

Patterns of Computer Ownership

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Abstract

This paper examines changing patterns of ownership and use of computers among young people. Two surveys at Boston Spa Comprehensive School, an 11-18 school of 1800 students in West Yorkshire, undertaken in Spring 1995 and 1996, show an increase in use of IBM-compatible computers during this period. Factors which have led to this situation are explored, together with some effects of these changes. Student use at home is compared with use at school, and with teacher use of computers. Some implications are considered.

Changing patterns of computer ownership

Computers as consumer commodities.

Surveys conducted in the first part of 1996 by Mintel [1](March) and Hewlett-Packard [2](May) suggested that an increasing number of Personal Computers were being purchased by domestic consumers. Advertisements in newspapers during December 1996 would serve to confirm the trend. Whilst personal computers were initially marketed for business or specialist enthusiast use they are now seen as yet another electronic consumer good. Advertisements in the pre-Christmas period of 1996, whether from direct sales organisations such as Time, DAN and Tiny or retailers such as Comet, Toys R Us or PC World, quote VAT-inclusive prices: a sure sign that domestic consumers, rather than businesses, are being targeted. (The Guardian, 30.11.96; The Times, 30.11.96; 11.12.96; The Independent, 14.12.96.)

The current incarnation of the PC for home use is as an integrated multimedia system bundled with a wide range of pre-installed programs and CD-ROMS, often with such peripherals as modem and printer as part of the package. This is the system identified by Hewlett-Packard in their May 1996 survey as representing a growing market sector. The increasing consumerisation of what was a technical market can be seen the introduction of design features such as integral speakers, hand-held remote controls and colours other than the ubiquitous grey.

Media exposure has integrated computer use, skills and ownership into the mythic tapestry of everyday life.

Newspaper advertisements for the products: television advertisements from manufacturers, featuring images and concepts rather than specific products: FIAT co-opts computers and the Internet to promote its automobiles.; meanwhile, journalists have re-worked the moral panic of pornography corrupting the innocence of childhood through unfettered access to technology. We can see how Internet providers respond to these concerns: they market programs which block access to areas unsuitable for children. Meanwhile, Microsoft leads us with the question 'Where shall we go today?' whilst Virgin Net advertises itself as 'Private school fees. £10 per month.'

The positioning of 'computer at the heart of modern life' is in part a reflection of the education system itself.

A series of government initiatives has provided both a supply of equipment to schools and the National Curriculum to test competence in their application and use. The National Council for Vocational Qualifications, through its programme of Key Skills embedded in all GNVQ courses, places full-page national advertisements to alert employers to the IT skills possessed by these students.

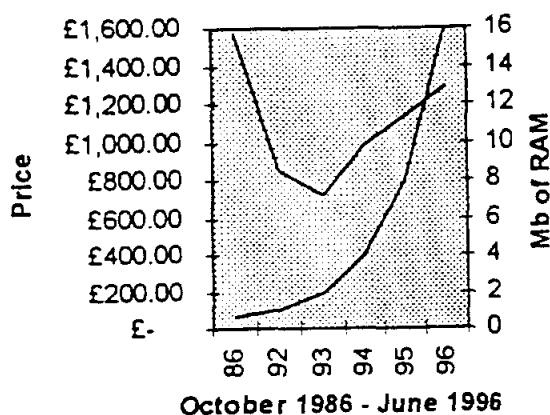
The domestic consumer base serves as a mirror to these factors.

The domestic consumer base serves as a mirror to these factors. In December 1995 the chief executive of Dixons, the electrical-goods retailer, reported that sales of computers had increased by 20%-30% on the previous year. "The fact that prices of these products have dropped so much over the past two years has made them almost as popular as televisions and stereos[3]". At the same time the market research group Romtec (Romtec, The Times) reported that most consumers bought multimedia PCs from high street or out-of-town speciality stores, and that 50% of all PC retail sales for 1995 would have occurred in the fourth quarter[4]. This increase in demand has accompanied the fall in computer prices during the past two years. The potential market for computers has expanded, despite an economic

environment characterised by lack of consumer confidence.

Advances in computer technology and software have made possible multi-tasking and the use of complex graphics. This is illustrated by the fall in the real price of personal computers and the increase in processing power.

The Price of Power



Prices shown have been adjusted to reflect inflation and purchasing power in 1996.

The Cost of Power.

"Computers are expensive but if you didn't have one you probably would be degraded (sic) because of it in later life."

