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Internet provision and use in secondary schools: the implications for design and technology

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Abstract
This paper describes the results of a survey, carried out in the summer of 1997, into Internet provision and use in secondary schools in Great Britain. These provide a detailed picture of Internet access and use in secondary schools that suggests that, in the majority of schools, the use of the Internet is at a very early and restricted level of use.

The data collected have supported the development of an exploratory model describing the various types of Internet connectivity and the possible uses of them in schools. The steps that schools will need to take if Internet use is to become embedded in the curriculum are explored through this model, with reference to recent Government policies for a National Grid for Learning (NGfL).

Some approaches to the use of the Internet within design and technology that are realistic within the constraints of limited access are reviewed. Looking to the future and the development of the NGfL, the paper concludes with suggestions for Internet based resources that can effectively support both teachers and their pupils in design and technology and asks what their implications for developments in connectivity, software and subject-specific content might be.

Background
The recent rapid growth of public interest in the Internet and the services which it provides, particularly the World Wide Web, has been mirrored in schools as teachers and managers have begun to appreciate its potential as a medium for communication, teaching and learning. Government statements and strong support for information technology in schools, as evidenced in the consultations concerning the proposed National Grid for Learning (NGfL) (DfEE, 1997b) and support for the Superhighways initiative (DfEE, 1995b) have fuelled this interest and placed a particular emphasis on communications technology. The European Union is supporting similar moves (European Commission, 1997).

Unfortunately Internet developments outpace even the fastest official policy making. The National Curriculum Orders for IT (DfEE, 1995) were deliberately written in generalities to account for technological development during their life. To a degree this strategy has been successful in assimilating some Internet developments, for example web page creation and wider access to electronic communications. However there are other critical aspects, perhaps most starkly those relating to the quantity and quality of information available via the Internet (McFarlane, 1997, Gilster, 1997), that the Orders do not address, yet which, whether statutorily required or not, are unavoidable for teachers working with pupils.

These difficulties have been compounded by a dearth of facts about the actual state of Internet connection and use in schools. Information is often based on the results of a number of well-publicised and funded projects (see DfEE, 1997c for example). While such projects are of great importance in pointing to the potential and possibilities offered, they also pose some difficulties as noted by Yeomans (1996:8):

"... these projects, usually publicly funded with some commercial contribution, tend to be capital intensive and short run, with outcomes inadequately evaluated and disseminated. They can be limited in their prognostic value because they depend on unrealistic levels of resource and often
mask implementation costs vital to long term success. Sometimes, they are counterproductive in raising unrealistic expectations and antagonising non-participants by diverting resources away from other priority areas.”

Similar points were made in the Schools Online Phase 1 Final Report (DTI, 1996:29,54)

The survey
As a preliminary to more detailed studies and because such figures did not exist elsewhere, the authors set out to:
• Establish a benchmark showing the present state of the adoption and use of Internet connectivity in schools.
• Establish the extent to which schools are using the Internet in teaching and learning.
• Make some assessment of their future plans and needs.

This was done by a survey that took the form of a questionnaire distributed to a random sample of secondary schools in Great Britain during June 1997. The findings are reported in detail in Jervis & Steeg (1998); a summary follows here.

General IT provision
Responses were received from 116 secondary schools having a total of 100,000 pupils. The general background to these schools is provided in Figures 1-3.

The average number of pupils per computer was 9.26. This compares to a figure of 9.0 reported by the latest DfEE statistics (DfEE, 1997a).

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Percentage of Responding Establishments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-18</td>
<td>53.4</td>
</tr>
<tr>
<td>11-16</td>
<td>37.9</td>
</tr>
<tr>
<td>13-18</td>
<td>8.6</td>
</tr>
</tbody>
</table>

Figure 1  Age range in schools

Figure 2  School control

Figure 3  School selection policy
• 72% of computers were located in computer rooms or teaching suites
• Computers are available for pupil ‘open access’ for only 17% of the teaching day.
• The average number of teachers of ICT was 2.1 full time equivalent (f.t.e.) and the average ICT technician support was 0.6 f.t.e. 36% of schools had no support from an ICT technician and only 5% had 2 or more.

Two other recent reports (Olivetti, 1997, RM, 1996) also reached similar conclusions, though these summary reports do not make clear the basis on which the results were gathered.

The National Council for Educational Technology (NCET) proposed four models for ICT teaching in schools (NCET, 1996). For the purposes of this survey, they were reduced to three. Teaching ICT;
• as a separate subject (‘centralised’),
• partially integrated into the curriculum (‘skills core’ and ‘kick-start’),
• fully integrated into the curriculum (‘cross-curricular’).

