British Journal of Educational Technology *Vol 33 No 2 2002* 201–211

ICT and attainment at primary level

Terry Goodison

Terry Goodison is Senior Research Fellow at The Learning Lab at University of Wolverhampton. Address for correspondence: Telford Campus, Priorslee, Telford TF2 9NT, UK. Tel: +44 (0) 1902 322834; fax: +44 (0) 1902 323952; email: t.goodison@delta.wlv.ac.uk

Abstract

During the last six months the British Educational Communications and Technology Agency (BECTa) has published two reports (downloadable from http://www.becta.org.uk/) on the relationship between information and communication technology (ICT) and attainment levels of primary school children in national tests. Together, they constitute a significant contribution to the debate over the place of ICT in our primary schools but they also raise a number of issues regarding the assumptions upon which they are based and the role of teaching staff in the successful exploitation of ICT in the classroom. This article provides a critical analysis of both reports and proposes ways in which the issues raised can be taken forward.

Background

BECTa's first study, "Preliminary report for the DfEE on the relationship between ICT and primary school standards", prompted many questions but offered few insights. Whilst it revealed a statistical correlation between ICT resources and levels of attainment at Key Stage 2, it did not attempt to identify any of the factors which might plausibly account for it. The second study builds on the findings of the first but attempts to make good this explanatory deficiency by looking for what it describes as the causal mechanisms linking the two phenomena. We need therefore to begin with a review of the first study which was based on two data sets drawn from Ofsted inspections carried out during the 1998–99 school year: one centred on inspectors' assessments of the adequacy of ICT provision and the other centred on Ofsted's ranking of schools on the basis of their pupils' scores in national tests at Key Stages 1 and 2. Both sets of data were compiled by Ofsted's Research, Analysis and International Division and the sample as a whole consisted of the 2500 or so schools that were inspected in that year.

In terms of attainment, the tests used at Key Stage 1 were reading, writing and maths and, at Key Stage 2, English, maths and science. Ofsted compared the test scores in

Published by Blackwell Publishers Ltd, 108 Cowley Road, Oxford, OX4 1JF, UK and 350 Main Street, Malden, MA 02148, USA.

each school with the national average, using national benchmarks to adjust for socio-economic disadvantage where appropriate, and then assigned the schools to one of seven categories:

Table 1: Seven Ofsted Key Stage 1 categories

A*	Very high	95–99%
A	Well above average	75–94%
B	Above average	60–74%
C	Average	41–59%
D	Below average	26–40%
E	Well below average	6–25%
E*	Very low	0–5%

So, the A* category represented the top 5% of the sample schools and E* represented the bottom 5% compared either to the national average or to schools in similar socio-economic contexts.

In order to establish the adequacy of ICT resources, two sources of information were used. The first was Ofsted, which asks inspectors to make a judgement on the extent to which ICT resources meet the requirements of the ICT curriculum (cross-curricular use of ICT was not obligatory at that time). The BECTa report emphasises that these judgements are subject to variability since inspectors do not operate from guidelines and "*may* (my italics) take into account a range of factors: the quality and quantity of ICT hardware, software and data sources" (p. 29). The report also draws attention to the fact that "staff skills and training were not included in this measurement" (p. 29). Seven categories were used to classify ICT provision but the descriptors differed slightly from those used for attainment levels:

Table 2: Seven Ofsted ICT categories

A*	Excellent
A	Very Good
B	Good
C	Satisfactory
D	Unsatisfactory
E	Poor
E*	Very Poor

The second source was information submitted by heads to Ofsted detailing the money spent per pupil on computer equipment in the year 1997–98 and the pupil:computer ratio.

There are two observations to be made at this point. Firstly, the Ofsted judgements necessarily have a degree of subjectivity built into them because of the lack of operational guidelines. To minimise this problem, BECTa mapped the spending data provided by the heads onto the categories derived from the inspectors' reports and obtained a

statistically significant correlation (0.23) between expenditure per pupil and the ICT resources rating. They also mapped the pupil:computer ratios onto the ICT resources ratings and obtained a correlation of –0.30 (it is a minus value because the higher the ratio the lower the category and vice-versa). Secondly, the restriction of the inspectors' remit to hardware and software opens up the possibility that some schools may have acquired relatively good resources but not put them to very good use. This deficiency is made good in the second BECTa report.