Girl, Year 9.

In 1985 an Amstrad PCW cost £399; £890 at today's prices. Contrast that with the base multimedia PC from Comet, which costs £999.99 today. (Comet advertisement: The Times: 14.12.96) Payment does not have to be made until June 1997. A family can purchase a machine, take home the box, plug the parts together and have the system up and running immediately. Much of the installed software will match that used by schools. There will be a selection of games. The additional purchase of Microsoft's Encarta 97 for £49.99 represents a total expenditure less than that which aspirational families were prepared to make for encyclopaedias in previous generations.

The previous division between computers for young people, which were primarily for games, with some task-based software, and 'real' computers for the business community and 'serious' computer users, has been eroded. The two markets have converged: the same

machine is sold to corporate users and domestic consumers: only the peripherals and software may change. Computer manufacturers such as Dell and Time customise their machines according to the specifications determined by the customer over the telephone.

Asset Transfer.

A further factor is the transfer of computers from the workplace.

"At home, I have a PC, bought originally for my Dad when he was self-employed, but it is only a 286 and cannot run that much. We use WordPerfect 5.1 for DOS. I normally get better grades because it is neater and I can go into more depth. It also saves drafting."

Boy, Year 10.

In accounting terms, PCs have a three-year write-down: after that they are replaced by the latest machines. During the past four years many companies have switched from dedicated terminals to networked desktop PCs running Windows. These machines are now in the process of being replaced by faster, more powerful, models.

Companies such as The Halifax [5] have a policy of offering redundant stock to schools and community groups. They, and many more companies, also have a policy of making them available to staff for home use. £40-50 for a 386 or early 486 machine, with a hard drive and Windows operating system, means that purchase for family use is an immediate decision. During the past decade asset transfer, in the form of a three year-old company car as a second (or third) family car, has transformed the lives of many families. We should expect to see a similar impact as computer ownership becomes more common

Teachers can purchase ex-office computers only if a partner works in such a company: The purchase of a new computer system, on the other hand, represents a considerable proportion of a teacher's disposable income: the price of a system at the leading edge of the market ranges from £800 to £1,000. This may go some way to explain why surveys of teachers show lower levels of ownership than the students they teach: why, once purchased, systems are kept for up to ten years without an upgrade: why the tasks to which their computers are applied can be considered 'low-level IT' by OFSTED inspection teams.

Access to, and ownership of, personal computers.

"My advice to you is "Buy a computer." you won't believe how handy they are ..."

Boy, Year 10.

It is the nature of multimedia machines that they conjure a world of possibilities for each purchaser: showrooms become like Aladdin's Cave, in which everyone can find a reason to justify the purchase. The Dixons retailing chain reinforces all of these with their advertising slogan for these neo-Stakhanovite times:

Work hard. Play hard.

Research Context

Anecdotal evidence during the academic year 1994-5 suggested that many students said that they preferred to work on their computers at home, rather than those at school. Teachers reported that such students were using this as a reason not to engage in work during classes. A survey was undertaken to determine to what extent this could be verified, and how this impacted on work patterns at school and at home.

Methodology

In the spring term of 1995 students in every tutor group were asked to indicate their access to, and use of, computers at home and school. The questions were open-ended prompts, and the response sheets contained spaces for students to comment in detail, should they wish. 1331 students responded: some 74% of the total school population. The shortfall reflects student absence, the pressure of activities during morning tutor time and the priority placed on the exercise by the form tutor.

The initial survey was followed by a more detailed investigation of responses from Years 9, 10 and 12, in which students were asked to comment on the extent to which they thought it worth having a computer at home for work. Detailed student responses formed the basis for interviews.

The survey showed the following pattern:

| Total Number of Respondents in Survey. | | Number of Respondents with a Computer at Home. | |
|--|--------|--|--------------|
| Sex | Number | Work | Games only |
| Male | 674 | 418 (62%) | 229 (34%) |
| Female | 657 | 355 (54%) | 170 (26%) |
| Total: | 1331 | 773 (58%) | 399 (30%) |

Students with a computer at home: the uses to which it is put. (1995)

- 88% of all respondents (1172 students) either owned a computer, or had access to one at home. This total included machines which students qualified as 'only for playing games'.
- 58% of the students (773) who completed the survey stated that they had a computer at home that they used for school-related work.
- 35% of the students - 466 - stated that they had access to a PC with a Windows operating system. This was the system that at the time represented the newest (and most limited) system in use at school.

