.

Studies linking provision and use of technology tend to find small positive associations with educational outcomes but it is not clear that there is always a causal link. It may be that more effective schools and teachers are more likely to use ICT and digital technologies effectively. We need to know more about where and how it is used to greatest effect, then investigate to see if this information can be used help to improve learning in other contexts.

Evidence from experimental and quasi- experimental designs indicates that overall technology-based interventions tend to produce only average gains when compared with other research studies. Further analysis is needed to identify what the most promising interventions are and what are their pedagogic (rather than their technological) characteristics. However, the time it takes for sufficient robust evidence to emerge and the rapid pace of change in terms of technology makes this difficult to achieve.

There are also methodological issues in the overall research in this field. Many studies tend to be small-scale and to rely on *ad hoc* evaluative designs. As a result we know a lot about which technologies have been used in education, and a fair amount about how they have been used, but somewhat less about their impact on learning, and almost nothing about how they change learning or why they might be advantageous for different learners, in different settings, with different learning goals. Overall the evidence base is neither cumulative nor explanatory.

There therefore seems little to be gained in generating more general evidence of this kind at this broad level without a clearer understanding of the pedagogical factors and mechanisms involved in the impact of digital technologies on learning.

There are a number of possible avenues for further research. The complexity of interaction between educational settings and objectives, digital technologies, and the diversity of learners suggests that current research should focus on understanding not so much *what* works, but *why* different approaches are effective. This could be achieved by more rigorous interrogation of the existing evidence using systematic methods of synthesis (both qualitative and quantitative) and by approaches such as rigorous comparative case study analysis. However this needs to be with the explicit intention of generating interpretive conclusions as the basis of hypotheses for further investigation. The longer-term aim would be to accumulate knowledge about the range of ways in which digital technologies can be beneficial educationally in order to guide the adoption and integration of new and emerging technologies.

Future research should also identify what the possible or probable benefits are for learners when using technology (both in terms of processes and outcomes) based on an analysis of current research and investigate under what circumstances these are achieved. In the short term this will require some clarity about the probable or possible benefits from the impact of digital technologies on learning and the development of some research approaches to capture and analyse these across different settings. Again this could be achieved through comparative case study analysis.

Background

The effect of ICT and digital technologies on learning is central to its use in education. A review conducted for the Department for Education and Skills (Cox & Abbott, 2003) concluded:

“The evidence from the literature shows a positive effect of specific uses of ICT on pupils’ attainment in almost all the National Curriculum subjects, the most substantial positive effects being in mathematics, science and English at all key stages.” (p. 4)

This quotation is typical of reviews in this field but is, I believe, in need of critique. The main approach for evaluating impact in national studies in the UK has been through retrospective or post-hoc models, in which students’ attainment across a range of tested curriculum outcomes has been correlated with the quantity or quality of ICT which was available or which they experienced in their institutions (see, for example, Watson, 1993; Wenglinsky, 1998; Weaver, 2000; BECTA 2003). The Impact 2 study (Harrison *et al.* 2004) identified statistically significant findings associating higher levels of ICT positively with school achievement at each Key Stage, and in English, Maths, Science, Modern Foreign Languages and Design Technology. An association between high ICT use and higher pupil attainment in primary schools was also reported in a Teacher Training Agency study (Moseley *et al.* 1999, p 82) though the interpretation here was that the more effective teachers (and more effective schools) tended to use more innovative approaches, or tended to use the ICT resources that they had more effectively, rather than that the technology was the cause of the differences in pupil performance. In the USA, information about computer use from a longitudinal study was analysed (Weaver, 2000). This study found a only small link between computer use in the curriculum in school and improvement in pupil’s test scores, indicating that at this general level computer use makes very little difference to pupils’ achievement. This connection is found consistently however and other studies have suggested a stronger association. The ICT Test Bed evaluation identified a link between high levels of ICT use and improved school performance. The rate of improvement was faster in ICT Test Bed Local Authorities (LAs) than in equivalent comparator LAs in KS2 English (Somekh *et al.* 2007). However, all this link shows is that, on average, schools with higher than average levels of ICT provision also have pupils who perform slightly higher than average. The causal link could be quite the reverse, with high performing schools more likely to be better equipped or more prepared to invest in technology or more motivated to bring about improvement. Fuchs and Woessmann’s (2004) analysis of this link between provision and performance based on the Programme for International Student Assessment (PISA) data supports this interpretation:

“the initial positive pattern on computer availability at school simply reflects that schools with better computer availability also feature other positive school characteristics. Once these are controlled for, computer availability at school is not related to student performance in math and reading.” (p. 13)

The OECD’s (2006, p 51-66) more detailed analysis of PISA data indicates a complex picture of association between student performance, their access to computers at home and at school together with frequency of use which varies from country to country. Though as a note of caution the research found that students who used computers

most widely tended to perform slightly worse on average than those with moderate usage. Overall the analysis suggests that the linkage may not be a simple causal one nor necessarily a simple linear association. There may be a limit to the amount of technology which is beneficial.

In experimental and quasi-experimental research, where gains in knowledge or understanding for groups of students using ICT has been compared with gains for groups learning the same content without technology, results tend to show positive benefits for ICT. These have been reviewed using a narrative approach (e.g. Parr & Fung, 2000; Andrews *et al.* 2002; Cox *et al.* 2003; Hartley, 2007) as well as through quantitative synthesis using meta-analysis (e.g. Soe *et al.* 2000 (*CAI and reading*); Torgerson and Elborne, 2002 (*ICT and spelling*); Goldberg *et al.* 2003 (*computers and writing*); Pearson *et al.* 2005 (*technology and reading*); Sitzman *et al.* 2006 (*web-based instruction*); Vogel *et al.* 2006 (*Computer Gaming /Interactive Simulations on Learning*); Liao, 2007 (*computers and achievement in Taiwan*): see Appendix 2 for a list of other meta-analyses). Again these reviews typically conclude that technology has a positive and measurable effect on learning. Most of these reviews of the efficacy of ICT or digital technologies do not, however, consider the effects comparatively. By far the majority of researched educational interventions have a positive impact but the relative impact is not usually considered (see, for example, Hattie, Biggs and Purdie, 1996; Sipe and Curlette, 1997; Marzano, 1998). When a comparative view is taken technology interventions appear to be less beneficial, as Sipe and Curlette (1997) observed:

“when compared to ‘no computers’, ‘computers’ produces a nice effect size. However, when compared with typical effect of innovation on educational achievement, computer innovations are not that different from the average innovation.” (p 608)

Taken together, the correlational and experimental evidence does not offer a convincing case for the *general* impact of digital technologies on learning outcomes. It may be the case, of course, that ICT and digital technologies do have an impact on learning, but that this is not apparent when looking at attainment (as measured by performance tests). If this is the case then it is important to consider how ICT is changing learning and whether assessment of learning needs also to change. It also becomes important to identify more precisely and articulate more clearly where and how the use of digital technologies is beneficial. As the OECD study concludes:

More micro-studies are needed within countries to explore the extent to which for individual students, certain kinds of computer usage raise performance, and which kinds are most effective. At the same time, in countries where basic computer access is approaching universal, policy needs to turn its attention from providing the technology to ensuring that its usage is effective.
(OECD, 2006, p 69)

The proliferation of technologies also makes this question hard to answer at a general level. One of the criticisms of the meta-analytic studies, cited above, is that they tend to put all of the different kinds of technologies into a single category of ‘technology’ or ‘ICT’ begging the question of what the range of impact is, and whether some technologies or some educational approaches using technology are more effective

than others. Similarly with correlational studies, it may be that some schools are using (some) technologies to beneficial effect, but that when the data is aggregated, this is impossible to identify.

A further more speculative point relates to the phases of implementation or adoption of digital technologies. The evidence for this is more tentative and is based on interpretation of trends over time. There appears to be a pattern of impact of ICT or digital technologies where in the early stages there is a high level of enthusiasm, supported by either anecdotal or qualitative accounts of the benefits of the introduction of a new or emerging technology in an educational setting, such as with integrated learning systems or interactive whiteboards. At the next stage, as the technology and teaching approaches develop and evolve these effects are investigated more rigorously. At this stage a more mixed message tends to appear with different studies finding different effects or levels of effect (see for example, Parr and Fung (2000) retrospective analysis of Integrated Learning Systems or Higgins, Beauchamp and Miller's (2007) review of interactive whiteboards. It is rare for further studies to be conducted once a technology has become fully embedded in educational settings as interest tends to focus on the new and emerging, so the question of overall impact remains elusive.

If this is the situation, there may, of course, be different explanations. We know, for example, that it is difficult to scale-up innovation without a dilution of effect with expansion (Cronbach *et al.* 1980; Raudenbush, 2003). It may also be that early adopters (Rogers, 2003; Chan *et al.* 2006) tend to be tackling particular pedagogical issues in the early stages, but then the focus shifts to the adoption of the particular technology, without it being chosen as solution to a specific teaching and learning issue it may be taken up without a particular teaching and learning focus (Rogers' 'early' and 'late majority'). At this point the technology may be the same, but the pedagogical aims and intentions are different, and this may explain a reduction in efficacy.

Where this makes a further difference may also be in what the technology *replaces*. Technology is not introduced into a vacuum. As schools and teachers introduce technology they stop doing something else. When teachers choose to adopt technology themselves they often do it as part of a process of inquiry (Somekh, 2007) and it replaces or displace some problematic practice; when it is adopted for its own sake, it displaces or replaces other teaching and learning activities which may have been as (or more) effective. Hence an ecological view of adoption is needed, where the justification of technology adoption is a relative one (Zhao & Frank, 2003). It should replace less effective practices, and be effectively integrated into the resources available to a learner to support their learning (Luckin, 2008), as part of a more effective or more efficient learning context. As yet we do not have the tools to enable us to support these decisions (Underwood and Dillon, 2004).

Overall, the challenge for identification of impact is more acute than ever. The proliferation of technologies and the range of ways that they can be used in diverse educational settings across the spectrum of learners, coupled with the pace of change of technology make the task ever more demanding. My argument is that the focus must shift from the technologies to the pedagogies of use and the analysis of general

impact to the specific differences that digital technologies make to teaching and learning contexts and interactions.