In order to ensure that socio-economic factors did not distort the comparison between ICT resources and levels of attainment, two checks were made over the whole sample, the first looking at prior attainment of pupils entering the school and the second at the socio-economic characteristics of the neighbourhood. Ofsted figures for prior attainment were amalgamated into a three-point scale: below average, average and above average and the results were then mapped onto the ICT ratings. The same procedure was followed for the socio-economic characteristics of the neighbourhood. In neither case was there any clear correlation with ICT resources ie, neither a school's socio-economic environment nor the attainment level of its pupils upon entry are related to the level of ICT resourcing and thus, indirectly, to attainment gains. It should perhaps be noted at this stage that the second report does not altogether bear this out since it shows that schools with low prior attainment but good ICT resources do not appear, at least in the early stages of ICT implementation, to benefit from increased attainment (see below).

Having discounted these two variables, BECTa focused on the results of the correlation between attainment and ICT ratings. The first set of results ranged across the entire sample at both Key Stages 1 and 2. At Key Stage 1 the attainment grades were all benchmarked and included a weighting for pupils entering school with English as a second language or no English at all. In writing at Key Stage 1, the correlation between attainment and ICT rating was low but significant: 0.052. In reading and mathematics, on the other hand, there was no clear correlation at all. The situation at Key Stage 2, again across the whole sample, was rather different. BECTa amalgamated the "Very Good" (A) and the "Excellent" (A*) ICT rating categories (183 schools out of 2111) and the "Poor" (E) and "Very Poor" (E*) categories (56 out of 2111). They then compared the performance of the schools in these amalgamated categories with respect to the core Key Stage 2 subjects. The results for English showed that 54% of the schools with an A or A* ICT rating scored B or better as against 36% of schools with an E or E* ICT rating. When these results were benchmarked, ie, schools were compared to schools of a similar type and socio-economic context, the discrepancy was of roughly the same magnitude ie, 52% and 30%. The results for maths were in line with the results for English, that is, 58% of schools with A or A* for ICT gained attainment ratings of B or better as against 38% of schools with E or E*. The benchmarked figures were 52% and 30% respectively. Science followed the same pattern: 57% as against 32% and, when the benchmarking criteria were applied, 52% as against 29%. When the benchmarked results for all three subjects were combined, 54% of schools with an A and A* ICT rating scored B or better as against 25% of schools with E or E*.

Finally, BECTa carried out an additional survey of the 115 primary schools commended by Her Majesty's Chief Inspector of Schools as "High Standard" or "Most improved" for 1998/9, the idea being to compare this group of commended schools with all the other schools in the sample with regard to their ICT ratings. Only 9% of commended schools had unsatisfactory or worse ICT provision (ie, fell into the D category or below) and 57% had good or better (ie, fell into the B category or above). The relevant figures for the other schools were 21% and 35% respectively. It would seem that schools which achieve high standards are likely to see investment in ICT as one way of achieving them, but the interesting question is how this perception came about and, more generally, what factors underlie the report's major finding that "when viewed alongside other ICT research, (this report) provides a compelling argument that ICT helps raise standards in schools at Key Stage 2".

BECTa's second report "Primary Schools of the Future—Achieving Today" is strikingly different in its approach. Whereas in the first report the authors were at pains to emphasise the fact that the correlations which they found did not justify postulating a causal link between ICT resources and attainment:

> "It is important to understand that the existence of a correlation, however large, does not imply causality, ie, it does not tell you that a change in one measurement causes a change in the other measurement." (p. 38 of the Preliminary report)

the second report has no such inhibitions and, in its own words, "builds up a compelling case for a direct link between ICT and pupils' standards of attainment" (p. 6 of "Primary Schools of the Future—Achieving Today"). This direct link is in fact a series of links, what the authors call "a causal chain":

> "Different elements of the causal chain (such as the impact of school management and the quality of ICT teaching) are examined to provide a more detailed explanation of the link between ICT and standards." (ibid. p. 6)

The chain consists of the following key propositions, all based on the work done in the first report which established a correlation between ICT provision and levels of attainment. They have been numbered here for ease of reference.

