Exploring Patterns of Computer Use in Schools

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ABSTRACT

Using data from official UK government reports spanning twenty years this paper attempts to identify patterns of ICT use in primary and secondary level schooling. Beneath the 'headline' statistics charting the reduction of pupil: computer ratios and increases in funding there lies an enduring picture of educational use of ICT remaining inconsistent and sporadic. From this basis the paper then considers the factors which appear to exert some influence over the general use of ICT in schools and, in doing so, highlights key areas of interest for future educational technology research.

Introduction

Despite the general lack of large-scale data-sets in the educational technology research literature little sustained attention has been paid to the plethora of national-level data collected by governments seeking to assess the permeation of ICT in their education systems. With this in mind the present paper starts by analysing the statistical bulletins compiled by the UK Department for Education (and 'Employment', 'Skills' or 'Science' as it has been variously labelled over the years) since 1986 examining the use of information technology in schools (DfES, 2002, 2001; DfEE, 2000, 1998, 1997; DfE, 1995, 1993; DES, 1991, 1989, 1986). This body of data provides us with a longitudinal picture of how computers have been introduced into schools in England over the past seventeen years and, whilst lacking definition, suggest some interesting trends for further study.

In many ways the absolute figures presented in this paper are not as important as the relative comparisons which can be made between them. With ICT an ever-changing area of education, any figures which are available at the

time of writing of a journal article are inevitably outdated when the journal is eventually published. Of more interest, therefore, are the persistent differences that occur throughout the available data over the last twenty years. At this broad level we can first consider these official government data from two different perspectives: the resourcing of ICT in schools and the practice of ICT use in schools.

The resourcing of ICT in schools

To start first with the simplest measures of the place of computers in compulsory education, it is perhaps unsurprising to discover that English schools are now spending more money on computers than ever before. It may also be unsurprising to discover that, as a result, schools have more computers for students and teachers to use than in the 1980s. In fact, in terms of expenditure, schools in England have been steadily spending more money on computers over the past seventeen years. As Figure 1 shows, whereas in 1986 secondary schools were spending an average of £2,240 on computers, by 2002 this figure had reached £65,900 – rising steadily since 1993. Although more modest, the same trend can be observed in the primary sector with an

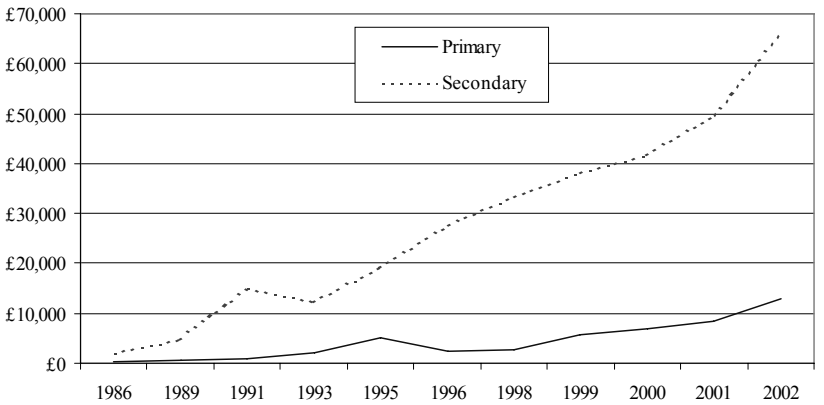

Figure 1
Average expenditure on ICT (excluding administration from 1993 onwards) by school sector (1986–2002)

equivalent rise from £305 in 1986 to £13,000 in 2002. As can be seen in Figure 2, when these data are adjusted for inflation rates the trend remains one of upward spending in each sector.

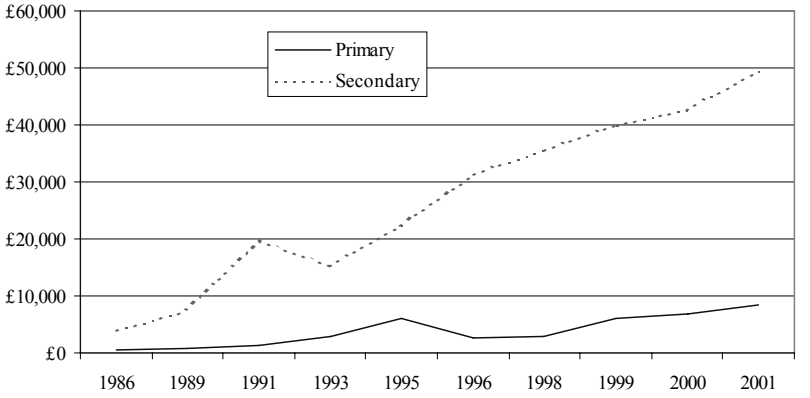

Figure 2
Average expenditure in 2001 prices on ICT (excluding administration from 1993 onwards) by school sector (1986–2001) (data have been adjusted in line with the retail price index for 1987–2001)