Recent Becta projects

This section reviews recent research managed by Becta and which is reported through Becta's research website. A wealth of projects have been undertaken in the last few years and commissioned or managed by Becta¹. These have varied in focus though with some common characteristics across the research as a whole (for a summary of projects, methods and reported impact see Appendix 1). They have addressed issues in terms of policy, technology and pedagogy, but predominantly have focussed on the first two of these:

- Policy (e.g. gender, underachievement, personalisation, school improvement, inclusion, special needs);
- Technologies (whiteboards, Web 2.0, virtual worlds, mobile phones, tablet PCs, computer games, broadband, e-learning, video conferencing, digital video);
- Technology management (thin client, managed services, wireless networks, managing costs, technical support);
- Pedagogy (learner strategies, learner voice, e-portfolios; e-learning).

Overall findings relating to technology and attainment

Although the level of enthusiasm for the impact of technology remains high, and both teachers and learners can identify benefits from the use of technology for learning, there is little convincing evidence of a causal link between technology and attainment documented in the reports. Correlational evidence may be persuasive (e.g. *Impact 2*²; *Schools Whiteboard Expansion Project (SWEPP)*; *Impact '07*) but it is not conclusive. No association was found, for example, between ICT and schools who had recently improved (*Technology and School Improvement*).

Positive correlations with provision of ICT or provision and use ("e-maturity") have been found with:

- ICT and National Tests English at Key Stage 2 (*Impact 2*)
- Science at Key Stage 3 (*Impact 2*)
- Key Stage 3 mathematics and science and GCSE level 1 (*Impact '07*)
- IWBs and mathematics and science (*IWB Pilot*)
- IWBs and performance of some groups of pupils in science and mathematics (*SWEPP*)

This suggests there may be some patterns of association worth pursuing to identify how schools are using technology to support learning in areas where consistent links are found. Findings from the Impact 2008 study are likely to be valuable in informing such an analysis.

¹ Analysis based on the reports available at:
http://partners.becta.org.uk/index.php?section=rh&catcode=_re_rp_02&filter=1&orderby=1&rows=9999&submit=Apply+Filter where the research mentions impact on attainment.

² Reports are referred to by title rather than authors to enable easy identification on the website.

Methodological features

A range of approaches to research have been undertaken. These include:

- reviews (academic literature analyses and expert summaries),
- large-scale surveys reporting on the state of technology,
- evaluative studies (usually mixed methods evaluations) and
- smaller scale case studies.

By far the majority of these are mixed method evaluations (about 40%) with reviews the next most common (about 20%) with survey (under 20%) and case study (about 10%) accounting for the remainder. Only a small number of evaluations use evidence about pupils' learning systematically to draw conclusions, either qualitatively or quantitatively. No studies used experimental or quasi experimental designs.

Most studies report on the research approach adopted, and tend to provide an overview of methods, but there is rarely an explicit justification for the methods chosen. The approach to analysis of data, particularly of qualitative data (such as interviews and observations), is usually not made explicit. This makes it difficult to build upon previous research and accumulate evidence over time. However, it should be noted that these issues have been identified in research on technology in education more broadly (e.g. Underwood, 2004: see also the recent interesting analysis of published studies by Hrastinski & Keller (2007)) and are of general concern in educational research (Hillage *et al.*, 1998). Overall there is a tantalising association between technology and learning, but further explanatory and cumulative research is needed to identify the complex causal relationships involved.

Global trends: increasing scepticism?

Research from the UK on ICT and digital technologies is in many areas leading research and evaluation internationally into digital technologies in the schools and FE sectors particularly. Historically, important contributions to the literature on Integrated Learning Systems (ILS) came from the UK (see Parr & Fung, 2000) and the reviews of the effects of interactive whiteboards, for example, still have the most rigorous evidence from UK studies (see the review by Higgins, Beauchamp & Miller, 2007). It is therefore not surprising that current international research is reiterating the broad messages outlined above, such as about the small overall association between technology and attainment (Wainer *et al.* 2008) and positive findings for smaller interventions (Liao & Hao, 2008). One feature of international research which is not reflected in the studies discussed above is the role of ICT and digital technologies in assessment. A considerable proportion of the published research in the field looks at computer-based testing (including the assessment of higher order thinking and assessment of extended writing) and computer-adaptive testing. Pedagogy, curriculum and assessment are inextricably linked (Mabry & Snow, 2006). The current situation in the UK perhaps indicates that this is an area for further research and development. The challenge will be to link work on students' involvement in formative assessment with effective diagnostic feedback for teachers with the summative purposes and accountability issues (Harlen, 2007).

Globally there are some trends identifiable which reflect enthusiasm for the new and emerging technologies accompanied by more varied evidence as these technologies

are adopted more widely (for a recent overview of evidence relating to schools see Voogt & Knezek, 2008):

- Continuing enthusiasm for new emerging technologies (Web 2.0, multi-touch, mobile and ubiquitous technologies (Chan *et al.* 2006)).
- The challenge of identifying the impact of one-to-one provision of technology. This is both for laptops (Dunleavy *et al.* 2007; Silvernail & Gritter, 2007) and mobile technologies (Naismith *et al.* 2004). Similarly, there is a challenge for one-to-one provision in terms of pedagogy (such as developing effective interaction and collaboration (Liu & Kao, 2007) and in addressing teachers' concerns effectively (Donovan *et al.* 2007): for a recent review see Penuel, 2006).
- The disappointing impact of the internet as an educational resource (e.g. Cole & Hilliard, 2006) and concerns about its use (e.g. Richards *et al.* 2008).
- The growth of e-learning and dearth of evidence of beneficial impact on learning students' learning. Much of the research published relates particularly to the Higher Education sector (e.g. Davis & Graf, 2005; Kanuka & Keland, 2008).
- Some concerns about the detrimental impact on health and well-being of sustained use of computer technology, particularly for younger learners (e.g. Straker *et al.* 2005).
- Acknowledgement of the tension between technological and pedagogical change (e.g. Steffens, 2008) and the influence of other aspects of the educational system (such as assessment e.g. Mabry & Snow, 2006).

One interpretation of the trends in the wider literature on impact of is that there is a recognition of the seriousness of the challenge from enthusiasts (e.g. Underwood, 2004) to a growing critical voice from the skeptics (e.g. Oppenheimer, 2003; Wainer *et al.* 2008; Slay, 2008) with an increased interest in cost-effectiveness or value for money of technology in education (e.g. Margolis *et al.* 2007) and the issue of sustainability (Mee, 2007), which can only be exacerbated in times of economic difficulty. This is a battle new and emerging technologies are likely to find hard to win, as early iterations of technologies tend to be more expensive than mass-produced models. If the speculation is correct that innovators and early adopters tend to get the best from such technologies, this sharpens the challenge. The majority who jump on the bandwagon of the technology (and get it cheaper), don't necessarily know what to do with the equipment to get the best from it educationally. If Rogers' (2003) theory is correct, effect will diminish over time as the 'late majority' may also be more reluctant converts. On the other hand, it seems impossible to imagine that digital technologies will not be used in educational settings as they are now so embedded in wider society. At this point the question of cost-effectiveness and relative benefit becomes increasingly urgent. Will schools be able to sustain the investment in interactive whiteboards, one-to-one provision of laptops or PDAs or the next generation of multi-touch desks *and* sustain the legacy equipment they already have? Do we have the evidence to argue which older technologies should be retained and which might be replaced with more effective or more efficient approaches for teaching and learning?

Conclusion

The overall conclusion is that it seems likely that more studies of the same kind as those described above will produce results which follow the pattern of results already outlined. Large-scale correlational studies will struggle to identify clear associations between technology use and learning due to variation in the way in which technology is used, and will not be able to identify causal associations. Small-scale evaluations of digital technologies by innovators and early adopters will tend to yield positive indications. Evaluations at the next level of adoption will produce mixed results as the pedagogical variation increases. Experimental trials will similarly produce benefits compared with controls, but scaling up the pedagogical fidelity (rather than just technological roll-out) will lead to a diffusion of impact. The challenge of isolating variables effectively will also narrow the range of what can be investigated through trials making this approach a Sisyphean challenge. All of the evidence accumulated to date argues that it is the pedagogy of use which needs more systematic investigation. There is a case to be made for design studies in the early stages of implementation to guide pedagogical development (Chan *et al.* 2006) but there is perhaps a stronger case at this point in time for in-depth comparative case studies where analysis might produce interpretive hypotheses for further investigation.

Such case studies will need to look at the quality of learning as well as impact on attainment (Lei & Zhao, 2007) and will need a rigorous framework of analysis. This suggests a research approach based on explanatory case studies (Yin, 1993; 1994; see also Venezky and Davis' (2002) approach in ICT) with a strong methodological justification. A number of approaches are worth considering here such as Pawson's (2002) realist synthesis or Ragin's fuzzy set qualitative case analysis (Ragin, 2000; Rihoux, 2006) or meta-ethnography (Noblit and Hare, 1988; Doyle, 2003).

The aim would be to take account of recent work on complexity modelling (Underwood & Dillon, 2004) and indications from earlier research into associations between technology use and attainment, to define areas of focus (such as from the Impact 2007 and 2008 studies), then to undertake systematic and interpretive comparative analysis to identify possible causal associations. The emphasis should be on identifying the 'instructional regimes' (Raudenbush 2008) or the sets of teaching and learning conditions which are found in the settings investigated.

The sampling frame from which the case studies would be drawn is a crucial issue. This could be tackled in a number of ways such as by identifying schools which have high contextual value added scores (or other measures of relative performance) and using e-maturity features then identifying similarities and differences with other settings. A relatively small number of case study sites would be needed due to both resource limitations and to enable sufficient depth of data collection and analysis. Cases need to be selected both for detailed within-case analysis and systematic cross-case analysis (Rihoux, 2006 p 689). The aim would be to identify interpretive hypotheses about the complex causal relationships involved in technology use and attainment in schools.