1. "If ICT resources contribute to improved attainment, then higher grades should be seen in all types of school, regardless of social and other factors that also influence pupil attainment." (p. 12)
2. "In order to demonstrate the causal connection between ICT and standards' the effect of good management has to be 'considered and eliminated'." (p. 16)
3. "If ICT resources contribute to higher attainment, then higher grades should be seen in all subjects that are directly supported by ICT." (p. 18)
4. "If schools that combine good ICT resources with good use of those resources by teachers achieve better Key Stage 2 results than schools which do not use them so effectively, this is a strong indication that there is a direct link between ICT and standards." (p. 21)

This approach merits careful scrutiny, especially since we are told in the preface that "this publication is different and sets new standards of methodological decency" (p. 3).

To begin with, there seems to be some confusion regarding the nature of causality. Here is a typical example:

"Research carried out elsewhere has identified causal mechanisms by which ICT may enhance teaching and learning. If ICT has a positive effect on pupil attainment, then research into the learning process will uncover the mechanisms that underpin this causation. In particular, studies of how ICT is used by teachers and by learners will show specific ways that ICT helps to enhance pupil attainment in English, maths and science." (p. 38)

This is the language of linear causality (Freeman, 1999), where some agent, in this case the entity denoted by "ICT", invariably produces some effect which may, or may not, produce further effects, thus constituting a causal chain. A mechanism, by definition, is something which invariably produces the same effect, unless, or until, it ceases to function properly. The invariance which defines the causal relationship is simply incompatible with expressions of epistemic modality such as "may", so the expression "causal mechanisms by which ICT *may* (my italics) enhance teaching and learning" is quite literally a contradiction in terms. The authors might object, of course, that what they mean by the expression "causal chain" has nothing to do with linear causality and, indeed, the chain of conditional propositions quoted above, which constitutes the backbone of their report, has none of the force of a causal explanation, as the authors of BECTa's first report clearly understood. But perhaps the major problem is that the posited causal chain simply has no agent. What, one wonders, is the referent of the term "ICT" in the following sentence?

"Are there identified mechanisms that would explain how ICT causes a rise in standards and could they plausibly contribute to the observed effect in the statistics?"

The term's scope, even within this limited educational context, is extraordinarily wide and covers, minimally, current infrastructures and technologies (hardware and software), a whole raft of policy frameworks and initiatives at a number of levels, and, most crucial of all, the skills and knowledge of the people who maintain the technology or use it: technicians, teachers and pupils. In fact, "ICT" denotes a large and complex web of interactions and interdependencies, even at the level of the individual school, that makes it impossible, in principle, to ascribe to it any causal agency whatsoever.

What is possible, on the other hand, is to probe the ecology of the educational setting (Schon, 1987) and try to identify some of the relationships which typically underpin the correlation in question in a range of different environments. Indeed, towards the end of the report, this is what its authors seem to be suggesting:

"Learning gains using ICT appear to be more likely when supported by effective pedagogical structures and effective teaching strategies. Research would suggest that a number of these factors need to be in place in order to reach a threshold above which ICT is more likely to have a significant impact and support education and learning effectively." (p. 39)

Unfortunately, they see future research not only in terms of establishing which factors are the most significant but also "how many are required to reach the threshold". Whilst it is entirely possible to generalise across a range of different contexts to establish which factors are most commonly present in those cases where ICT is effective, it is

extremely unlikely that research could ever identify just those factors which constitute the necessary conditions for the threshold of effectiveness to be crossed, for the simple reason that each school is a dynamic system of many interdependent components which has to operate within the constraints of its own history and context.

These methodological and philosophical issues unfortunately undermine some of the basic propositions upon which the study is based, as well as its general design. We will take each of them in turn.