In some cases responses cited specific software applications: Microsoft Works (the integrated package used across the school PC platform); Microsoft Office and its components, or Lotus SmartSuite and its components. The significance of this is that in Spring 1995 more than 30% of students had access to the same technology as the business world. These students utilised the same programs. They used the same exemplars for document production.

The ways in which students classified their hardware produced a spectrum of age and utility which correlated very closely with uses. For IBM-compatible PC users, older students referred to their machines in more technical terms - 286; 386; 486-SX or -DX - than younger students, who simply cited PC, or Acorn. In Years 7-9 students would state that they used their computers for writing, drawing or graphs, whereas in Years 10-13 the software would be stated - Works ("...for everything..."; Year 11 girl); AmiPro or Excel - and the uses related to specific coursework assignments.

Acorn Archimedes computers have been promoted as the standard machine for education in the United Kingdom. Leeds City Council developed IT programmes and expertise around this standard as did its funding and supply policies. Despite this, Archimedes users constituted only 3% of the school total, and the BBC Acorn a mere 0.4%. This compares with Macintosh ownership of 1% and Amstrad PCW use of 4%.

Student ownership and use of the Commodore Amiga, on the other hand, was 15%. The Amiga constituted the most problematic machine for student use. The marketing policy for the computer was targeted at the games market, but the added value was perceived to be the software bundles that enabled 'real' work to be done. This had proved to be an important strategy when students were negotiating their purchase with parents. All Amiga users cited 'assignments' or 'work for school' as one of their uses. A number, however, added that there were compatibility problems with file transfer or

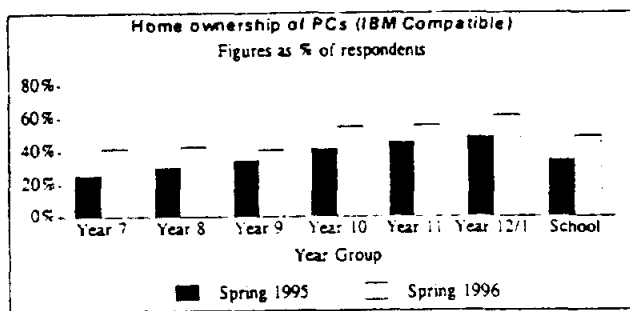
printing between home and school. The games capacity of these machines was their greatest attraction. Students from Year 11 onwards volunteered that they would have been better advised to purchase a PC.

The same survey was carried out in Spring 1996 to determine whether any trends could be identified. The results were compared with those of Spring 1995. They showed a significant shift in home ownership of PCs.

Home ownership of Personal Computers (IBM Compatible) as %

| Home ownership of Personal Computers (IBM Compatible) as % | | |
|--|-------------|-------------|
| Year Group | Spring 1995 | Spring 1996 |
| Year 7 | 26% | 42% |
| Year 8 | 31% | 43% |
| Year 9 | 35% | 41% |
| Year 10 | 42% | 55% |
| Year 11 | 46% | 56% |
| Year 12/13 | 49% | 62% |
| Whole school, as % of respondents | 35% | 49% |

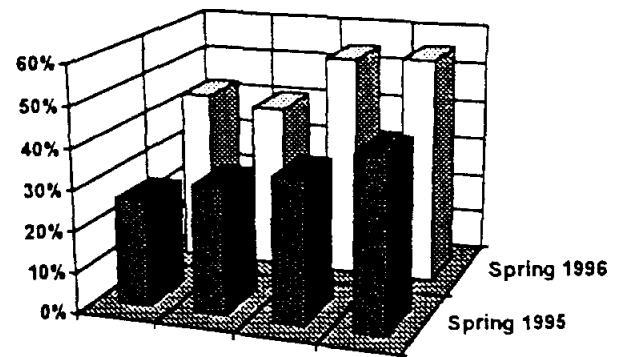
The following chart maps the changes.



The significance of the shift can be seen when the growth in ownership across each student cohort of Key Stage 3 and 4 is examined.

| | Spring 1995 | Spring 1996 | |
|-----------|-------------|-------------|-----------|
| (Year 7) | 26% | 43% | (Year 8) |
| (Year 8) | 31% | 41% | (Year 9) |
| (Year 9) | 35% | 55% | (Year 10) |
| (Year 10) | 42% | 56% | (Year 11) |

Increase in ownership over 1 year



If this growth in ownership of machines continues then the site of production for many students will then be relocated from school, (which is associated with limited access to facilities - time and resources - and, above all, teacher direction) to home.