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Appendix 1: Summary table of recent Becta research

Title	Published	Overview/ Research approach	Findings/ Impact reported
How do boys and girls differ in their use of ICT?	2008	This literature review explores the differences between boys' and girls' use of ICT, both within and outside school, and for both educational and leisure purposes. A particular focus of this briefing is on how girls use ICT, what impact it has on them, and whether they are disadvantaged by the increasing use of ICT in education. (Narrative literature summary)	<i>The use of ICT in education improves the motivation and attainment of both girls and boys, though the increases are more marked for boys than girls. There are few significant differences in girls' access to and use of technology within schools, but at home the differences are more marked: girls have lower levels of access at home... and generally use ICT less. Girls use ICT more for school work, whereas boys use it more for leisure purposes. Although there is little evidence that girls are less skilled than boys in the use of ICT (indeed, in some areas they show greater skill), girls generally feel less confident in their ability to use technology. Whereas boys are interested in technology for its own sake, girls see ICT as a means of pursuing their interests and furthering their learning. This may help to explain the lower number of females studying ICT or following a career in technology, but it can also mean that girls' use of ICT is more productive in terms of learning gains.</i>
International Baccalaureate E-Learning Laboratory (iBEL)	2008	The International Baccalaureate E-Learning Laboratory (iBEL) investigated the role that design-for-learning (D4L) plays in fostering independent learning on the International Baccalaureate programme using integrated open source platforms, namely Moodle and LAMS. (An Interpretative Phenomenological Analysis (IPA) method was selected as the most effective means to inform findings, given the close working relationship and proximity of project team members. This method combined elements of the rich case study methodology developed in the JISC Design for Learning (D4L) project strand and was influenced by the interview plus method developed in the LEX 12 project.) (‘Rich’ case study - An Interpretative Phenomenological Analysis (IPA)	Results from the project indicate these technologies increased independent learning, especially when teachers provided a clear framework by linking to pre-selected, reliable resources, and structured these through appropriate activities. Visual design was highly valued and learners enjoyed using resources containing rich media. In subject disciplines such as Modern Foreign Languages and English they were motivated by the integration of social learning tools, notably forum, glossary tools and chat. Students expected the use of technologies to form a part of their learning.

Barriers and Issues		processes of innovation at individual and institutional levels; highlight choices, opportunities and visions presented by Web 2.0 in education and draws out implications for current policy. The report draws upon evidence from multiple sources: field studies of 27 schools across the country; guided surveys of 2,600 school students; 100 interviews and 206 online surveys conducted with managers, teachers and technical staff in these schools; online surveys of the views of 96 parents; interviews held with 18 individual innovators in the field of Web 2.0 in education; and interviews with nine regional managers responsible for implementation of ICT at national level. (Mixed methods evaluation: field studies surveys, interviews)	exploratory rather than embedded, but four potential benefits to learning and teaching of using Web 2.0 to establish and sustain a participatory, collaborative and creative ethos of enquiry were found in the data, though in differing degrees: (1) <i>stimulating new modes of enquiry</i> ; (2) <i>engaging in collaborative learning activities</i> (3) <i>engaging with new literacies</i> ; (4) <i>publication of content</i> ” (p7). “Of the teachers in the survey schools, 54% believed that ‘ <i>Web 2.0 resources could support more effective collaborative learning</i> ’, but many were unsure about the opportunities presented by Web 2.0 or felt they did not have enough information to decide. Some teachers were enthusiastic proponents: 59% believed that popular Web 2.0 resources should get more use in the classroom, but others were more concerned about issues such as time for familiarisation and planning, or problems of control and trust. Many teachers felt that curriculum and assessment pressures reduced their opportunities to introduce Web 2.0 approaches. More than a third (37.4%) of teachers believed adopting Web 2.0 resources would be very time-consuming, and teachers frequently (18.7%) or occasionally (47.0%) found that student use of the internet in class was hard for them to manage. Many teachers had concerns about being let down by technical failure, or even worse, removal of the facility due to rising costs/insufficient budgets.” (p8)
Web 2.0 technologies for learning: The current landscape – opportunities, challenges and tensions	2008	This is the first report from research commissioned by Becta into Web 2.0 technologies for learning at Key Stages 3 and 4. It is based on a review of the current literature and thinking around Web 2.0 and its potential in education. (Expert review)	“Confident adoption of Web 2.0 practices must be grounded on convincing research that shows its appeal and its impact. Yet empirical studies in this area are rather rare. This may reflect the neglect of researchers or it may be an indication that Web 2.0 practices themselves are still poorly represented in the curriculum and, therefore, hard to investigate in situ. This encourages consideration of the reservations that practitioners may feel and the obstacles that they may encounter as innovators”.
Enabling independent access to a learning platform by children with CLD	2008	Learning platforms are mainstream models, with slow adaptation for SLD. Modifications which suit learners with cognitive difficulties are severely limited and typically introduce graphics suited to a very young audience and/or avatars: the need to be literate remains very high. (Practitioner review)	Five elements required for a VLE to be accessible for children with SLD are: Simplified interface, with ability to customise it Symbols (eg Widget) embedded at every level Sound recording embedded at every level, navigable by graphics and symbols Scannable elements of the interface for switch users Large storage capacity for individual users to accommodate lots of video etc
Technology and	2008	This project investigated how technology has influenced the	“ <i>This research found no direct link between using ICT and raising</i>

school improvement: reducing social inequity with technology		<p>reduction of social inequity in primary and secondary schools and its impact on school improvement. It aimed to answer the following questions: How do 'turned around' schools use technology to reduce social inequity by enabling learners from relatively disadvantaged backgrounds to improve their: achievement level; behaviour; attendance; aspiration and retention in employment, education or training? What characterises 'turned around' schools that use technology in order to bring about and sustain whole school improvement? What is successful in these schools in adding contextual value added (CVA) and what role does technology for learning strategies play in that?</p> <p>Based on analysis of questionnaires returned by 181 of the 356 schools removed from 'Special Measures' (SM) or 'Notice to Improve' (NtI) by Ofsted during 2006-7; an analysis of school attainment data, interviews with 32 key staff in 25 schools which had identified that technology had played a part in their improvement and discussions with pupils in groups. (Mixed methods: survey, attainment data, interviews)</p>	<p><i>levels of attainment, or narrowing the gap between different groups of pupils.</i> However there is evidence that technology provides an essential tool in facilitating change, improving school effectiveness and functioning, and providing evidence of pupil progress. The research also suggests an indirect influence of ICT on pupils learning, not through direct links with learning in each subject, but via improved self esteem, engagement and desire to learn."</p>
The schome-NAGTY Teen Second Life pilot	2008	<p>The Schome Park Programme has been working with 13 to 17 year olds to explore the educational potential (and pitfalls) of Teen Second Life™ virtual world and to extend our thinking about schome (not school - not home - schome - the education system for the information age). This report provides a summary of initial findings from the Schome Park Programme: with a particular focus on 'knowledge age skills'. (Mixed methods evaluation: usage data, surveys, analysis of virtual artefacts; wiki posts)</p>	<p>The report concludes that: "It seems clear that Teen Second Life does offer affordances that other media lack and that it has the potential to offer powerful new forms of support for learning, particularly in relation to knowledge age skills. However, as is the case with any new technology, there is a substantial initial learning curve that has to be overcome before its full educational potential can be realised. These start-up costs should not be underestimated. At the time when the Pilot took place it was the only project in Europe that was using Teen Second Life, and one of only five or six projects internationally. <i>A great deal more work is needed in order to fully understand the optimum ways using Teen Second Life (or other future 3D virtual reality worlds that may supercede it) as a vehicle for enhancing learning.</i>"</p>
Online or mixed mode? A study examining learning preferences for business development training	2008	<p>The study outlines some of the critical issues in relation to e-access and e-learning uptake patterns within land-based businesses in rural and remote Scotland; through dialogue with employers and learners, the study examined the learning preferences of small to medium sized enterprises in relation to e-media platforms and their potential for delivery of e-learning. (Survey)</p>	<p>The conclusions made are that e-learning has a role to play in the development of landbased education and training in the future; the report documents factors that have reduced the uptake of learning by the sector, identifies factors that training providers need to address to provide the vital impetus and development of high quality e-learning content specifically related to the landbased sector and appeals for policy action to champion the development and use of technology to support highly differentiated and self-paced mixed mode learning in</p>

			rural landbased SMEs.
Learner strategies using learning technologies in taught curriculum time	2008	In order to meet the continuing challenge of delivering greater educational value from technology and realising significant benefits for learners, the project aimed to identify learners' strategies when using technology as a cognitive tool in taught curriculum sessions. It was considered important to identify the continuities and discontinuities that currently occur between the Secondary school, FE and HE sectors in students' learning with technology in taught curriculum time. (Online survey, observation and interview)	<i>Findings indicated that technology often helps students to sort out their ideas and to solve problems as well as helping students to make their work better across the three sectors. While the majority of participating students in all three educational sectors say that they often or very often use technology to be critical, a large minority in each sector say that this happens not often or not at all. Technology often and very often helps students to revise in each of the educational sectors.</i> <i>Students are reporting dwindling enthusiasm for learning with technology and a sense of lost momentum. Discontinuities between educational sectors are leading to discontinuity and lack of progression in the learning strategies students use. To make a difference at policy level, support and guidance materials should be produced for teachers in the Secondary school, FE and HE sectors on the development of effective cognitive learning strategies and active learning strategies as identified and recommended in this report.</i>
How mobile phones help learning in secondary schools	2008	In spite of school policies banning mobile phones in class, teachers in three schools explored ways of using students' own phones and borrowed smart phones for learning. As a result, students had permission to use the mobiles for activities such as: timing experiments with the stopwatch; photographing apparatus, models, and experiments for reports; bluetoothing project material between group members; receiving SMS & email reminders from teachers; synchronising timetables and setting reminders; connecting remotely to the school learning platform; accessing revision sites on the Internet; creating short narrative movies; downloading foreign language podcasts; using GPS to identify locations, and transferring files between school and home. The university team used broad ethnographic approaches. Data collection included documents, observations (with video), conversations and samples of digital products created by students and teachers. A baseline student survey of use and attitudes was constructed with one of the teachers and shared across all sites. A second survey, building on the first, was developed by the university team during the project in light of the data coming in from each site. (Survey and interview)	School heads and parents were supportive of the project, and in fact some parents asked why their students were not involved. In every case, other teachers became interested and involved, and the project teachers decided to continue using mobile phones. These champions of change have shown that, with good planning and anticipating class management and technical issues, <i>using mobile phones can be a very productive way to augment access to tools for computing, communication and photography</i> . As one student said 'It is good to use new technologies. It prepares us for the future as we will be using mobile phones more and more.' "It is clear that whilst prior to the project only 12% of all students thought the phones could be used for specific learning activities, after some involvement, this proportion increased to over 42%. " (p13)
Assessing the	2008	The project explored the attitudes of 16-18 year olds with Not in	The findings help to: better understand the potential of the technology