As a result of this increased expenditure the physical numbers of computers in schools have steadily risen (see Figure 3) as the numbers of students per computer (the student:computer ratio being a favoured measure of ICT resourcing in most countries) has steadily fallen (see Figure 4). Thus we have moved from a situation in 1986 where there were an average of 1.7 computers per primary school (or one computer for every 106 pupils) to a comparative figure of 31.0 machines in primary schools today (and a ratio of 9.7:1). Similarly, the 1986 average of 13.4 machines in secondary schools (a student:computer ratio of 60:1) has risen to 155.6 machines in secondary schools (or 6 pupils for each computer). Thus in terms of physical presence computers are certainly more prevalent in schools than they ever have been.

These and other data certainly suggest that the current New Labour government in the UK has been successful in resourcing schools in ICT hardware over the past six years. At the latest count over 99 per cent of primary and secondary schools were connected to the Internet (100 per cent

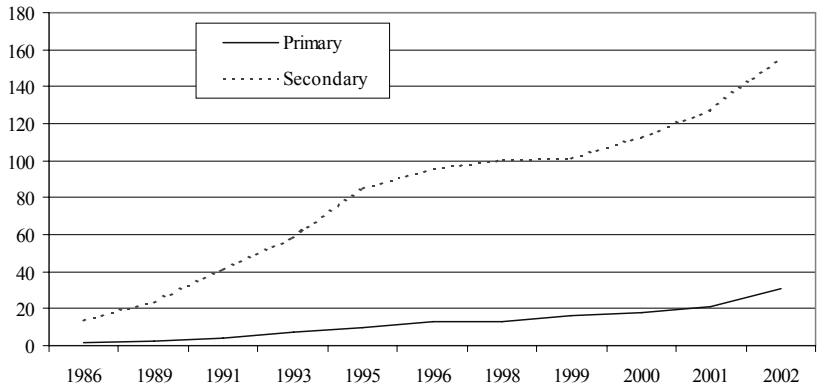

Figure 3
Average number of 'teaching' computers by school sector (1986–2002)

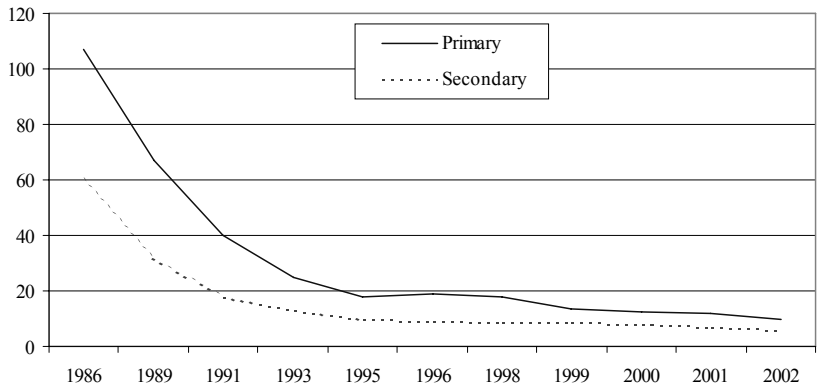

Figure 4
Number of pupils per 'teaching' computer by school sector (1986–2002)

connectivity being a key pledge of the government's first five years in power). Thus, on the face of it, schools now have the resources and the connectivity to get on with using ICT to the potential suggested by technology enthusiasts over the past twenty years.

Of course, these 'headline' figures hide a multitude of complexities – not least the *quality* of resourcing (see also Schofield, in this issue). Reconsidering the Internet connectivity headline figure which so many governments are keen to cite, we can see that the phrase 'access to the Internet' can refer to one telephone-based Internet connection in the head teacher's office (as is still the case in some UK primary schools) *or* a 'fully wired-up' school with every computer enjoying a fast broadband connection. When we consider the quality of ICT in schools, the high-tech veneer suggested by the 'headline' figures slips slightly. Compared with twenty years ago schools are certainly high-tech – but not *that* high-tech. As Table 1 shows, ICT applications such as broadband connections, digital projectors and DVD are more often the exception rather than the norm in schools – with much of schools' ICT being rather 'ordinary' by domestic or business standards. If we look back over the UK government figures during the 1980s and 1990s the same situation occurs with the technology of the moment (be it barcode-readers, computer mouses or interactive video machines). Similarly, the 'churn' of computer hardware in schools is variable, with over a third of computers currently in schools being over three years old (considered the industry standard for obsolescence).