The factors affecting the growth in ownership - the transfer of older machines from the workplace, the marketing of multimedia PCs as domestic consumer goods, the establishment of PCs as a standard for games programs - have already been outlined. What is of more interest, however, is the effect of extensive computer use on students

Work hard. Play hard.

"The only bad point of doing your homework on a computer is that you tend to find you have a lot more homework as you cannot write things up in lesson. ... PS Make sure you get some good games etc. Doom2 is an excellent game...."

Boy, Year 10.

"the writing is smaller when you print it out ... you have to write more so you get a better mark."

Girl, Year 9.

The comments from both of these students illustrate themes identified at the beginning of the research. The first is that students are now doing work at home that they would otherwise have done at school. The second is that

many students find that using a computer tends to objectify their work. The process of schoolwork and assignments is seen by students as the production of an artefact - a business report, a newspaper, a PowerPoint presentation - and evaluated as such: it correlates with the students' sense of 'neatness' and purpose. Improvements to the artefact are related to the rewards of the task.

Student computer use

Students see computers, with their multiple uses, as an integral part of their lives: all of the students who listed more than one use of a machine cited schoolwork as the primary use, with games as a method of relaxation.

- "I play games when I need a break from my work/other things."* Boy, Year 9.
- "If I can't do my work I play a game to take my mind off things."* Boy, Year 9.
- "I play when I'm bored, or when I need to relax."* Boy, Year 9.

The primary use of computers for work was seen as word-processing. Correct spelling, legibility of text and good presentation were consistently cited as reasons for using a computer.

(52% of users Year 7; 42% of users Year 10; 32% of users Year 12)

The production of documents, rather than simple pages of text, becomes more important through Year 9 into Year 10. The ability to incorporate graphs, tables and clip art into a document was seen in transactional terms: the better produced and presented the document, the higher the grade it was likely to earn. (57 % of users)

- "It also makes it easier for the teacher to read so I think it helps them when marking too. I do find that I do get better marks when I use a computer for my work but I think this is because when doing work on the computer you think about what you're doing more."* Boy, Year 10.

"It also helps you get better marks because it looks good and worth reading even if what's written inside is not really that good." Girl, Year 10.

"Although your work doesn't look as much on a computer it is still the same content and is easy for the teachers to work on and read." Girl, Year 9.

Student reference to, and use of, spreadsheets was related to the production and presentation of a document. The

integration of these two software applications was therefore seen as a means to an end - charts and tables - which were to be incorporated into documents. The use of databases, on the other hand, was restricted to specific subject applications. These were Mathematics (Years 7-9) or Business Studies and Economics (Years 10-11). Students rarely used databases as a way of organising information to achieve their own ends. Only from Year 12 onwards were databases seen as a way of organising and manipulating data.

Most students view computers as a tool for information access and retrieval through use of CD-ROM and Multimedia. A consistent reason for using computers is given as '...learning about things...', but few linked the structure and content of the CD-ROM with databases. (This results in inefficient or inappropriate searches with such resources as The Times on CD-ROM: "...there isn't anything about ..." or, even worse, hundreds of 'hits' in which a single word has been identified. Searches on broad topics using the Internet produce a similarly frustrating result. Search routines need to be taught.) There is little research evidence as yet that relates to this. What is needed is a broad-based observational study to identify strategies used by students. Initial observation, however, would suggest that many students use such information searches as initial 'fishing', after which a search becomes more focused and specific.

- "... Computers with reference software, such as "Encarta" are great for research."* Boy, Year 9.
- "...Encarta 95 ... an easily operated, vast encyclopaedia with many facts and lots of information. At home it will help improve research skills and speed up the time doing it, so you can get more written content in your work..."* Girl, Year 10.

58% of students in the school use their home computer for work: it would suggest that the computer is seen as a tool. This increases in frequency as the students move through school.

Results from Boston Spa Comprehensive School are complemented by work in progress at ULTRALAB, Anglia Polytechnic University [6]. The National Survey of 11-14 year old Children's Emergent Capabilities provides an initial sample against which the whole-school survey at Boston Spa can be compared.

The report of the 1994 pilot study was published in December 1994. The sample size was 500, less than the sample of Y7-9 at Boston Spa.