potential of e-learning to support re-engagement amongst young people with NEET status		Education, Employment or Training (NEET) status towards technology and its potential to support their re-engagement in learning which includes formal education and/or training. The evidence base for this study consisted of 53 young people interviews, 305 questionnaire returns, 50 key informant interviews, 21 training provider interviews, and a range of case study data. (Mixed methods survey, interviews, case study)	to re-motivate these young people after they have disengaged from education; explore the reasons why they have left education, and whether or not they have any intention of going back; gauge their attitudes towards technology generally; and explore what they think about the prospect of technology-based learning. "The findings of this study indicate that there is a clear case that ICT has a place in supporting young people 16- to 18-years-old who are NEET. However, the development of the implementation of appropriate support practices will not be simple." (p6)
Benefits and issues of managed services	2008	This project researched the efficiency and effectiveness of ICT provision through managed services, including offsite solutions, for the schools and FE and skills sectors. Efficiencies included financial, reliability, availability, response and fix times, time savings and benefits for teaching and support staff. The research had five main aims: to create a strong evidence base of the benefits and issues associated with a managed service approach; to identify the drivers for change and how the barriers have been overcome; and to highlight efficiency savings, either quantitative or qualitative. (Mixed methods: survey, case study; cross-case analysis – progressive focus)	"More comprehensive managed services, where most or all ICT provision had been outsourced, had the greatest positive impact on staff and learners and had made a greater contribution to the development of the establishment's e-maturity." (p4) "Increased reliability leads to greater staff confidence in ICT which in turn gives an increased willingness to embed ICT in everyday practice. <i>This has led to both efficiency gains for staff and a wider range of experiences for learners.</i> " (p4) " <i>Many sites identified improved learner confidence in ICT as a key benefit.</i> This often corresponded with the introduction of the managed service. Whilst the managed service is not totally responsible for the improved learner confidence, it is an important element in driving the confidence needed to make best use of this investment." (p5) " <i>Most sites reported an increase in the adoption of e-learning as a result of more reliable and robust ICT.</i> They also reported better facilities resulting from capital investment associated with the handover to managed service." (p5)
A review of the evidence on the use of ICT in the Early Years Foundation Stage	2008	This review, commissioned by Becta and carried out by the Early Childhood Research Unit at the University of Warwick, looks at the benefits, opportunities and risks associated with technology use by young children, parents and practitioners in the Early Years Foundation Stage. (Narrative literature review)	Young children aged from birth to five years are growing up in media-rich digital environments in which they engage actively from a very early age. Family members are positive about this and actively promote the use of new technologies through social-cultural practices in the home. Early Years practitioners are also generally positive about the role of electronic media and ICT. However, not all practitioners are fully confident in using ICT. Nor are they always able to use ICT to contribute to children's learning or see how this can be integrated into the EYFS curriculum. Technology can contribute to three main areas of Early Years learning: <i>developing dispositions to learning that thread through personal, social and emotional development and across the EYFS in general extending knowledge and understanding of the world in the broadest</i>

			<p><i>sense of communication, language and literacy, problem solving, reasoning and numeracy, and creative development acquiring operational skills.</i></p> <p>However, the full benefits are only realised when young children's use of technology is mediated, guided and focused by an appropriately trained adult.</p>
Learners and technology: 7-11	2008	<p>This research project aimed to facilitate the 'learner voice' of Key Stage 2 pupils with regards to their use of technology for learning. Data was collected from 612 pupils. Pupils' engagement with technology was, on the whole, found to be unsophisticated in nature. The nature of engagement was influenced significantly by pupils' age and school attended. The research was conducted in five primary schools in the London and West Midlands regions of England, selected to force variation in terms of pupils' ethnicity, geo-demographic and socio-economic factors. These schools included two inner city schools and two suburban schools in London, and one school in a small town located in the West Midlands.</p> <p>(Mixed methods approach: questionnaire, interviews drawings)</p>	<p>There was a strong sense throughout our data of pupils' uses of technology being constrained by the nature and demands of the school. That said, the majority of children did feel that technology use led to gains in learning, especially in terms of finding things out and other forms of self-directed learning. Notably these perceived learning gains were felt to apply equally to in-school and outside-school use of technology. Pupils' visions for changes in school technology provision mostly concerned the direct transfer of 'home' ICT devices and practices into the classroom. ...<i>pupils were most likely to indicate that they felt they were learning from school and home ICT use in terms of finding out new things, learning to make and create things, and doing other things that they could not do before. Pupils were less likely to indicate that they felt they were learning from school or home ICT use in terms of maths, revising for tests or learning to read...</i> (p19)</p>
Emerging technologies for learning	2008	<p>'Emerging technologies for learning' aims to help readers consider how emerging technologies may impact on education in the medium term. The publications are not intended to be a comprehensive review of educational technologies, but offer some highlights across the broad spectrum of developments and trends. It should open readers up to some of the possibilities that are developing and the potential for technology to transform our ways of working, learning and interacting over the next three to five years.</p> <p>(Expert review)</p>	<p>This latest edition (March 2008) complements volume 2 (2007) and the original publication from 2006. Includes the following chapters: Growing up with Google - what it means to education (Diana Oblinger, EDUCAUSE); Mobile, wireless, connected - information clouds and learning (Mark van't Hooft, Kent State University); Location-based and context-aware education - prospects and perils (Adam Greenfield, NYU); Emerging trends in serious games and virtual worlds (Sara de Freitas, SGI); 'If it quacks like a duck...' - developments in search technologies (Emma Tonkin, UKOLN); Interactive displays and next generation interfaces (Michael Haller, Upper Austria University of Applied Sciences)</p>
Meeting their potential	2008	<p>This literature review, commissioned by Becta and carried out by Citizens Online, looks at the evidence surrounding disadvantage and educational under-achievement. The review explores how the use of ICT, in education and beyond, can contribute to raising the attainment and aspirations of disadvantaged young people.</p> <p>(Literature review)</p>	<p><i>Access to and use of technology is not equal across socio-economic groups but simply providing technology to a disadvantaged young person, or using ICT within a traditional pedagogy, is unlikely to succeed in alleviating disadvantage or increasing aspirations and attainment.</i></p> <p>Personalised learning shows considerable promise in helping disadvantaged pupils by enhancing confidence and promoting positive attitudes towards learning but the right context is needed –</p>

			<p>teacher training and pedagogy, parental support and a flexible and creative approach to curriculum materials.</p> <p><i>A number of initiatives have used ICT to re-engage significantly disaffected learners with formal education and provide an alternative to the school environment and distance learning for traveller families.</i></p> <p>ICT can be used as a social and cultural tool for sharing information and experiences through peer-to-peer networking and communities of interest. This has been shown to benefit isolated rural young people. ICT can enable confidential support and advice. This is important when a young person faces challenges related to sensitive issues such as health, bullying and crime. These challenges are more likely to be faced by disadvantaged young people, yet their lack of social and cultural capital means they are less likely to have access to this kind of information.</p>
1:1 access to mobile learning devices	2008 (Interim)	<p>Researchers from the University of Bristol are investigating the educational impact of personal access to mobile learning devices at Key Stage 2 and Key Stage 4 in five schools. This development and research project is using mixed methods to evaluate the impact of using personal digital assistants (PDAs) on learners' learning skills, attendance, behaviour and attainment. It will also review the success of the implementation and sustainability of the schools' PDA initiatives and provide examples of emerging good pedagogic practice. The final reports from the project will be available in autumn 2008. (Mixed methods evaluation)</p>	<p>Interim – January 2008</p> <p><i>“We have as yet no hard measurable evidence of a possible impact on attainment of mobile device use since our sample students will not have end-of-key stage formal assessment until summer 2008. However, we are gaining indications from teachers who have looked at end of Year 5 outcomes and Year 6 SATs results (for mobile device users not included in the research sample) which suggest a positive effect of device use on attainment. This research will follow up these indications when we have attainment data at the end of the school year 2007-08.”</i> (p9)</p>
Digital creativity and behavioural, emotional and social difficulties	2008	<p>The 'Using digital creativity to engage and motivate the hard to reach youngsters in behavioural, emotional and social difficulties' (BESD) schools' project is just completing its first phase. Researchers from Liverpool University have been working with teachers and pupils at New Rush Hall BESD school using computers, digital videos and cameras. The data they gathered has been shared with teachers at 10 other BESD schools around the country and the researchers have been visiting the teachers and sharing the data with them. The 'new' teachers are now using the creative software with youngsters and the researchers gathered data from pupils and teachers using video and interviews. (Mixed methods evaluation, qualitative analysis of impact)</p>	<p>Almost universally, pupils wanted to be involved in digital creativity activities. Previously disengaged pupils were proud to present their work to peers, teachers and parents. <i>Some otherwise disengaged learners were attracted back into achieving formal educational outcomes.</i> This was the result of taking part in activities that tapped into their personal interests. Pupils with difficulties that affect concentration and attention span (for instance, Attention Deficit Hyperactivity Disorder - ADHD) <i>showed increased persistence and concentration</i> when engaged with digital creativity activities. <i>Headteachers reported increased attendance</i> in classes where pupils were involved in digital creativity activities.” (p4)</p>
Survey of FE learners and e-	2008	<p>This study involved a large-scale survey of Further Education college learners, exploring their experiences of and attitudes</p>	<p>Around three-quarters of learners feel quite or very confident in using technology for a wide range of tasks, although this varies according to</p>