Table 1
Percentage of schools with Internet and peripherals (DfES 2002)

	Primary	**Secondary**
Connected to the Internet	>99	>99
through a modem	9	-
through ISDN2	80	32
through ASDL	2	2
through broadband	9	66
Digital Cameras	90	99
Digital Projectors	41	78
Electronic interactive whiteboards	44	69
DVD	11	33
Schools with their own website	56	79

Although the range of English schools' computer hardware is nowhere near as idiosyncratic as it was in the 1980s and 1990s, many schools still make use of a range of ageing computers – from the residual BBC computers in some infant and primary schools to pre-Windows 386 and 486 PCs.

Table 2
Percentage of 'ageing' computers in primary and secondary schools (1995–2002)

Year	Primary	Secondary
1995	44.0	37.0
1996	41.0	38.0
1998	64.0	56.9
1999	52.1	50.2
2000	46.2	44.5
2001	37.2	36.1
2002	44.0	34.0

Note: Data from 1998–2002 are percentage of 'teaching' computers over 3 years old by school sector. Data from 1995 and 1996 are percentage of 'teaching' computers over 5 years old by school sector.

Use of ICT/practice in schools

Despite these concerns over the quality of hardware these official data certainly suggest that schools are by no means devoid of computers and other ICT hardware. In this respect ICT *has* made a considerable impact in schools. Currently, many primary schools are mirroring the practice in secondary schools and building or refitting whole rooms to be used as ICT suites as opposed to the established 'computer in the classroom' approach. In both primary and secondary sectors, technologies such as video-conferencing and electronic whiteboards are also beginning to be integrated into classrooms. Visitors to schools are almost always shown the ICT suite and computer facilities in classrooms as a first port of call on a tour. On the face of it computers are now a considerable presence in UK schools. At least they are a *physical* rather than practical presence – for these data so far reveal little as to how computers are being used in schools by teachers and students. On a national level the current Department for Education and Skills (DfES) data pertaining to use are less revealing in this respect than they used to be, yet it is still clear that use of computers is by no means uniform across schools. One of

the recurring findings in the official statistical bulletins during the 1990s was the variability of ICT use through different school-year groups – with levels of use slowly rising through compulsory secondary years (peaking in the coursework-dominated GCSE years 10 and 11) and then falling away in years 12 and 13. With these data no longer collected by the DfES it is, however, worth considering the available data on ICT use across subject areas.

As can be seen in Tables 3 and 4, the use of computers differs substantially from subject area to subject area and, interestingly, appears to have remained relatively delineated throughout the last thirteen years of available data. While the percentage of secondary school teachers making 'regular' use of ICT in some subjects has remained steadily high (unsurprisingly in the case of computing and information technology), remained steadily moderate (art, religion, music), has improved (English, geography) or even declined (in the

Table 3
'Regular' use of ICT by staff in secondary school departments (1989–2002)

	1989	1991	1993	1995	1997	1998	2000	2001	2002
Art	31	30	32	29	28	32	27	35	13
Design and technology	38	50	53	53	47	55	73	81	56
Comp/IT	84	92	93	92	88	92	97	99	99
English	19	27	31	31	25	32	49	56	17
Geography	15	19	25	24	17	25	37	56	19
History	11	20	22	22	15	24	30	42	10
Maths	24	31	34	31	24	28	48	60	21
Modern foreign languages	17	16	20	22	17	25	31	43	14
Music	34	29	30	31	29	43	30	43	26
Physical education	18	13	12	20	15	17	1	9	3
Religion	17	12	18	20	11	19	16	27	5
Science	23	30	30	33	21	29	49	67	29

Note: Data are percentages of schools covered in the DfES surveys. In the 1989 figures 'significant' use of microcomputers is defined as 'at least twice a week on average'. Between 1991 and 1998 this is replaced by using computers 'regularly' (defined as 'at least twice a week on average'). From 2000 this is replaced by 'substantial' use of ICT (as opposed to 'little' or 'none' in 2000/01 and 'some' or 'none' in 2002). For 1989 and 1991 'science' is the average score for biology, chemistry and physics. From 1993 science was reported in the statistical bulletins as a composite score.

case of physical education) over the last thirteen years, it is possible to group these subject areas into discernible clusters of 'high-using', 'medium-using' and 'low-using' subjects. Art, religion and physical education can be seen as decidedly and steadfastly low ICT-using areas of the secondary school curriculum, where as IT/computing and design and technology can be seen as high-using areas (as could business studies until the DfES stopped collecting data on it). Occupying the middle ground are the humanities subjects, English, maths and sciences which have moved from around a fifth of teachers making regular use in 1989 to around half in 2002. Similar groupings of high, medium and low ICT-using subjects (although not necessarily the same ones) can be seen in the primary school curriculum (see Table 4).