The ULTRALAB survey found that 82% of students had a computer at home, although it was stated that this figure might well reveal some confusion about what constituted a computer. If a similar analysis is applied to the Boston Spa results for Years 7-9, then the data can be compared.

Uses to which computers are put

| Years 7-9 | Computers for Work | | Computers for Games | |
|-----------|--------------------|----------|---------------------|----------|
| | Boston Spa | Ultralab | Boston Spa | Ultralab |
| M | 62% | | 57% | 86% |
| F | 89% | | 42% | 65% |
| Total | 75% | 48% | 49% | 76% |

The Boston Spa sample would suggest that a significant number of those students who used a computer for games also used it for schoolwork. Supervision of the students whilst they completed the questionnaire was minimal: this reduces the likelihood that they told their teachers what they thought they wanted to hear. This, then, raises two possibilities: either the Ultralab sample contains a greater number of students for whom games playing was the only appropriate use for the computer, or that a greater number of students only wanted to play games on their machines. Students were invited to respond to the Anglia Polytechnic survey: those who responded were therefore self-motivated. It is unlikely that such respondents failed to consider that schoolwork was an appropriate use for a computer.

What is more likely is that, for the age group surveyed at the time, possession of an appropriate system was the critical factor. The 11-14 age group at Boston Spa is the one which shows the least ownership of home PCs. The ULTRALAB results would correlate with those students at Boston Spa whose response was that their computer was unsuitable for schoolwork. Given that data from the computer industry confirms that a significant percentage of purchases are made at Christmas, students with older or dedicated systems, purchased as presents primarily for games playing (cf. responses relating to Commodore Amigas), would be likely to give this response. The completed survey from ULTRALAB should confirm the trend.

The steady increase in computer sales and the market convergence, in that PCs are now presented as machines that can be used for games, information access and communication, as well as for work, may be expected to end the games/work dichotomy.

The WIMPs have won.

"Computers are the future they are quick and easy."

Girl, Year 9.

Few now use (or understand) the term WIMP in anything other than its most pejorative sense. When the acronym (Windows Icons Menus Pointers) was first coined, however, it was seen as a truly revolutionary way forward for computers and computing. No longer would users have to master the mysteries of CP/M or DOS operating systems and make an appropriate response to the tyranny of the flashing A:\ or C:\ prompt before a program would install itself or run. People could use computers, rather than have to learn about them. Jeremiahs warned that this would lead to a generation of computer illiterates. What has happened, however, is that young people can increasingly use computers without a steep initial learning curve. The Graphical User Interface - GUI - enables users to relate the task to icons. Students practise functional semiotics: The Button as Signifier.

The market for integrated office software is an oligopoly dominated by Microsoft, with Lotus and Corel seeking to expand their market share through bundled packages (pre-installed programs) that come with most PCs. Microsoft Works is a popular suite of programs that is increasingly used by schools; Microsoft Office is sometimes supplied on more expensive machines. Lotus SmartSuite combines a range of applications familiar to many corporate users and Corel have combined WordPerfect with CorelDraw and other applications to form their version of Professional Office. All of these programs integrate applications in a similar way: all enable file transfer in a range of formats: all focus on document production: all contain similar tools.

Young people now have the possibility of utilising computers to undertake tasks which would otherwise have been beyond their capability. The production of text in volume, using a range of formatting techniques: instant access to information from a range of encyclopaedias and reference books: the ability to manipulate images: all of these can be carried out by young people at a far earlier developmental stage than was previously the case.

"Computers can make homework need a lot more time, even if you're very good at using them, because you end up spending a lot of time tweaking your work. The end product can look very good, especially with expert use. Spell checks and automatic language aids such as Thesaurus help your writing. Computers with reference software, such as "Encarta" are great for research. AmiPro2 is the best word processor/d.t.p. program in the world. Apart from AmiPro3. You can also sharpen up your brains playing games such as Tetris and Doom."

Boy, Year 10

It has become evident that the ease of production has enabled young people to move beyond previous limits imposed by motor skills, time and performative competence.

"On my PC we have AmiPro, for a word-processing package and Lotus 1-2-3 as a spreadsheet program. I use the computer to word process assignments as my handwriting is very messy. Also because it is easy to change things, and move things around. On AmiPro there is also a Thesaurus, a spell-check and a grammar check, which I think improves my work." Girl, Year 10.