Proposition 1

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

It is difficult to imagine how ICT resources in themselves can contribute to improved attainment unless they are being used constructively within the teaching context and indeed this is one of the more significant findings of the report. Since ICT resources constitute just one aspect of the substrate that supports the web of inter-related factors that shape the learning context, it simply makes no sense to entertain the notion that ICT contributes to improved attainment "*regardless* (my italics) of social and other factors that also influence pupil attainment". What is more, even if we were to accept the hypothesis at face value, it is invalidated by the report's own findings. In order to establish that ICT is effective despite social factors, BECTa compared pupils' results at Key Stage 2 in those schools subject to Ofsted inspection in 1999. They then mapped these results onto the DfEE benchmarking classifications which are determined by those same pupils' attainment levels upon entry to Key Stage 1. The results show the percentage of pupils who achieved level 4 or above at Key Stage 2 in two types of institution: one where ICT resources were classified as unsatisfactory (D or below) and the other where they were classified as good (B or above). In benchmark groups 4 and 5, ie, those schools where early attainment is best, there is a slightly higher level of attainment if ICT resources are good, between 1% and 3%. In the case of benchmark group 3 (children of average ability) improvements in attainment are slightly better when ICT provision is good (3% to 4%). The situation with regard to children with the lowest attainment levels on entry to Key Stage 1 is quite different however, in English as well as maths. ICT provision is negatively correlated with levels of attainment in the 1999 figures whilst the 2000 figures show the same negative correlation in English and a very slight positive correlation in maths. The authors' comment on the apparent failure of ICT resources to have any impact upon this group of pupils is illuminating:

"It may be that, for schools with the lowest levels of pupil attainment, the effects of ICT take longer to manifest. It will be interesting to see the further development of the effects of ICT on low-achieving schools, as shown by 2001 results." (p. 13)

So the hypothesis that ICT resources will have a positive effect "regardless" of other factors is not supported, even in the report's own terms. Not only this, but hypotheses like this run counter to other findings which suggest that successful IT projects require considerable collateral changes in the structure and behaviour of organizations in order to be effective (Menou and Potvin, 2000).

Proposition 2
"In order to demonstrate the causal connection between ICT and standards" the effect of good management has to be "considered and eliminated". (p. 16)

Ofsted awards a management grade to schools on the basis of a four point scale: "very good", "good", "in need of some improvement" and "in need of substantial improvement". BECTa mapped these grades against ICT resource grades to give four types of schools:

- Poor management (in need of improvement) and unsatisfactory ICT resources.
- Poor management and good ICT resources.
- Very good management and unsatisfactory ICT resources.
- Very good management and good ICT resources.

The proportion of pupils assessed as "above national standards" (ie, above level 4) for each school was then calculated. The results for maths and science did indeed indicate that whether the school had poor management or very good management made little difference: in both cases good ICT resources correlated with higher attainment. In English, however, this was simply not the case. In poorly managed schools, for some reason, good ICT resources are not linked to higher attainment. This is not commented upon by the authors, but it suggests that management, as an issue, cannot simply be eliminated from the picture as they intend.

Proposition 3
"If ICT resources contribute to higher attainment, then higher grades should be seen in all subjects that are directly supported by ICT."

The data used to support the hypothesized correlation between the amount of subject usage of ICT and improved levels of attainment are particularly interesting because they come from two very different sources and produce quite different results. The first source, once again, is Ofsted inspectors' reports. The BECTa team looked at the reports on schools that have very good ICT resources and counted the number of positive mentions of ICT usage in maths, science and English. They then mapped these result against the percentage of pupils in each school achieving above national standards. There was a clear difference in ICT usage across the three subjects: English was mentioned positively in over 80% of schools, maths in over 70% and science in over 30%. In the case of maths 45% of schools with no positive mention performed above national standards as against 65% of schools which did have a positive mention. In the case of science the corresponding figures were 50% and 80%. But in English there was no discernible difference at all. The authors account for this fact by alluding to the small number of schools where English was not mentioned positively: 16 out of 135. However, in maths there were only 38 schools not mentioned positively and yet the percentage difference in terms of pupil attainment was around 20%. On the face of it, the level of above average attainment in English is not related to the amount of usage of ICT, contrary to the report's main contention. It may also be the case that in future we need to assess the impact of ICT in different ways according to the nature of the subject.

When we turn to the figures derived from the DfEE's "ICT in Schools Survey 2000" we note that the sample is four times larger (582 schools), that the measure of attainment is not "above national standards" but level 4 or above and that the opinions upon which the data are based are not those of Ofsted inspectors but the head teachers of the schools in question, who were asked to say whether ICT was used "substantially" or "little". The differences in attainment levels obtained on this basis are very small indeed. Those schools which claimed substantial use of ICT obtained Key Stage 2 results around 3% better for English, 1% better for science and 2% better for maths. The authors remark that these figures support their case but fail to draw attention to the discrepancy between the results obtained from the different data sets. One conclusion that might be drawn is that ICT usage alone is not necessarily important in helping to raise standards and this is borne out by the next section of the BECTa report which centers on the quality of ICT teaching.