Table 4
'Substantial' use of ICT by staff in primary school curriculum areas (2000–2002)

	2000	2001	2002
Art	36	41	5
DT	8	13	3
Comp/IT	89	94	90
English	87	98	65
Geography	24	34	6
History	35	46	9
Maths	66	74	48
Modern foreign languages	0	1	2
Music	4	9	2
Physical education	0	1	0
Religion	3	8	1
Science	35	50	26

That these differences exist should not come as a surprise to anyone who has spent even a short length of time in a school. *Why* these differences exist throws up many more questions than we are able to answer at the moment with these data – but the suggestion certainly is that computer use in schools is not a simple matter of providing resources or, indeed, a simple matter of training teachers. Of late the UK government has made great play of training existing and trainee teachers in the use of ICT. Making ICT skills a mandatory

part of initial teacher training courses and aiming for all (and ensuring that most) in-service teachers receive a degree of ICT training over the last six years has meant that the majority of teachers are being exposed to ICT. Indeed, Table 5 shows that most, but by no means all, teachers have received some training and have access to ICT at home.

Table 5
Teachers' training and home access to ICT (data are head teachers' estimates of percentage of teachers (DfES, 2002))

	Primary	Secondary
Received some training in ICT	93.4	73.5
Received training within last two years	87.4	83.8
Have access to computer at home	87.0	85.0

What can be gleaned from these official data?

These findings have broadly been replicated by other official large-scale surveys around the world. From the large-scale IEA study of computer use in twenty-one countries (Pelgrum and Plomp, 1993) to the OECD annual 'at a glance' indicators there is little to suggest that the UK is by any means unique in the variable picture presented above. Although other countries have managed to implement lower student:computer ratios (for example, 2:1 in Singapore) and achieve blanket Internet connectivity years before the UK (see Research Machines, 1996 and 1998), the traditional claim that the UK 'leads the world' in educational ICT is not that far off the mark although, as the Stevenson Committee (1997) ruefully noted, this should not be seen as that much a cause for celebration.

Yet these official data only tell us a limited amount about the state of ICT in schools. While the UK government has been using these figures as testament to the success of their most recent educational ICT policies, they can be seen as presenting a more mediocre picture of schools' computing than would first meet the eye. This is highlighted by considering briefly what the official data represent and how they were collected. First, the criteria used in the DfES data are often based on low thresholds of success. For example, the criteria for 'regular', 'substantial' and 'significant' use of computers by subject areas is 'twice a week or more'. Considering that the average teacher will teach at least twenty-five lessons a week, to use ICT in two of them (taking a charitable interpretation of

'twice' as opposed to twice in one lesson) is hardly 'regular', 'substantial' or 'significant'. Given that the official data now collate 'little' and 'never' into one category we have no way of ascertaining how many teachers are not using ICT but, at best, the remaining percentages in all the data presented above will be using a computer once a week. Similarly, as noted above, how substantial an 'Internet connection' and indeed a 'website', a 'printer' and 'training' has to be to qualify for inclusion in these figures is not made clear.

Second, and even more important from a methodological perspective, the DfES data are based on self-reports from schools. Given the surveys' coverage of around 800 primary and 800 secondary schools the practical need for self-report is obvious and in line with practice in most other countries, but the theoretical limitations of this are significant; as Cuban argues: 'What I find in the national data is far too much reliance on self-reports and far less investigation of actual use in local schools' (Cuban, 2001: 73). As Cuban's criticism of US data intimates, these data cannot reflect *actual* use – merely perceived use. The limitations of self-report data-gathering techniques are well documented. Even with the best intentions respondents are prone to misremembering, erring on the side of caution or, if measuring their own performance, providing a 'generous' account of events. These problems are compounded when we consider that in many instances the DfES data cannot be seen as even self-report data. Their crucial weakness lies in the fact that they are collated from questionnaires sent by the DfES to schools and completed by the head teacher. The head teacher then has to provide information for a whole host of categories. While head teachers should be in an ideal position to report how much money they have spent on ICT in the past year and how often they *themselves* have used a computer, they are not best placed to answer many of the other questions. With some secondary schools having over 2,000 students and 200 staff and with many secondary head teachers on minimal (or non-existent) teaching loads they are not in an ideal position to estimate the exact number of teaching staff in their school who are using ICT on a regular basis in the classroom. In what other similarly sized organization would the boss know the exact numbers of staff who had a computer at home assigned for their own personal use? The DfES data also contain all manner of spurious data on the extent of the 'beneficial effect' of using ICT in the classroom and the number of teachers 'confident' to use ICT. These have not been included in this paper because of their highly subjective nature. In short, it should be concluded that these data need to be approached cautiously.