"... they can get you marks for presentation, spelling, punctuation and sentence structure. If I do a draft and want to change it, it is quicker and easier than scribbling and making the paper messy, so you can read it." Girl, Year 10.

The cumulative effect of these programs on student work is to produce a document hegemony. Students who use these programs are enabled to produce documents that include tables, charts and clip art.

"Now I use my computer for all the work I do apart from Maths and things like that. I can draw on my computer, make music, listen to music, write stories, look up words to find a meaning for it like a dictionary, print out any work I want for homework. I think it makes homework a lot easier because of all the different programs." Boy, Year 9.

The documents are paginated, use a range of text formatting styles (often based on document templates), incorporate checking systems such as spelling, Thesaurus and grammar and produce a high-quality print-out. Reference sources from CD-ROM can be pasted into such documents at will. Students feel that text is less limited and more varied, since they can use the Thesaurus to extend their vocabulary, and more 'perfect', since they believe that the spell-check and grammar checks will remove the surface errors which form their teachers' initial comments.

"I have a CD-ROM at home and find it very useful when doing projects ... (it) could result in getting better marks as you have more info on the topic." Girl, Year 9.

The quantity of work produced in this way is likely to increase as students move from Key Stage 3 to 4 and GCSE. For the 94-96 GCSE cohort at Boston Spa the average was 30 substantial pieces of coursework during five terms. Student responses showed that many with computers at home felt that their output was increased.

"The amount of time spent on homework is still the same but when on computer you end up doing more detailed work and more of it too." Boy, Year 10.

Access to programs which will facilitate the production process becomes a priority during this period.

"... if you don't have a computer and your handwriting is not too good then you could lose marks for being untidy..." Boy, Year 9.

"I find it a lot quicker to write up on a computer, and I find it much easier to write as it all just flows out." Girl, Year 10.

Those with systems at home gain a significant advantage over those who have to share those at school - and recognise this.

"It won't get you extra marks for content, you may get some for presentation. It may be possible, though, to pick up extra marks if you use a special program like Encarta 95 ... an easily operated, vast encyclopaedia with many facts and lots of information. At home it will help improve research skills and speed up the time doing it, so you can get more written content in your work." Boy, Year 10.

Using the resources

The increasing facility of young people to utilise computing resources in their work would suggest that they have internalised the routines and skills required by the software which they employ. Comments made by students in Years 9 and 10 during the second survey, and quoted in earlier sections of this paper, would bear this out. The ways in which students use computers reflect their facility.

"... I do find that I do get better marks when I use a computer for my work but I think this is because when doing work on the computer you think about what you're doing more." Girl, Year 10.

Their approach to schoolwork, coursework and assignments is linked to the IT resources available to them, whether at home or at school.

"... it is easy to change things, and move things around ... there is also a Thesaurus, a spell-check and a grammar check, which I think improves my work." Girl, Year 10.

A consequence of this is that the amount of time which is spent using computers for work, and the range and volume of the tasks undertaken, is often far greater than

that of their teachers. Mention has already been made of the average of thirty documents that students produce in five terms of GCSE coursework.

"I think that no matter what teachers say about you not getting any extra marks for the work being printed, a well-presented piece of typed work with (obviously) no crossings-out and no spelling mistakes can make a teacher go "Wow!" as soon as they see it."

Boy, Year 10.

Teacher computer use: at school, and at home.

Their teachers spend far less of their working day using computers. They were asked to complete the same surveys as the students. The results showed that such use as takes place primarily involves the production of worksheets for students (74% of respondents cited 'typing' - word-processing as their main use) or administration: entering orders on the school SIMS terminal (School Information Management System), or student data for departmental records. This involves the production of class and set lists, rank order lists and other administrative tasks. Teachers undertake these tasks on school PCs or Archimedes machines, or on machines at home. No year team, department or member of staff indicated that data transferred from SIMS was used for this task, or that SIMS itself was used: it is simply regarded as an electronic order-generating machine.

Teachers also use equipment at home far less than do students. Whilst 43% of staff respondents had access to a PC at home, only 57% of this total stated that they used the PC for word-processing - the most frequently cited activity. Teachers consistently use the word 'typing' to describe this.

In other words, less than 25% of the school staff used a computer at home - even though 43% of the staff had access to one.

The primary use of their computers is for word-processing: the production of worksheets, correspondence, church newsletters or recipes.