Proposition 4

"If schools that combine good ICT resources with good use of those resources by teachers achieve better Key Stage 2 results than schools which do not use them so effectively, this is a strong indication that there is a direct link between ICT and standards."

This proposition is the one which provides the strongest and most interesting evidence of the link between ICT and attainment, not surprisingly, since it is basic common sense to assume that when ICT resources are well used the impact upon standards will be correspondingly greater. The teaching assessments that were used in the analysis were restricted, however, to the teaching of ICT, thereby excluding science, maths and English. Possibly, BECTa might have found higher standards still had they been able to assess the direct contribution of ICT to good teaching in those three subjects rather than restrict themselves to the indirect influence of good ICT teaching. Be that as it may, BECTa took the data on ICT teaching from those schools that obtained an ICT resources rating of B or better. These schools were then divided into five categories of ICT teaching quality ranging from very good to poor with the contrast being drawn between those schools with very good ICT teaching and those with poor ICT teaching. The measure of pupil attainment was "above national standards" and the sample size was 128 schools. The position in science was that 60% of schools with good ICT resources and very good ICT teaching achieved above national standards whereas only 30% of schools with good ICT resources and poor ICT teaching did so. What is significant is the size of this attainment gap which was approximately the same for maths and English.

BECTa then went further and investigated the correlation between attainment and more detailed Ofsted measures of ICT provision, for example: pupil interest in ICT, their ICT skill levels, the enthusiasm for ICT at school level, high teacher expectations of ICT, and teacher skills in ICT; in other words, all those factors that one would expect to play a role in generating learning improvements through ICT use. Not surprisingly, the results show a much higher correlation between attainment and factors such as these when compared to the figure for the correlation between attainment and ICT resources generally (0.05). For example, the correlation between pupils' (positive) attitudes to ICT and attainment in English was 0.12, more than twice the figure for the correlation

between ICT resources and attainment. The conclusion reached is that there are five factors which are especially important in using ICT to improve standards: high quality teaching, school support for ICT, access to ICT, pupils' ICT skills, pupils' positive attitudes to ICT. This list is interesting as much for what it leaves out as for what it includes, but at least it has the merit of bringing to the fore factors based on the perspectives and values of the participants in the learning context.

Reinforcing the link between good ICT resources and good ICT teaching, the report looked at those schools that not only had very good ICT resources but also used those resources in exemplary fashion: some 77 schools in all which the report describes as "schools of the future". These schools were compared to all the other schools inspected in 1998–99 with regard to the percentage of level 4 grades. The "schools of the future" performed better than the rest by margins of between 5% and 7%. The report is at pains to emphasise that the proportion of these "schools of the future" falling into each of the social categories reflects the proportions for the school population as a whole and that these schools have already achieved, in 1999, the government's attainment targets for 2002.

Section B of the report "Professional judgments of teachers and heads" deals with data generated from the perceptions of practitioners themselves and, in the process, raises once again the issue of the fundamental assumptions that have shaped the study. The key paragraph reads as follows:

"If ICT is a pedagogical tool that enhances the learning process, then those professionals who have experience of using ICT in their work will tend to believe that it is having a positive impact on pupil achievement." (p. 28)

Notice the characterization of ICT as "a pedagogical tool that enhances the learning process". Far from being an inert, though highly complex, mechanism, ICT is presented as an agent. The argument being advanced is that if ICT does indeed have this special quality we can expect that the professionals who use the tool "will tend to believe" that it has a positive impact. All that remains to be done, therefore, is to check whether the professionals do indeed have this belief and, if they do, this can count as additional evidence that ICT is a special sort of tool. This backwards logic is strongly reminiscent of the argument used earlier when the issue of teachers' use of ICT was first raised:

"If the use of ICT resources to support learning does not impact on standards (for example, if the association was merely coincidence), it would make no difference to pupil attainment whether or not those resources were well used." (p. 21)

The false assumption here, once again, is that either the medium does not impact upon standards (in which case using it well will make no difference) or it does impact on standards, in which case using it well will make a difference, a piece of reasoning seen by the authors as "a good test of the causal connection between ICT and standards". An alternative view is that ICT is no different from any other medium in that its effectiveness is determined exclusively by the way in which it is used. Almost by definition, using any teaching tool well will improve the learning experience.