That said, the official data are the best available record of how ICT is being implemented in schools and provide a valuable longitudinal picture which is

unavailable elsewhere. For this we can be grateful and, given their potential for over- and mis-reporting, the fact that even these data indicated areas of non-use and non-implementation of ICT is cause for further consideration. Indeed, following on from this broad-brush picture there are a number of areas which require more investigation. Based on other research evidence collected over the last twenty years the remainder of this paper now briefly considers these areas.

Reconsidering actual access to computers as opposed to formal access

To date we have discussed the *provision* of computers in schools and implicitly equated this with 'access'. The more computers that are available the easier it is to access them. This simple definition obscures the fact that 'access' is a woefully ill-defined term in relation to technology. As Wise (1997) observes, in policy terms 'access' tends to refer to making ICTs available to all people – in other words 'access' is used solely to refer to the provision of physical artefacts. Yet this notion of 'access' in terms of whether technology is 'available' or not obscures more subtle disparities in the *context* of ICT access. For example, accessing on-line information and resources from a home-based computer or digital television set is not necessarily equivalent to accessing the same materials via an open-access work station in a school library or classroom. Issues of time, cost, quality of the technology and the environment in which it is used, as well as more 'qualitative' concerns of privacy and 'ease of use' are all crucial mediating factors in people's 'access' to ICT (Davis, 1993).

It is important when considering 'access' to computers in schools to acknowledge the importance of an individual's effective access in practice over the formal access to ICT (Wilson, 2000). Indeed, any realistic notion of 'access' to ICT must be defined from the individual's perspective. Although in theory the formal provision of ICT facilities in classrooms, computer labs and resource rooms means that all students and teachers have physical access to that technology, such 'access' is meaningless unless people actually feel able to make use of such opportunities. The logic of this argument can be seen if we consider the increasing numbers of public payphones in UK towns and cities that have recently been converted to offer e-mail facilities alongside conventional telephony. Despite this formal provision it would be a nonsense to claim that every individual in these towns and cities now has effective and meaningful access to e-mail or, indeed, equitable access to e-mail when compared with individuals who use e-mail from their home or place of work.

Table 6
Reported use of different computing activities in and out of schools by secondary school pupils

	[In-school use]			[Out-of-school use]		
	Daily to weekly	**Monthly or less**	**Never**	**Daily to weekly**	**Monthly or less**	**Never**
Writing/word processing	45	40	12	60	26	4
Drawing/designing	19	46	30	30	45	14
Working with spreadsheets	24	47	23	12	39	38
Looking up information on a CD-ROM	13	41	40	41	38	10
Looking up information on the Internet	25	31	38	44	23	23
Making web pages	4	15	74	12	21	56
E-mail / chat rooms	16	20	57	30	22	35
Using software which is designed to teach me something	12	32	49	21	41	26
Playing computer games	11	16	67	61	23	6
Making music/recording music	7	13	73	Not asked		

Note: Data are percentage of respondents (n=1953 across twelve schools). Summed percentages do not equal 100 per cent due to missing data.
Source: BECTa, 2001a

The same logic applies in schools, where research shows that despite high levels of provision not all students and teachers feel able to access computers. As Lanahan and Cronen (2002) report, teachers' actual use of computers varies from individual to individual despite similar school-level access. Research in the US reveals that teachers are more likely to make use of the computer resources at their disposal if they feel that they have ready access to them – for example, if they have a computer in their own classroom instead of having to relocate to make use of a computer (Smerdon et al., 2000). As Lanahan and Cronen (2002) conclude, 'universal' school-access to technology does not lead to 'universal' instructional use of the resources.

Students' and teachers' access to computers at home is also an important mediating factor. A number of earlier researchers have commented on students' use of home computers and the subsequent relationship with their use of school-based IT. For example, Kirkman (1993) found that the majority of the average twelve-year-old pupil's computer experience was gained at

home. Underwood et al. (1994) found that out-of-school experience with computers correlated positively with classroom IT performance, both in terms of computer proficiency and amount of use in school. There is no doubt that children's exposure to technology is rapidly increasing and diversifying. It is estimated that around three-quarters of six- to seventeen-year-olds have some form of domestic access to a personal computer (Child Trends, 2002) with the average six- to seven-year-old spending ten minutes a day on a PC and nearly half an hour a day playing computer games (Livingstone, 1999). Indeed, such research tells us that considerably more children use the Internet, and for longer, from home, parental workplace or the home of a significant other than come into contact with the Internet in school.