learning		towards using technology within their current programmes of study, and also their access and use of technology for leisure purposes. (Survey)	age and gender. Over eight in ten learners have access to a computer at home, with the overwhelming majority also having internet access (usually via broadband). Around one-third of learners without home computer access do not ever use computers at college. 62% of learners state it is essential to use a computer on their course to learn about the subject. They use technology most frequently for researching and presenting work, and less often for communication or group working. Only a minority are required to use a virtual learning environment (27%), e-portfolio (20%), or computer-based tests that count towards the final course mark (30%). <i>The majority of learners feel computers give them more flexibility (66%), improve subject understanding (59%) and lead to better performance in assessments (65%), although there is still a strong preference for face-to-face learning.</i>
The DCSF Primary Schools Whiteboard Expansion project	2007	The Department for children, schools and families (DCSF) Primary Schools Whiteboard Expansion project (PSWE) provided substantial funding to 21 local authorities in 2003-04 to support the acquisition and use of interactive whiteboards in primary schools. The research was carried out between September 2004 and December 2006 and involved the collection and analysis of a large body of quantitative and qualitative data, including surveys of teachers and headteachers, visits to schools and local authorities, and teachers' log of the interactive whiteboard use. The impact findings are based on an analysis of two substantial datasets: 4,116 pupils in Key Stage 2, in 172 classes, in 97 primary schools, in 20 local authorities in England. 3,156 pupils in Key Stage 1, in 160 classes, in 96 primary schools, in 20 local authorities in England. The analysis took into account pupils' gender, term of birth, eligibility for free school meals and Special Educational Needs status. (Mixed methods evaluation including the use of multi-level modelling for attainment differences.)	"The interactive whiteboard has been welcomed enthusiastically by a large number of primary teachers and its take-up in schools has proceeded with unprecedented rapidity. ... Pupils are universally enthusiastic about the interactive whiteboards, because of their clear visibility..., the easy access they give to ICT through touch, and the added variety they bring to lessons. <i>There is a consistent finding across all data that the length of time pupils have been taught with an interactive whiteboard is the major factor that leads to attainment gains. This appears to be the result of the interactive whiteboard becoming embedded in teachers' pedagogy: that is, when teachers have had sustained experience (around two years) of using an interactive whiteboard, they are able to change their teaching practices to make best use of its facilities. The qualitative data strongly support this.</i> " (p4) <i>This study measured the effects of exposure to teaching with the interactive whiteboard for longer than previous studies (a mean of 16.2 months at Key Stage 2 and 13.4 months at Key Stage 3), giving an unprecedented picture of the impact of the technology over time. In certain subjects, the more experience the teacher has of using the interactive whiteboard, the greater the likelihood of positive attainment gains for pupils: In Key Stage 2 maths, average and high attaining boys and girls who had been taught extensively with the interactive whiteboard made the equivalent of an extra 2.5 to 5 months' progress over the course of two years. There was less effect on progress for boys and girls of low prior attainment.</i>

			<p><i>In Key Stage 2 science, 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.</i></p> <p><i>In Key Stage 2 English, the presence of an interactive whiteboard does not appear to have a significant effect on attainment, though further investigation with larger data sets is required.</i></p> <p><i>In Key Stage 2 writing, boys with low prior attainment made 2.5 months of additional progress.</i></p> <p><i>At Key Stage 1, there are indications of attainment gains once teachers have embedded use of the interactive whiteboard in their practice. In particular:</i></p> <p><i>In Key Stage 1 maths, high attaining girls made gains of 4.75 months, enabling them to catch up with high attaining boys.</i></p> <p><i>In Key Stage 1 science, there appears to be improved progress for girls of all attainment levels, and for average and high attaining boys.</i></p> <p><i>In Key Stage 1 English, average and high attaining pupils benefit from increased exposure to interactive whiteboards. However, there is little effect on progress for low attaining boys and girls.</i></p>
Harnessing Technology Review 2007	2007	The use of ICT by teachers has continued to grow, both in schools and FE (Further education) colleges. Educational leaders are planning further investments in technology to sustain existing provision and to keep pace with changing priorities and educational needs. (‘Strategy-level’ review)	<p>Improvements in connectivity and access to the internet in both schools and colleges has given practitioners increased confidence to use the technology live in the classroom. Schools make extensive use of electronic attendance and registration systems and evidence shows they reduce both unauthorised absences and administrative time. Schools are beginning to appreciate the improved effectiveness and reduced costs that can result from these systems. However few have achieved full integration of their curriculum and administration systems, and there is still considerable potential for further gains by using ICT to support information management and assessment. Building e-maturity continues to be a challenge both to schools and the FE and skills sector, and there is wide variation in its development. <i>Achieving the benefits of learning platforms, and their integration with management information systems, is still some way off for the majority of schools and colleges, and they require ongoing support in recognising and realising these benefits.</i> Schools are beginning to provide remote access to their networks from for staff and pupils. In secondary schools and FE colleges, learning platforms give practitioners and learners access to growing repositories of digital resources, increasing the range and quality of materials available. In the FE sector, there is a noticeable increase in remote access to learning. This suggests a trend to allow learners access to</p>

			<p>their programmes at a time and place to suit them. However the primary function of learning platforms continues to be as repositories for course materials and resources. The idea of using ICT, at least in some part of the teaching and learning process, is now commonplace in most schools and colleges. Teachers and lecturers prepare lessons using ICT, exploit presentation software and word processing and many expect students to access and use online resources and course documents. Few practitioners, however fully exploit the possibilities for learning and teaching offered by technology. Some use of technology to support personalised learning is evident, this is at an early stage. Technology is most often used to 'push out' resources and the opportunity for learners to choose their own pathways through them is rarely offered.</p>
Harnessing Technology local authorities survey 2007	2007	<p>The Harnessing Technology local authorities survey is an annual survey of the support of ICT in education by local authorities in England and overseas territories (Guernsey, Jersey and the Falkland Islands). It aims to understand the extent to which, and way in which, local authorities support the use of ICT in schools. It also sheds light on what challenges local authorities encounter in this, and what assistance they would require in helping deliver the objectives of the Harnessing Technology e-strategy. The 2007 survey, which was the first survey of this kind, was conducted on behalf of Becta by NatCen (the National Centre for Social Research). Data was collected via an online survey from February to April and the survey yielded a particularly high response rate of almost 50%. Due to its nature, the survey is quite wide, but focuses on the following three key areas: leadership and policy; resources and organisation; support and development. (Survey)</p>	<p>Main findings include the following: Three quarters of local authorities (74%) reported having a strategy in place; of the remaining quarter, almost all (24%) indicated planning one. Of local authorities having a strategy, nearly all indicated this incorporates the Every School Connected initiative (broadband) (98%), Learning Platforms (95%) and an online learning space for every child (91%). Responsibility for co-ordinating and monitoring the provision of technical support services was shared between the local authority and schools in approximately half of local authorities (47%). Nine in ten local authorities reported that their Management Information Systems were integrated with the systems in their schools. 37% of local authorities run an integrated learning platform for all schools, while 21% run this for some schools. In three quarters of cases (73%), local authorities reported that they acted as aggregators of demand for schools wishing to purchase ICT equipment and services. Almost all local authorities (97%) provided schools with advice about their ICT infrastructure. Respondents were asked whether their local authority provided an area-wide e-portfolio system for learners to record their progress. A third of local authorities currently had such a system for at least some learners (33%). In order to share effective ICT practice amongst schools local authorities most commonly used special events (83%), websites / intranet (80%) or cluster meetings (79%).</p>
Impact 2007: Personalising learning with technology	2007	<p>The Impact 2007 study looked at the ways 67 primary and secondary schools used technology and how this influenced the personalising learning process and its outcomes. (Mixed methods approach including survey, case study and the</p>	<p>The study found that: <i>e-maturity is linked to higher school performance and also to greater 'investment in learning' (work ethos, self-efficacy, motivation, engagement, behaviour, etc.) by pupils.</i> Investment in learning is a</p>

		use of multi-level modelling to identify patterns of association)	crucial factor in pupil and school performance. <i>There is a relationship between e-maturity and school performance in Key Stage 3 Maths and science, and GCSE Level 1.</i> Teachers believe that ICT is strongly associated with personalising learning. They are committed to the personalising learning agenda, although many find it difficult to put this concept into practice. ICT is strongly embedded in the majority of teachers' practice. Over two-thirds of teachers reported that either their laptop or interactive whiteboard was now an essential tool for them. Pupils' experiences of the personalising learning process, at primary and secondary level, were associated with greater opportunities to use ICT.
Wireless networks in schools survey	2007	Becta purchased questions on an online survey run by C3 Education about wireless technology in schools. The survey was sent to a profiled selection of members of C3 Education's National Education Research Panel (Nerp). The Nerp is a pre-selected panel of schools across England that includes a mix of schools of different sizes, location and technology maturity. The online questionnaire was conducted in March 2007. Although not necessarily nationally representative, the survey below does provide some useful additional detail about wireless networks in English schools. (Survey)	"The most popular reason for implementing wireless was to support the use of ICT in classrooms other than ICT suites (81 per cent primary and 66 per cent of secondary schools)." (p3)
Harnessing Technology schools survey 2007	2007	The Harnessing Technology schools survey is an annual, nationally representative survey intended to assess the uptake of ICT in schools across England. It aims both to give a broad overview of the 'state of the nation' of use of ICT in the school sector and explore, and further clarify, what it means for educational institutions, notably schools, to be 'e-mature'. The focus of the survey is particularly wide, with topics including ICT leadership, infrastructure and (effects on) learning and teaching. The 2007 survey, which followed on from the Evaluation of Curriculum Online: Report of the third survey of schools (2005), was conducted on behalf of Becta by the National Centre for Social Research (NatCen). It employed questionnaires for three target groups (school leaders, ICT co-ordinators and subject teachers) and data collection ran from November 2006 to January 2007. (Survey)	Main findings include the following: The infrastructure (devices, network, connections) to facilitate full use of ICT in education seems to develop at a steady pace in most schools. Computer : Pupil ratios seem to plateau, and at most schools, satisfaction with quantity of devices is higher than before. Where schools invest in new devices, investment seems to focus on laptops rather than desktops, possibly indicating a wider shift towards more 'mobile technologies'. Interactive whiteboards are in place in almost all schools (98% of secondary and 100% of primary schools); they are intensively used and, on average, highly rated by teachers on fitness for purpose. Learning platforms are climbing the adoption of innovation curve, albeit quicker in secondary schools (present in 46% of schools) than primary schools (present in 11%). As many schools prioritise learning platforms for future spending (26% of primary and 57% of secondary schools), the adoption of the device nationwide looks likely to continue to grow. The diversity of application of ICT resources in classrooms is relatively limited. ICT is mostly used for whole class activities,