The results of the survey carried out in this part of the study come as no surprise. 86% of heads of schools with very good ICT resources and who, by definition, have invested heavily in technology, tend to believe that ICT has been important in raising standards in the last two years. They also tend to think, in their overwhelming majority, that it helps pupils' subject knowledge (96%), their motivation (98%), and the completion of work in the classroom (90%). In addition, they are convinced it makes both teachers more effective (93%) and the school more effective (89%). What is surprising, however, is the interpretation that the authors of the report put on these findings:

"At this stage it is not possible to say whether schools are using ICT regularly because they believe it has a positive impact on standards, or whether the increased use is encouraging these positive attitudes." (p. 29)

The second of these alternatives would appear to open up the startling prospect of a school investing heavily in ICT and using it extensively without having positive attitudes towards it in the first place; another illustration of the authors' uncertainty regarding the proper status to be accorded to the beliefs and motivations of teachers. In point of fact, of course, the beliefs of the teachers are constitutive of the effectiveness of ICT in much the same way as the inescapably subjective beliefs and values of Ofsted inspectors are constitutive of the statistics upon which this report are based.

Conclusion

The report ends with a survey of studies which identify a range of factors which can help, or hinder, the use of ICT to enhance learning (Section 8—Research evidence). Not for the first time, the authors seem to be in a state of confusion. "Are there", they ask,

"identified mechanisms that would explain how ICT causes a rise in standards and could they plausibly contribute to the observed effects in the statistics? Are there experimental studies that have shown a real impact of the use of ICT on improved learning by pupils and improved teaching in similar situations to the schools in the study?" (p. 38)

The search for causation and the appeal to "experimental studies" seems inconsistent with the recognition that in ecologically based research one has to content oneself with "a consideration of the various environmental/contextual factors [which] help to convey the complex pattern of variables that can help or hinder the effective use of ICT" (p. 39). This latter approach is precisely what is now called for. Many schools have successfully implemented ICT across the curriculum over a considerable period of time, thereby achieving the sort of results identified by BECTa. What is now needed is some detailed investigation of how they have been able to implement effectively a range of policies which embrace, *inter alia*, the factors listed on the last page of the BECTa report:

- level and type of pupil and teacher ICT training and skills
- pedagogical awareness among staff
- staff attitude towards ICT
- the integration into classroom practice and existing teacher interventions
- pre-use and planning
- school ethos

- technical support, resources management and infrastructure
- establishing clear learning and curriculum objectives.

BECTa's reports have revealed some important developments which are taking place in primary schools today. However, the approach adopted in "Primary Schools of the Future—Achieving Today" tends to diminish the role of the very people who have created the realities upon which the report's statistics are based: the teachers themselves. Rather than seeking to endow ICT with special properties and powers it would be better to accept that the principal agents in the teaching and learning process are teachers and their pupils, and that if both parties commit to the use of what is undeniably a powerful tool, then improved learning is very likely to occur. To establish that ICT makes an effective contribution to learning one does not have to invest it with qualities which it does not and cannot possess, nor does one have to commit to a notion of causation that has no place in the study of complex human systems.

References

Freeman W J (1999) *How Brains Make up their Minds* Weidenfeld and Nicolson, London.

Menou M J and Potvin J (2000) *Toward a Conceptual Framework for Learning about ICTs and Knowledge in the Process of Development* The Global Knowledge Learning and Evaluation Action Program, Global Knowledge Partnership. http://www.bellanet.org/ICT_res_pol/docs/LEAP_Concept_2May2000.HTM.

Preliminary Report for the DfEE on the Relationship Between ICT and Primary School Standards: http://www.becta.org.uk/news/reports/contents.html.

Primary Schools of the Future—Achieving Today http://www.becta.org.uk/news/reports/primaryfuture/index.html.

Schon D A (1987) *Educating the Reflective Practitioner* Jossey-Bass, San Francisco.