Reconsidering the actual use of computers in schools

As the above examples show, it is important not to conflate 'access to ICT' with 'use of ICT'. To extend this argument further it should be noted that 'use' of computers should not be conflated with meaningful use, as Cuban (2001: 72) argues: 'Although we need to know how often students turn on computers in school, we also need to know what they do when the screen lights up.' When we examine what students and teachers actually use ICT for in schools the picture is again one of schools being 'low-tech' users of 'high-tech' equipment. A recent study carried out by the University of Bristol examining the use of computers in ten primary and twelve secondary schools in 'pathfinder' school districts which have been given their full quota of funding from the UK-wide National Grid for Learning initiative, shows how the actual use of ICT in schools varies wildly – even in schools considered to have 'good' levels of ICT resourcing (BECTa, 2001a). The Bristol project shows how students' use of ICT in schools is dominated by word processing and, to a lesser extent, using spreadsheets and occasionally using the Internet (see Table 6). The majority of pupils reported never using a computer in school to make web pages, use e-mail or make music.

The prevalence of computers being used to present written material or retrieve information, as opposed to the more desirable use of computers for communicative or creative applications, belies many of the arguments justifying the use of computers in schools. Moreover, the disparity between students' use of technology in and out of school is striking. With 88 per cent of the students in the Bristol study having access to computers outside school we can see by comparing the 'never' columns that students make far more use

of more applications at home than at school – including 'educational' software and retrieving information on the Internet. Indeed, over 96 per cent of students with home computers reported using them for schoolwork. This mundane use of computers is also replicated in teachers' use of technology in school (see Table 7) – again dominated by word processing and also management and administration.

Table 7
Secondary school teachers' responses to the question: 'How often do you do the following things on a computer at school?'

	Daily to weekly	Monthly or less	Never
Preparing lesson/classroom materials using a word processor or desktop publisher	39	29	28
Classroom administration and management	37	28	34
Searching a CD-ROM for information and resources to use in the classroom	10	44	43
Searching the Internet for information and resources to use in the classroom	21	35	42
Sending/receiving e-mails	25	16	58
Working with software which you will use in your subject-based teaching	17	50	32

Note: Data are percentage of respondents (n=179 across twelve schools). Summed percentages do not equal 100 per cent due to missing data.
Source: BECTa, 2001a.

Yet these trends are by no means exclusive to the UK – with similar patterns emerging in the education systems of 'developed countries' around the world where creative and innovative use of computers is often shunned in favour of lower-level applications. For example, word processing and the retrieval of information have also been found to be the most prevalent uses of computers in US classrooms (Becker, 2000). Similarly, an Australian survey of over 220 schools revealed a similar picture of differential ICT use and skills for both teachers and students (DETYA, 1999).

Reconsidering the outcomes of using computers in schools

Moving on from access and use, data on the outcomes of using ICT are rare. There are a range of small-scale case studies which claim a causal relationship between students' use of ICT and a range of learning outcomes from increased test scores to improved memory (Kulik, 1994; Lou et al., 2001). Larger meta-analyses of computer-based instruction studies also show modest positive relationships between technology and achievement at all levels of education (Kulik, 1994), increased motivation to learn (Underwood and Brown, 1997) and learning self-concept (Sivin-Kachala and Bialo, 1994). Nevertheless, there is an equally pervasive body of literature which counters these assumptions – finding only moderate or even negative correlations between ICT use and learning outcomes (Baker et al., 1993; Miller and Olsen, 1994; Wenlinsky, 1998; Angrist and Lavy, 2002). There has been considerable debate as to whether cognitive skills used when using a computer are indeed transferable (Krendl and Leiberman 1988; McQuillan, 1994), and if this is reason enough for cultivating the widespread use of ICT in schools. Many of the small-scale case studies purporting to show increases in learning attributable to ICT use are methodologically and theoretically flawed (Clark, 1985; Oppenheimer, 1997). Thus, even if we are to take this research on face value, the evidence for 'increased' learning outcomes with individual students is inconsistent enough for us not to draw any general conclusions.

The UK government has also long been keen to 'prove' that ICT has ameliorative effects on school-level outcomes such as test scores, learning and even more esoteric outcomes such as truancy levels and classroom behaviour. Recent analyses of school inspection data by the British Educational Communications and Technology Agency (BECTa) attempted to show how 'schools with good ICT resources have better achievement than schools with unsatisfactory resources' (BECTa, 2001b, 2001c), thus isolating 'an additional ICT factor that predominantly affects those schools with better resources' (BECTa, 2001b: 12). As in similar studies, the BECTa reports are dealing with such generalized notions of 'good' and 'satisfactory' as to render their findings highly subjective and, from a broader perspective, they seem to ignore the possibility that 'good' schools may just be doing better at everything – acquiring ICT resources, achieving higher assessment grades, appearing higher in performance league tables, employing better staff and producing glossier prospectuses (Hickling-Hudson, 1992). To attempt to pinpoint and isolate the 'effect' of ICT on student performance is to underestimate grossly the myriad confounding factors at play when attempting to understand how schools

'work'. As has been discussed at length elsewhere, theoretically this 'cause and effect' mentality is simply the wrong way to think about technology, society and education (see Bromley, 1997).