			possibly referring to the use of the interactive whiteboards, and for traditional purposes such as information gathering. Only a minority of teachers encouraged the use of social software by their learners. The use of e-assessment and e-portfolios is still fairly limited in many schools. Where e-portfolios are used, they are often not used for all learners. The majority of teachers feel that the use of ICT in the classroom positively impacts on the engagement / motivation and achievement of their learners. <i>Perceived impacts are slightly greater for boys than girls, and slightly higher for engagement / motivation than achievement.</i> A majority of teachers believe that use of ICT resources save, rather than cost them time; the interactive whiteboard is particularly mentioned as a time saving device.
Impact of e-portfolios on learning	2007	Becta commissioned researchers from the Learning Science Research Institute, University of Nottingham, to investigate the impact that e-portfolios can have on learners in schools, further education, higher education and work-based learning. Case studies of eight e-portfolio projects were created from document analysis and interviews and surveys of learners and teachers. Findings relating to the impact of e-portfolio systems on learning outcomes and processes and commencing and sustaining e-portfolio development were drawn from cross case analysis. (Case studies: interviews and qualitative analysis)	Key findings: <i>e-portfolios benefit learning most effectively when considered as part of a joined-up teaching and learning approach, rather than as a discrete entity.</i> The approach should include online repositories, planning and communication tools, and opportunities for both students and teachers to draw out and present e-portfolios at particular times and for particular purposes. There is then likely to be substantial impact on both learning processes and learning outcomes. <i>e-portfolio processes support both pastoral or social needs and curriculum outcomes</i> <i>e-portfolio processes and tools for organisation and communication support the learning outcomes of students with a wide range of abilities</i> <i>e-portfolios make progress and attainment more obvious to both teachers and students, because viewing and revisiting the repository of work reveals development, achievements, strengths and weaknesses</i> Some learners in all age ranges find that software that includes structured processes and organisational tools scaffolds their learning until they are confident enough to progress to working independently
Impact of ICT in schools: a landscape review	2007	Becta commissioned researchers from the Quality in Education Centre, University of Strathclyde, to review the literature on ICT in schools to build a 'big picture' of the impact ICT has had across the schools sector in the UK. The review looked at the evidence of the impact of ICT across all areas of school life, including teaching and learning, attainment, personalisation, home-school links, administration and management. Although the evidence of impact is inconsistent across schools,	Teachers' ICT skills have developed significantly over the years, as has the range of both hardware and software available in the classroom – there is evidence that these developments have led to a reduction in teachers' workloads. ICT can help personalise learning by putting greater control in the hands of the learner, but the challenge this presents to the traditional teacher-pupil relationship may not always be welcomed. A whole-school strategy that addresses the development and sustainability of ICT is a critical factor in the

		<p>subjects and technologies, the introduction of ICT is seen as a positive development by the majority of both teachers and learners. Key findings include:</p> <p>The greatest impact on teaching and learning is found where the use of ICT has clear educational goals and is seen as purposeful by pupils, and where a number of different technologies are integrated in everyday classroom experience.</p> <p>(Systematic literature review)</p>	<p>effective use of technology.</p> <p><i>“There are few studies that attempt to discern a direct, causal relationship between ICT use and attainment, although many identify improved attainment as one of a number of outcomes of increased ICT use. Unfortunately, it is not always clear how attainment is defined or measured in some of the research reports. In some, ‘attainment’ refers to performance on standardised tests while in others, the definition is broader and impact relates to observed improvements in pupils’ understanding within specific subject areas, that is, domain-specific cognitive development.” (p22)</i></p> <p><i>“Overall, the evidence on the impact on attainment of learning through ICT remains inconsistent, however.” (p23)</i></p>
Evaluation of the ICT Test Bed project	2007	<p>Final report of the Evaluation of the ICT Test Bed project. It provides key evidence for policy-makers on the impact of providing very high levels of ICT to schools and FE colleges on: teaching and learning; leadership and management; workforce development; cross-cluster relationships; and home and community links. Its aim was to see to what extent high levels of ICT resources could enable schools and colleges to change the life chances of children and young people in areas of relative socio-economic disadvantage. (Mixed methods: performance data analysis; case study, action research)</p>	<p>As technology was embedded, schools’ national test outcomes improved beyond expectations.</p> <p>The impact of ICT on attainment levels was greater for primary schools than for secondary schools.</p> <p>Effective use of presentation technologies led to greater interaction between teachers and learners.</p> <p>Effective use of ICT personalised learning by enabling greater learner choice within the curriculum, improved assessment for learning and more learner-directed teaching.</p> <p>Technology facilitated more effective assessment for learning by making it easier for learners to be more involved in target-setting and for teachers to give individualised feedback.</p> <p>The use of electronic registration improved attendance levels in some schools by three to four per cent, while behaviour management systems were perceived to have a positive impact on both behaviour and attendance, prerequisites for effective learning.</p> <p>To enable learners to get the maximum learning benefit from using the internet, internet protocols that safeguarded learners’ welfare without being overly prohibitive were required.</p> <p>Some changes to teaching and learning strategies were inhibited by tensions between the priorities of different government policies and agencies with regard to ICT. (p 6)</p>
Study of Thin Client technology in schools	2006	<p>Becta commissioned KPMG LLP to conduct research into the use of Thin Client technology in schools. Two reports are available. The aim of the research was to provide insights into the use of Thin Client technology in schools for the benefit of education professionals and policy makers. In particular the</p>	<p><i>“Apart from ICT skills, no schools were able to point to specific improvements in attainment as a result of implementing the Thin Client technology, though Ofsted had reported favourably on some of the schools’ practice and outcomes in relation to ICT. However, the specific benefits identified below such as motivation, independence of</i></p>

		research looked at the functionality, benefits, issues, impact on learning and teaching and the Total Cost of Ownership (TCO) of Thin Client technology. (Case study approach)	<i>the learner and more flexibility in learning will have a positive impact on pupils' learning generally."</i> P 40
Managing ICT costs in schools: report	2006	Becta undertook work with 43 schools between 2002 and 2005 in a series of projects which focused on the total cost of ownership (TCO) of ICT. The projects highlighted how knowledge of the full costs of ICT can support management investment decisions. (Survey)	The findings include: The annual TCO of ICT (including hidden costs) averaged around £50,000 for project primary schools and around £270,000 for project secondary schools. The average annual TCO per PC was around £1,200 in the primary schools and around £1,000 in the secondary schools. The annual average TCO per pupil was around £195 in the primary schools and £246 in the secondary schools. The total costs per PC and the cost of individual elements varied greatly between schools "The cost of user self-support remained hidden in many cases as it was never recognised by the school, for example as a charge or invoice from a supplier. <i>Salaried time spent on technical support tasks is an indirect cost to schools and may have an impact upon the quality of teaching, learning and overall achievement."</i> (p5)
Educational change and ICT	2006	This research explores priorities 2 (Integrated online support for children and learners) and 3 (A collaborative approach to personalised learning activities) of the DfES e-Strategy, Harnessing Technology. The findings' section of the report focuses on some 'solutions' implemented by schools and colleges that could support Priorities 2 and 3 of the DfES e-strategy. The 'key implementation issues' section of the report focuses primarily on the importance of 'management of change' issues in relation to the implementation of the DfES e-strategy. The report also suggests areas where further research and development are needed. The report is based on research conducted in late 2005/early 2006. (Expert and stakeholder review; literature review; interviews)	<i>"There was little empirical evidence in the interview data of the impact of ICT on learning outcomes, a finding which reflects the current research literature. Reasons for this include the time scales needed for any impacts to become 'measurable' and the mismatch between the methods being used to determine impacts and the changes that ICT facilitates."</i> (p5)
Becta Review	2006	The Becta Review series presents findings from recent large-scale surveys and research studies with the aim of assessing the progress of ICT in education at a national level. It identifies key challenges to address in making further progress. The reviews have been published annually in 2005 and 2006 and seek to establish a picture of technology provision, practice and impact in the schools and learning and skills sectors at the time. The primary evidence and research sources used are drawn from: national statistics and large-scale and national-level surveys, such as the DfES survey of ICT in schools and the Becta survey	<i>There is a growing body of evidence that the use of ICT in education has a positive, if small, impact on learner attainment as measured in national tests. The ICT Test Bed evaluation, for example, found that technology deployment and use predicted an improvement in test performance relative to 'benchmark' comparators. (p5)</i> <i>"There is also impact evidence relating to home use of ICT in a study by Valentine et al., (2005). They found that home use of ICT for educational purposes was linked statistically with small improvements in children's attainment compared with expected targets in maths at Years 6 and 9. There was a modest but more</i>

		of ICT and e-learning in Further Education, including some international comparisons national and large-scale research studies of ICT implementation and use, including the evaluation of ICT Test Bed projects to evaluate national ICT programmes, such as the evaluation of Curriculum Online inspection data and reports from Ofsted systematic reviews of literature relating to ICT in education. The reviews cover schools and the learning and skills (post-16) sector, but excludes higher education and work-based learning. Due to issues of availability of evidence, the reports relates primarily to England. (Review and secondary analysis of data)	<i>extensive effect in English and maths at Year 11. However, substantial use of ICT for leisure purposes was statistically linked to a sizable decrease in attainment against expected targets. The researchers concluded that it is not access to, or general use of ICT per se that will affect attainment, but rather how the technology is used.” (p46)</i>
Evaluation of the Framework for ICT technical support (FITS)	2006	In December 2002 the Department for Education and Skills (DfES) asked Becta to set up an advisory service to improve the quality of technical support provision in schools. A programme of consultation and development was carried out and the Framework for ICT Technical Support (FITS) was launched on the Becta website in September 2003. FITS is based on the industry best practice standard - IT Infrastructure Library (ITIL) - and is a toolkit of advice, checklists and downloads relevant for schools of any size or ICT proficiency. (Mixed methods: survey, interviews)	The most successful schools believed that it [FITS] is already encouraging greater use of technology in teaching and learning and will continue to do so since it frees up time to discuss teaching and learning needs; it improves overall communication between teachers and technical support staff, leading to a better understanding of user requirements. Teachers also have more confidence in the reliability of equipment, or that the technicians will resolve any issues quickly if they arise. <i>Ultimately, this will improve school performance and inspection outcomes.</i>
Curriculum Online: four year evaluation	2006	This final report summarises qualitative and quantitative findings from the four year evaluation of the Curriculum Online programme. The report contains findings relating to the operational effectiveness of Curriculum Online and the programme's impact on industry and teaching, learning and leadership. (Survey and qualitative interviews and analysis)	<i>“ICT was perceived by the majority of subject leaders to have positive educational impacts on attainment and the capacity to respond to different pupil abilities. Teachers and pupils referred to how digital materials could be used to appeal to a range of learning styles and support independent learning.” (p 19) “Teachers mostly found it difficult to say to what extent the use of digital materials had affected attainment, but often said that although it was not possible to prove that use of digital materials improved attainment, they believed that it did make a significant contribution.” P 19</i>
ICT and e-learning in Further Education	2006	Becta carried out this study in January and February 2006 on behalf of the Learning and Skills Council. This study is the seventh in a series that assesses progress in the provision of ICT within the further education (FE) and sixth-form college sector since 1999, along with the extent to which this provision is integrated into the teaching and learning process (e-learning). (Survey of 122 FE Colleges)	“There is evidence that some colleges use ICT to personalise learning. Some learning platforms offer basic personalisation features, and some colleges make use of e-portfolios for managing evidence of learning.” (p3) “ICT remained more widely used for learning support and independent learning than for formal delivery.” (p5)
Computer Games in Education	2006	This report summarises research commissioned by Becta to explore how games developers design their products to engage and motivate players. The report includes recommendations for	Games development processes are more formalised and structured along generally accepted project management principles than the popular image of games developers implies. There are clear