The survey was repeated in late spring 1996 to determine whether the same increase in PC ownership had occurred amongst teachers as with students. Ownership appeared to have increased to 52% of respondents.

However, only 60% of the teaching staff completed the return. If the staff total is used as a base, and we assume that teachers who failed to complete a return neither use Information Technology in school nor own a computer, an even more gloomy picture emerges.

Computer use at school and home: teacher response 1996.

| Staff | 111=100% | W/P | S/S | D/B | CD-ROM | CAL | CAD | Cont rol | Interne t | Video-conferen ring |
|------------|----------|----------|----------|----------|---------|----------|--------|----------|-----------|---------------------|
| School use | 40% (44) | 40% (44) | 11% (12) | 18% (20) | 7% (8) | 29% (32) | 6% (7) | 2% (2) | 4% (4) | 4% (4) |
| Home use | 32% (35) | 32% (35) | 11% (12) | 11% (12) | 9% (10) | | | 1% (1) | 4% (4) | |

This would suggest that the staff as a whole may not have internalised the skills and concepts implicit in the application of computers to work in the same way as have their students.

This disjunction will possibly have serious implications for teachers.

"Once you have finished and the teacher asks you to add or do it again you can say "OK" without a face."

Boy, Year 9.

Conclusions.

Workers of the Future

The working methods for students who use computers are different from those who do not. Task outcomes envisaged by students have changed, as computing facilities available predicate the finished product. In 1988 one Year 10 student at Boston Spa Comprehensive School regularly produced documents with embedded charts and tables. Other students were able to wordprocess text and generate accompanying charts and tables. The majority of students had to hand-produce assignments: their expectations were framed by the skills and time available to them, and their work shaped accordingly.

The comments from Year 9 and Year 10 students during the research undertaken during the summer term of 1995 show that an overwhelming majority of students now see the boundary of their possibilities at a different level. For them, the technology available represents the limit. Those students who do not have access to these facilities at home, or who do not use them at school, are still aware of what is possible. Their peers provide compelling evidence of what can be done. For these students, McLuhan's aphorism has become :

The medium is (part of) the message.

Not only does the medium determine the way in which the message is read, but it also determines the way it is produced - and, inevitably, the content.

Different circuits

Students' internalised concepts may well be different from those of their teachers. They see the product as the integration of a number of computer facilities through their computer skills. These students use and synthesise information. The availability of Internet and CD-ROM information sources presents a vast range of informational possibilities: far greater than those a student could access in a conventional school library, or from domestic reference books. Students no longer struggle to rephrase one or two text sources for their assignments: rather, magpie-like, they select from a range of them and assemble a collage. They epitomise the post-modern condition, in which reality vies with the virtual reality of a techno-media simulacrum.

Official Orthodoxies: A Clash of Expectations

Curriculum applications of Information Technology, especially those required by the Statutory Orders of the National Curriculum, may need re-thinking in the light of the previous points. Much current practice seeks to identify opportunities to integrate Information Technology applications within specific sections of subject curricula. Students who use their computers for as much of their work as possible integrate their subjects with the appropriate applications of their computers and their skills.

Their teachers ask questions such as:

"Where can I use a database in Key Stage Three History?" or "How could we set up a spreadsheet to calculate the dietary value of these meals?"

The students ask themselves

"How am I going to produce the front page of the Glamis Times after the death of Duncan? or "What am I going to do with all this supermarket data for my Economics assignment?"

The students think about the final product, and the way in which their computing resources can be used to shape that.

The front page of the Glamis Times will depend on the Desk Top Publishing program that is available, the range of fonts, styles, clip-art and page layout, will shape the

ways in which the text is generated. The ways in which the text is generated will determine the text itself. Similarly, the range of charts which can be produced from a set of data will stimulate observations on supermarkets, food prices and competition in the Economics assignment. When students can, with a minimum of effort, generate and print one chart after another they can compare and contrast these to discern patterns and trends, rather than having to determine what the pattern or trend was, and then produce an accompanying chart.

New Signposts: New Paradigms?

Curriculum delivery may have to be rethought, in that assumptions about developmental stages and theories of learning may no longer be appropriate. Children who have mastered computer routines are freed from the limitations of their developing motor skills. They are able to focus on the content of their artefacts, which become much more a reflection of their identity.