Reconsidering computers and inequalities

Although the rhetoric of educational computing is often one of all-encompassing change, it is worth considering finally the inequalities in all the above factors, at the level of both the school and the individual. If we do so we can quickly see how the provision of computer resources is patterned by schools' situations – both geographically and socio-economically. The UK government data which I used at the beginning of the paper contained until recently information on the disparities in ICT spending and resourcing between 'relatively prosperous' and 'economically disadvantaged' schools as well as city, town and rural. For reasons best known to the department these data ceased to be collected from 1997 and 1998 respectively – but even without these recent figures we can see how the differences between these different types of schools were marked and enduring (Tables 8 to 11).

Rural primary schools, for example, consistently spent more money on ICT and had lower student:computer ratios than schools in towns and cities. 'Economically disadvantaged' secondary schools consistently spent less money on ICT than their 'non-disadvantaged' counterparts. 'Economically disadvantaged' primary schools consistently had higher student:computer ratios than their 'non-disadvantaged' counterparts. In the US, similar data also show how schools' computing provision varies significantly between schools according to their intake of ethnic minority students and those students on free school meals – a commonly used proxy for lower socio-economic status (US Department of Education, 2002).

Teachers' and students' actual access to and use of computers are also heavily mediated by social factors. For example, boys are twice as likely as girls to have a PC in their bedroom; middle-class (ABC1) children are more likely than their working-class peers (C2DE) to have access to a PC at home but significantly less likely to have a games machine or television in their room (Livingstone, 1999; Child Trends, 2002). Similarly, within schools, social inequalities in students' use of ICT continue to be found. Boys continue to be more interested and motivated in using ICT as well as more confident in their abilities to use technology (Sutton, 1991; Yelland, 1995). Attitudes towards computers have also been found to correlate with socio-economic status, at

Table 8
Average expenditure on ICT in secondary schools (excluding administration from 1993 onwards)

	1986	1989	1991	1993	1995	1997
Relatively prosperous	2890	5903	9288	12000	26750	30050
Economically disadvantaged	2010	3842	10030	12900	16450	22000
Neither prosperous nor economically disadvantaged	2100	5036	21395	12200	17800	31450

Table 9
Average number of pupils in primary schools per computer

	1986	1989	1991	1993	1995	1997
Relatively prosperous	94	62	36	24	18	17
Economically disadvantaged	130	73	42	27	19	21
Neither prosperous nor economically disadvantaged	102	66	40	24	17	18

Table 10
Average expenditure on ICT per pupil by primary schools (excluding administration from 1993 onwards)

	1986	1989	1991	1993	1995	1997	1998
Rural	2.55	4.32	6.37	20	61	15	14
Small town	1.79	2.50	5.37	13	25	9	10
Outer area of large town/city	1.43	2.41	4.69	13	20	8	11
Inner area of large town/city	1.26	2.54	7.44	7	30	12	12

Table 11
Average number of pupils per computer in primary schools

	1986	1989	1991	1993	1995	1997	1998
Rural	66	50	33	17	13	14	13
Small town	101	72	40	26	18	18	18
Outer area of large town/city	118	72	44	27	19	20	19
Inner area of large town/city	143	67	36	28	20	20	19

least when indicated by eligibility for free school meals (Todman and Dick, 1994).

A few authors have also been brave (or foolish) enough to attempt further to research the inequalities in outcomes of using ICT. Attewell and Battle (1999), for example, examined the 'effect' of using a home computer on children's test scores in mathematics and reading. Having controlled for family income and (albeit very crude measures of) cultural and social capital, using a home computer was associated with higher test scores. That said, marked differences in this 'effect' were apparent – with children from higher socio-economic status homes, boys and white children (as opposed to ethnic minorities) reporting higher gains in test scores. Looking back to Cook's (1975) research on the effects of educational television programming ostensibly aimed at disadvantaged children, Attewell and Battle (1999: 10) conclude that computers may well be replicating the 'Sesame Street' effect whereby ICT 'may well widen educational inequality rather than narrow it'.

Conclusions

The optimistic conclusion that can be drawn from all these quantitative data is that, in terms of provision, the computer has a far more noticeable and high-profile presence in the classrooms, hallways and financial planning of schools now than it ever has. Since comparative data have been collected in the UK, levels of resourcing and expenditure on computers have been steadily rising. To argue that all schools are poorly resourced and devoid of computerized technology would be wrong. Computers are certainly in schools in fairly substantial numbers.