		<p>increasing dialogue between the education and games sectors based on the findings. (Qualitative interviews with games developers)</p>	<p>similarities between the processes and roles utilised by both games developers and education developers. Having a strong knowledge and experience of playing and examining games is an important part of creating and refining new games. The product design of games-based learning should include developers with a good knowledge of games. In creating products which are engaging and motivating, games developers see factors such as celebrity licences and good marketing as just as important as good software design. The role of these 'entertainment' factors needs to be accounted for when assessing the potential value of games-based approaches for learning. While there are important factors in games (such as cutting-edge graphics) that involve high development costs, there are other factors which rely more on experience and skilled design than access to expensive resources. These factors include techniques for structuring goals and rewards to create positive feedback loops which can increase motivation and engagement.</p>
Learning Activity Management System (LAMS) Specialist Schools Trust pilot review	2006	<p>During 2004 and 2005 the Specialist Schools and Academies Trust (SSAT) piloted the use of the Learning Activity Management System (LAMS) with a small number of members. Becta reviewed the pilot using workshops, questionnaires, visits and interviews. (Mixed methods: workshops, questionnaires, visits and interviews)</p>	<p><i>Links between attainment and using LAMS were explored from staff perspectives; the short scale of the pilot did not allow the examination of longitudinal data or other quantitative methods.</i></p> <ul style="list-style-type: none"> • <i>Most staff reported that LAMS could impact positively on attainment.</i> • <i>Some were unwilling to commit an opinion, citing the small scale and duration of their LAMS use. (p8)</i>
Interactive whiteboards in primary schools pilot study	2005	<p>In 2002 the DfES commissioned the University of Newcastle to conduct a two-year research study to evaluate the 'Embedding ICT in the Literacy and Numeracy Strategies' pilot project. This project involved the installation and use of interactive whiteboards (IWBs) in Year 5 and Year 6 classes in 12-15 schools in each of six selected LEAs. Between autumn 2002 and summer 2004 the research team investigated a number of areas, including: a quantitative study of how IWB use affected the nature of classroom interaction, teacher and pupil perceptions of the technology uses of IWBs to teach literacy and numeracy changes in patterns of IWB use over time the impact of IWB use on pupils' attainment, as measured through their performance in national Key Stage 2 tests (results from 67 IWB schools and 2,800 pupils compared with matched comparison group). (Mixed methods evaluation: survey, online logs,</p>	<p>The introduction of the technology, training in its use and the support of the IWB consultants were all rated highly. There can be no doubt that the introduction of IWBs had a real impact on the primary classrooms where they were introduced. The response of the teachers and pupils involved in the project has been overwhelmingly positive. Both were convinced that these changes were improving the teaching and learning in lessons where they were used. <i>The observations confirm that there were significant differences in patterns of classroom interaction</i>, both as the teachers learned to use the technology and a year later as IWBs became more embedded in literacy and mathematics lessons. The indications from these observations also suggested that the changes in questioning by the teachers and the responses from their pupils were consistent with the kinds of interaction associated with effective teaching. <i>However analysis of national test data at first suggested that the impact of the</i></p>

		interviews, structured classroom observations, analysis of attainment data)	<i>introduction of IWBs was associated with small improvements in children's learning in mathematics and science. These gains were not found in the second year, suggesting that the early improvement was due to the initial intervention or that sustained improvement is harder to achieve, especially in high performing schools."</i> (p3)
Impact of broadband in schools	2005	The study is based on sources of information such as quantitative data of broadband usage drawn from Regional Broadband Consortia (RBC) and Local Education Authorities as well as data from a more representative sample of schools. Where possible the impact of broadband on standard performance data was investigated in addition to staff surveys and interviews with headteachers. A limited number of individual school case studies were also carried out. Such reliability has led to increased confidence in the technology for all users and in turn to widening and deepening of participation as multiple users can be connected at any one time without adversely affecting speed of access. In essence a broadband level connectivity allows technology to become embedded throughout a school, and leads to significant efficiency gains and interesting changes in working practices of both staff and pupils. (Mixed methods: usage data, survey and case studies)	The study showed that there are fewer instances of broadband-dependent activities (e.g. video conferencing). This is partly explained by the fact that many of the schools were in the first year of working with the increased level of connectivity and were yet to understand its potential. However, a second and equally interesting finding emerged, and this concerned the embedding of the technology into classrooms. Teaching and support staff and pupils have commented on the increased reliability and capacity of a broadband supported classroom. These two characteristics jointly increase the quality and quantity of educational activities that can and are being undertaken. <i>At GCSE, significant differences were evident in pupils' performance on GCSE/GNVQ tests, with significantly improved performances in the year immediately following the installation of broadband. This finding should be treated with caution due to small sample size. No significant effects on nationally accessible performance data were found at KS2.</i> (p7) The ICT skills base for both staff and pupils continues to improve and competence and confidence in ICT usage is increasingly pervasive throughout the schools. <i>Multimedia and interactive content is engaging and motivating, particularly for primary pupils.</i> Use of such material in primary and secondary institutions adds variation to lessons and helps to keep pupils focused by seamless transition from ICT to non-ICT activity, and from website to website. <i>For many secondary schools broadband is enhancing learning by being an additional tool to aid research.</i> A number of case studies and the questionnaire responses record enthusiasm of both staff and pupils for activities that use the technology. (p8)
Research into the use of ICT and e-learning for work-based learning in the skills sector	2005	While computer-based training has been around for two decades, its uptake by employers has been patchy. However, with the now-ubiquitous nature of information and communications technology (ICT) and e-learning, government, employers and training providers are increasingly recognising that it has an important role to play in developing and maintaining the skills required by the workforce. This research - commissioned by Becta and funded by the Learning and Skills	<i>Providers report that the major benefits associated with using ICT and e-learning are related to increased learner satisfaction and improved outcomes.</i> This supports our anecdotal evidence that many providers are implementing e-learning to provide a better quality learning experience for learners and to respond to learner expectations. However, only one quarter of providers report cost benefits from using ICT and e-learning, which has significant implications for its sustainability. <i>In addition, 30% are unsure of the</i>

		Council (LSC) - focuses on publicly funded small and medium-sized enterprises (SMEs) and the public sector. It describes developments and identifies how to best use the opportunities offered by new technologies to improve the effectiveness of learning in the workplace. (Literature review; stakeholder interviews; 5 case studies)	<i>effectiveness of the e-learning they are delivering. (p5)</i>
Tablet PC Evaluation	2005	Becta commissioned The Open University to conduct research on the use of Tablet PCs in Schools. The research examined the use of Tablet PCs in schools, both in learning and teaching, and school management. The research also considered the differences in use and benefits of Tablet PCs compared with other technologies such as laptop and handheld computers. The research focused on primary and secondary schools in England. (Small scale case study of 7 schools.)	The key findings emerging from the case studies were that Tablet PCs: <ul style="list-style-type: none"> • increased the amount of ICT use and the degree of integration of ICT across the curriculum... • <i>increased motivation, and hence were likely to have a positive impact on learning outcomes</i> • <i>supported moves to more independent and collaborative study (p3).</i>
Video Conferencing	2005	The reports presents findings from an evaluation of the project over the period of approximately a school year. The study, commissioned by the DfES, explores the relationship between the use of video conferencing technologies and their impact (both actual and potential) on pupils' attainment and attitudes to school, and on teachers' practices. 28 schools mixed methods evaluation. (Mixed methods: literature review Interviews, observations of video, usage records case study with 12 schools (further observations & interviews))	<i>While teachers were generally unable to offer statistical evidence for performance gains, their judgements were that video conferencing impacted upon achievement positively.</i> <ul style="list-style-type: none"> • <i>Teachers and students acknowledged powerful learning effects as a consequence of a video conferencing session.</i> • <i>Video conferencing is, in the main, highly motivating to students and improvements in pupil behaviour occur during video conferencing sessions.</i> • Teachers had yet to explore the potential of video conferencing and how it might affect the way that they taught. (p42)
Barriers and enablers to teachers' use of ICT	2004	In 2003 Becta commissioned two literature reviews to identify the factors which hinder or promote the effective use of ICT by teachers. A review of the research literature on barriers to the uptake of ICT by teachers (PDF 423KB) This report brings together evidence from a range of sources on the actual and perceived barriers to the uptake of ICT by teachers. It draws on the literature associated with teachers' use of ICT, and also on a small scale survey of teachers conducted by Becta. It is published in conjunction with a companion report looking at the factors which enable teachers to make successful use of ICT.	Barriers: Key findings of this report include: Confidence, time and access to quality resources are major factors in determining teachers' engagement with ICT. Recurring technical faults, and the expectation of faults occurring during teaching sessions, are likely to reduce teacher confidence and cause teachers to avoid using the technology in future lessons. Resistance to change is a factor which prevents the full integration of ICT in the classroom. In particular, teachers who do not realise the advantages of using technology in their teaching are less likely to make use of ICT. There are close relationships between many of the identified barriers to ICT use; any factors influencing one barrier are likely also to influence several other barriers. For example teacher confidence is