The blemishes, imperfections and limitations which so clearly stamp their trademark *This is the Work of a Child* across every page are removed. It is easier for us to look at the child's ideas, rather than the child's mistakes. We should also look at the processes involved in the child producing that work. The use of a range of PC facilities requires the user to manipulate data, processes and skills in the abstract-symbolic environment of hyperspace (*the conjunction of The Thinking Process and What the Machine Might be Made to Do.*) It may well be this process that is of ultimate significance in what we call schooling. Programmes that focus on the process, (of action planning, monitoring, information access, use and evaluation) as much as on the product, (what is produced) could offer a way forward.

Student-centred learning may yet re-define itself, cloaked in The Web and, Phoenix-like, arise in the new respectability of Lifetime Learning.

Computer prices and specifications 1984-96

| Date | Make | Memory | Hard Disk | Features | Printer | Software | Price | 96 Price | Supplier |
|---------------------|-----------------------|--------|-----------|-----------------------|------------------|-----------------------------------|--------|----------|------------|
| Jan. 1984 (1) | BBC B | 32k | | Green monitor | Daisy-wheel | View w/p | £1360 | £3035 | Specialist |
| Nov. 1985 (2) | Amstrad PCW | 256k | | Green monitor | 9-pin dot matrix | CP/M Locoscript | £399 | £890 | Dixons |
| Nov. 1986 (5) | Amstrad PC-1512 | 640k | 20 Mb | Mono monitor | None | MS-DOS Wordstar | £999 | £1575 | Dixons |
| May 1992 (3) | Chipboards 266-12 | 1 Mb | 40 Mb | Mono monitor | 9-pin dot matrix | MS Works | £786 | £850 | Specialist |
| | ALR 386-SX16 | 1 Mb | 105 Mb | SVGA monitor | None | MS Works | £1082 | £1164 | Time |
| | ALR 486-50 | 5 Mb | 105 Mb | SVGA monitor | None | MS Works | £2582 | £2780 | Time |
| January 1993 (4) | Unitron 286-12 | 1 Mb | 40 Mb | Mono monitor | 9-pin dot matrix | Lotus Works | £415 | £440 | Morgan |
| | Megatron 486SX-25 | 2Mb | 40 Mb | Mono monitor | None | Windows 3.1 Works | £688 | £729 | Morgan |
| | Amstrad 486SX-50 | 4 Mb | 105 Mb | SVGA monitor | None | Bundled packages | £1102 | £1167 | Dixons |
| Sept. 1994 (5) | Escom 486DX2/66 | 4Mb | 420 Mb | SVGA | None | WFWG Works | £949 | £982 | Escom |
| | Escom 486DX2/66 | 8Mb | 525 Mb | SVGA | None | WFWG Works | £1099 | £1138 | Escom |
| | Packard Bell 386SX-16 | 1Mb | 40 Mb | VGA | None | None | £399 | £413 | Morgan |
| | 386DX-40 | 1Mb | 40 Mb | SVGA | None | None | £419 | £434 | Tiny |
| | 486SX-25 | 4Mb | 130 Mb | SVGA | None | None | £529 | £548 | Tiny |
| | 486SX-25 | 4Mb | 210 Mb | | None | None | £699 | £724 | Tiny |
| 08.05.96 (6) | P75 | 8Mb | 630 Mb | Multi-media | None | Lotus/MS package 7 CDs | £899 | £899 | Tiny |
| 05.06.96 (7) | P100 | 16Mb | 1.3Gb | Multi-media | None | None | £779 | £779 | Tiny |
| | 486 DX2-66 | 4Mb | 630 Mb | SVGA | None | Bundle | £799 | £799 | Tiny |
| | P75 | 8Mb | 1.2 Gb | Multi-media | None | full package | £1105 | £1105 | Byte |
| 28.12.96 (8) | P150 | 16Mb | 1 Gb | Multi-media Fax/Modem | Laser | Lotus SmartSuite 5 packages 5 CDs | £1162. | £1162 | Time |

Prices adjusted to 1996 levels: data supplied by Lloyds Bank Economics Department.

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5. *The Halifax Building Society: circular to schools*: September 1995.
6. HEPPELL, S. *National Survey of Emergent Capability* ULTRALAB Anglia Polytechnic University

Other Information sources:

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2. Sales Invoice November 1985
3. PC Magazine May 1992
4. Windows User January 1993
5. PC Magazine September 1994
6. The Times May 8 1996
7. The Times June 5 1996
8. The Times December 28 1996