However, the 'success' and 'effectiveness' of schools and schooling are ultimately about matters of practice rather than matters of provision – what goes on in the classroom is far more important than what the classroom looks like. Here we can find overwhelming evidence that the computer is decidedly not dominating schools as some educational technology enthusiasts claim. This is not to deny that changes in practice have taken place, but rather to contend that such changes have been relatively moderate and certainly not appropriating the wholesale revolution that educational technologists have been predicting over the last forty years. Commenting on the US evidence-base, Cuban (2001: 72) concluded that 'over the last decade there has been some movement among elementary teachers from non-users to occasional users and a modest shift toward occasional and serious use in high schools'. Yet throughout the English data that we have examined in this paper the mediocrity of the use of computers shines through in the criteria being used. How many teachers are using computers at least once a week? How many schools have a web site at all, regardless of content and purpose? Can levels of ICT resourcing be associated with any increase whatsoever in the results of three-hour examinations completed with paper and pencil? Such categories of data are illuminating in the lack of ambition and permeation of educational technology in schools. If the educational technology revolution had really arrived we should be asking: how many teachers are *not* using ICT in every lesson? In how many schools do pupils *not* have a personal web page? Yet as it stands the data presented in this paper and the breathless predictions that pervade educational technology appear to be poles apart from each other with little sign of convergence.

Thus when we examine the *use* of ICT as opposed to the *resourcing* of ICT, we can see that there is a system of (relatively) high-tech schools with (relatively) low-tech teaching (Cuban, 2001). As mentioned earlier, that this is the case should not be surprising to anyone with even passing acquaintance with the day-to-day workings of schools (see Garrison in this issue). Reports by the schools inspectorate in England and Wales have regularly painted a picture of ICT as subject to 'substantial underachievement in about two fifths of primary schools' (OfSTED, 1998). Other educational commentators have sporadically bemoaned 'twenty years of relatively major investment and quite limited returns' (Robertson 2002: 408). But *why* this is the case throws up a whole host of interesting but under-researched questions.

A common response from governments to this less than rosy situation is to blame schools and teachers for being somehow 'anti-technology' or at least being guilty of dragging their heels on this educational imperative of the moment. Schools and teachers in return would blame the government in

terms of resourcing and financial support to buy and maintain computers. They may also blame students for being generally apathetic to ICT whilst in schools. A common outcome of this 'blame culture' is that governments feel compelled to invest increased amounts of funding in educational computing, provide increased amounts of teacher training and increased amounts of equipment (as has recently been the case in the US, UK, mainland Europe and east Asia). It is then only a matter of time before the pendulum swings back to people wondering why technology is still not being used in education to its full effect and blaming schools, teachers and students for dragging their heels.

The reality of the situation is, of course, far more complex than simply the deficiencies of schools, teachers and students. Educational technology – like all aspects of education – is about far more than people and institutions. Technical solutions such as increased funding, resourcing and training can go some way, but not all the way, to addressing the decidedly entrenched non-technical problems of why computers are not used in schools to the levels they are in other areas of society. Of course, cleanly and clinically disentangling the causal factors underlying the patterns of (non)access and (non)use described in this paper is nigh on impossible. For example, previous education has been found to be the best predictor of home computer access and use in adults (Nakhaie and Pike, 1998) and yet educational technologists have found home computer access to have a positive impact on children's education. All we can be certain of at this point is that there is a lot to consider that such quantitative data can only hint at, as can be seen from the following conclusion from a recent academic study of schools and computers in the UK:

> The disparity between institutions is evident in terms of the different levels of hardware they possess, the diverse ways in which ICT is employed in the curriculum, and the quantity and quality of access time that children are allowed outside the structure of formal lessons. These differences, in turn, are at least partially a reflection of the extent to which individual schools embrace or dismiss the government's vision of using technology to counter social inequalities (Valentine et al., 2002: 306).

Within this brief prognosis are a host of mediating factors which merit deeper investigation: the role of the child as a passive recipient of school ICT (which in turn suggests the alternative possibility that children may also be active (non)users of ICT), teachers as gatekeepers in the 'employment' of ICT at the 'chalkface', the institutional nature of the school, the structuring of the formal curriculum which, in turn, leads to the mediating effect of government

policy-making. Moreover, there is a range of other factors which Valentine and colleagues do not touch on – the role of the IT industry, wider media and cultural constructions of what is 'educational' and what is not, the mediating influence of parents, local education authorities and the societal culture of 'IT'. Having established that the computer is still some way off from dominating schools, the task of educational technology researchers is now to go on to consider in depth this 'wider picture' of computer and schools.

Notes

The author would like to thank Rob Evans for his help in calculating inflation-linked expenditure.

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