		<p>Enabling teachers to make successful use of ICT</p> <p>This literature review seeks to identify the factors which are most effective in enabling and encouraging the uptake of ICT by teachers. It is a continuation of the work begun by Becta in the above report on barriers preventing teachers from making full use of ICT. The report aims to discover from the literature the recommendations that might assist schools and local and national support agencies to help teachers make better use of ICT in their classrooms. This includes both school based strategies - ways in which schools working independently can make successful classroom use of ICT more likely - and external enabling strategies - ways in which schools can draw on outside support to improve their use of ICT.</p> <p>(Literature reviews)</p>	<p>directly affected by levels of personal access to ICT, levels of technical support and the quality of training available.</p> <p>Enablers</p> <p>Key enablers identified in the literature include:</p> <ul style="list-style-type: none"> leadership and planning sharing of resources reliable technical support schools working with each other and with the local community differentiated training and continuous professional development for teachers participation in national ICT initiatives and projects.
Greenwich Millennium Primary School	2004	<p>This report represents a case study of the impact of significant investment in ICT at the Millennium Primary School (MPS), Greenwich. MPS is a pioneering new school, representing a practical demonstration of the Government's vision of the 'school of the future'.</p> <p>As a result of a DfES-funded infrastructure project carried out in partnership with the LEA, 'cutting edge' ICT was incorporated into the design of the school building. This project represents the Government's commitment to promote and develop schools with sophisticated ICT infrastructures to help improve standards and to encourage new ways of teaching and learning.</p> <p>This case study explores the effects which the investment in ICT had and captures some of the key events that occurred. It provides information that will inform future development and practice. This report contributes, therefore, to the growing body of research evidence surrounding the impact of ICT and illustrates the potentially positive effects ICT can have on teaching, learning and management of our schools.</p> <p>(Case study: mixed methods approach - questionnaires, semi-structured interviews and lesson observations. Some secondary data was also studied. A comparison school was identified for a</p>	<p><i>There was widespread acknowledgement that the ICT skills of both the staff and the pupils had increased.</i> High-quality training enabled most staff to rapidly develop their knowledge and skills and respond successfully to the many challenges of such significant ICT provision. ICT, particularly the provision of laptop computers to each member of the teaching staff, improved teachers' planning and reduced unnecessary duplication. The combination of laptop computers and interactive whiteboards has made planning high-quality lessons in advance very much quicker and easier. However, the workload savings have been offset by increases in the time needed to keep ICT knowledge current. The combination of high-quality software and readily available hardware meant that the integration of ICT to enhance teaching across the curriculum, especially numeracy and literacy, was particularly successful. The pupils reported high levels of computer usage. In particular, the internet was used frequently by over 70 per cent of pupils, compared with only just over 20 per cent from the comparison school. Also the use of interactive whiteboards, digital cameras, databases and spreadsheets was extensive. Observations and interviews with teachers identified that ICT was proving to be a dynamic addition to existing teaching resources. In particular, the visual impact and dynamic aspects of the interactive whiteboard were extremely effective in engaging pupils with, and</p>

		comparative analysis of questionnaire responses.)	promoting interaction within, lessons. <i>It was widely reported that ICT had improved pupils' motivation, concentration, confidence, self-esteem, communication skills and enthusiasm. In particular, pupils with special educational needs (SEN) had benefited. Tests introduced by Greenwich LEA to evaluate pupil ICT competencies revealed that 89 per cent of Millennium's Year 6 pupils were at National Curriculum Level 5, compared with only 11 per cent elsewhere in the authority.</i> Parents of pupils at MPS were extremely positive concerning the school's ICT provision and its impact on teaching and learning. The use of ICT to enhance home-school links, however, was in its early stages.
ICT and attainment	2004	In 2003 Becta commissioned two literature reviews on behalf of the DfES as part of the ICT and attainment project. Both studies were carried out by the same research team at King's College London. The literature reviews complement the ImpaCT2 project by considering the available research evidence on two related topics: the impact of ICT on attainment in primary and secondary schools, and the impact of ICT pedagogy on attainment in primary and secondary schools. (Narrative literature review)	<i>The evidence from the literature shows the positive effects of specific uses of ICT on pupils' attainment in almost all the National Curriculum subjects. The most substantial evidence is in the core subjects of English, mathematics and science at all key stages. Other subjects require further independent studies in order to substantiate the findings currently available. There is a strong relationship between the ways in which ICT has been used and pupils' attainment. This suggests that the crucial component in the appropriate selection and use of ICT within education is the teacher and his or her pedagogical approaches. Specific uses of ICT have a positive effect on pupils' learning where the use is closely related to learning objectives.</i>
ICT and pedagogy: a review of the research literature	2004	This review reveals evidence of teachers' uses of ICT, and thereby pupils' attainment, being influenced by teachers' pedagogical reasoning. (Narrative literature review)	<i>When teachers use their knowledge of both the subject and the way pupils understand the subject, their use of ICT has a more direct effect on pupils' attainment</i>
Digital video pilot project	2003	Between October 2001 and March 2002 Becta ran a Digital Video pilot project involving 50 schools from across the UK. The aim of the project was to gather evidence of the impact of digital video technology on pupils' engagement and behaviours, and to identify models of effective practice. Becta commissioned the British Film Institute to undertake an evaluation of the Digital Video pilot project. Their report looks at patterns of use and good practice in Digital Video, and considers how the technology has increased pupils' motivation, broadened access to the curriculum and has fostered both creativity and moving image literacy. The report contains key	<i>As a short-term study, the pilot did not measure how the integration of DV technology affected standard attainment measures. However, qualitative evidence from the teachers' own monitoring of the effects suggests that the use of DV stimulates and support the development of other skills, such as problem solving, negotiation, thinking, reasoning and risk-taking. Evidence gathered from the pilot also suggests that the integration of DV technologies into subject teaching does not automatically improve the quality of work or standards of attainment; high quality teaching remains the key factor in raising achievement... (p3)</i>

		findings, analysis, case studies and recommendations. (Case studies)	
Teaching and learning with digital video assets 2003-2004	2003	In 2003 Becta commissioned The University of Hull to undertake an evaluation of the Teaching and Learning with Digital Video Assets Project. The Teaching and Learning with Digital Video Assets Project was unique in that it sought to 'Investigate the potential of broadband connectivity to facilitate and promote the integration of digital video assets into subject teaching and learning'. The project investigated: how teachers and learners exploit digitally authored video assets to enhance learning and attainment; how the use of the technology affected learning and attitudes to learning; teachers' and pupils' experiences of rich-media resources for learning; the implications for the provision and management of the assets in schools. (Mixed methods: 'realistic evaluation' methodology (Pawson and Tilley, 1997), representative sample, in-depth case study)	<i>There is evidence to link the use of digital video and digital video editing to improved conceptual understanding in many subject areas. When pupils author with digital media assets, there is evidence to show that learning gains are transferred into other subject areas. This can result in attainment gains in certain areas. These gains are most noticeable in the area of literacy, where there appears to be an improvement in writing and speaking skills. (p9)</i>
ImpaCT2	2002	ImpaCT2 aimed to evaluate the progress of the ICT in Schools Programme. It was a major study carried out between 1999 and 2002 involving 60 schools in England and is one of the most comprehensive investigations into the impact of information and communications technology (ICT) on educational attainment conducted in the United Kingdom. ImpaCT2 was designed to: Identify the impact of networked technologies on the school and out of school environment Find out the degree to which these networked technologies affect the educational attainments of pupils at Key Stages 2, 3 and 4. The study involved three related strands: Strand 1: to develop and apply appropriate methods for evaluating the use of ICT in school and out of school, and to analyse the statistical relationship between the effective implementation of ICT and standards of performance in National Tests and GCSEs Strand 2: to develop and apply a variety of methods to establish how pupils use ICT, in particular out of school, and what is gained from such use. Strand 3: to explore the nature of teaching and learning involving ICT in various settings, with a focus on the views of	<i>The key findings from this strand of the study are:</i> <ul style="list-style-type: none"> • Differences in attainment associated with the greater use of ICT were clearly present in more than a third of all comparisons made between pupils' expected and actual scores in National Tests or GCSEs, though these were not large. • In none of the comparisons was there a statistically significant advantage to groups with lower ICT use. <i>Key Stage 2:</i> <ul style="list-style-type: none"> • A statistically significant positive association between ICT and National Tests for English was found at Key Stage 2. • Positive associations were also found for mathematics at Key Stage 2, although they were not as striking and not statistically significant. • It is possible on the basis of these findings to estimate that high ICT use at Key Stage 2 in English can help to raise performance by 3.12 National Test marks or 0.16 of a National Curriculum level, and in mathematics by 1.69 marks or 0.061 of a National Curriculum level. <i>This is equivalent to a substantial acceleration in progress through these levels of 16% of two years' achievement in Key Stage 2 English, and 6.1% of two years' achievement in Key Stage 2 mathematics.</i> <ul style="list-style-type: none"> • The general level of ICT use in Key Stage 2 English is the highest reported for any subject at any key stage in 2001: 61% of the pupils

		<p>pupils, teachers, and parents. (Mixed methods including quantitative analysis of attainment data and ICT usage, interviews surveys)</p>	<p><i>report using ICT in their English lessons at least some weeks (41% report using ICT at home for English at least some weeks). The equivalent figure for lesson use in mathematics is 47% (36% at home), and in science 24% (20% at home).</i></p> <p><i>Key Stage 3:</i></p> <ul style="list-style-type: none"> <i>• A statistically significant positive association between ICT and National Tests for science was found at Key Stage 3, but there were no other clear-cut associations at Key Stage 3.</i> <i>• It is possible on the basis of this finding to estimate that high ICT use at Key Stage 3 in science can help to raise performance by the equivalent of 0.214 of a National Curriculum level, and in mathematics by 0.083 of a National Curriculum level. This is equivalent to a substantial acceleration in progress through these levels of 21.4% of two years' achievement in Key Stage 3 science, and 8.3% of two years' achievement in Key Stage 3 mathematics.</i>
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Appendix 2: Meta-analyses of the impact of computer and digital technologies on education

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