The pattern of ICT teaching in the responding schools is shown in Figure 4.

<table>
<thead>
<tr>
<th>(% of schools)</th>
<th>Separate</th>
<th>Partially Integrated</th>
<th>Fully Integrated</th>
<th>No of schools responding</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS3</td>
<td>38</td>
<td>46</td>
<td>16</td>
<td>(114)</td>
</tr>
<tr>
<td>KS4</td>
<td>26</td>
<td>49</td>
<td>37</td>
<td>(111)</td>
</tr>
<tr>
<td>6th form</td>
<td>46</td>
<td>37</td>
<td>17</td>
<td>(59)</td>
</tr>
</tbody>
</table>

Figure 4 Pattern of ICT teaching

Most schools have open access for pupils at lunchtimes and after school, but fewer have computers available for pupil use during breaks and before morning school as shown in Figure 5.

When considering computer availability, an arbitrary level of one available computer per 20 pupils was taken as a benchmark that would provide adequate Internet access for all members of the school population

Figure 5 Schools without computers for pupils’ use (approximately half the value for overall computer availability). Figure 6 shows that:
• 41% of schools reached this level of provision at lunchtimes.
• 5% of schools have no computers available for pupils’ use at lunchtime.

Internet provision
Schools were asked whether they had an Internet connection and, if so, for how long or, if not, whether they intended to establish a connection in the short, medium or long term. Almost 83% of the schools have some kind of Internet connection, with only 3% expressing no intention to connect at all as shown in Figure 7.

Figure 7 Connections and connection plans
It was found that urban schools, smaller schools, schools without sixth forms and Secondary Modern schools are less likely to have an Internet connection than other schools and are also more likely to have no plans to make such a connection.

These findings suggest that funding has a critical role to play and there is other support for this:

- Schools with lower numbers of computers and of networks are also less likely either to have an Internet connection or to plan for one,
- All the (relatively generously funded) ‘Technology’ schools surveyed did have Internet connections,
- Numerous comments were made by teachers that funding was an important factor in both establishing and expanding Internet connections.

Most schools with Internet access have a connection for one or two stand-alone computers. Figure 8 shows the number of computers connectable via a standard phone line (PSTN). Note that, as a ground rule, one PSTN line supports one computer connection. Figure 9 shows the numbers of computers connectable via an ISDN (Integrated Services Digital Network - i.e. digital as opposed to analogue) line. One ISDN line can support up to about 20 computer connections.

These machines are also often in ‘staff only’ areas.

The difficulty schools have is that establishing multiple access is costly and they are thus thwarted in their desires to move from their single connections. Decisions are often based on ‘what’s free (or cheap)’ rather than ‘what’s best’ and managers are apprehensive about the ongoing costs they will become committed to once they start to move towards multiple connection.

Use of Internet connections

The majority of Internet use by staff is research (93%), downloading curriculum materials (71%) and downloading software (55%). The connection is used for private e-mail in 75% of schools. For pupils, individual research accounts for 80% of use followed by directed class research (46%), class e-mail projects (41%), undirected class research (35%) and private e-mail (28%).

It is important to note that these figures do not suggest, for example, that 93% of staff are using the Internet for research - simply that at least one teacher is doing so in 93% of schools. Research Machines’ recent report (1998) notes that Internet use “...can be divided into a few heavy users and a large majority of very occasional users... ” and finds a similar range of uses.

Internet connections are largely being used in a self-directed fashion by a few staff and
pupil enthusiasts. There is little serious curriculum work being done and where this is happening, it is restricted to a few teaching groups. These conclusions are supported by the recent report from Research Machines (1998) which also reports that most Internet use occurs outside the timetable. On NCET’s model of ICT integration into schools (NCET, 1995), Internet use is at an ‘Evolutionary’ stage and, in most schools, ‘Localised’. The exploratory development of this NCET model found in Appendix A provides a summary description of the curricular possibilities of a range of levels of connectivity.

Conclusions and implications for design and technology

It is, perhaps, obvious to note that schools will only benefit widely from Internet access when multiple access is more generally available within the school. This is implicit in the proposed NGfL target (DfEE, 1997b:24) that, by 2002, 75% of staff and 50% of pupils are using their own e-mail addresses. A model for the expansion of Internet connectivity developed by UKNetYear (1998a) suggests two hardware items that are needed if this multiple access is to be achieved; a high bandwidth Internet connection to the school and networked distribution of access to it within the school.

Recent offers from BT (1997) and the Cable Communications Association (1997) have fixed the costs of Internet connection via ISDN. However our connectivity model (Appendix A) suggests that ISDN connection may not be adequate to meet the needs of any but the smallest secondary schools even in terms of the Government’s own NGfL targets. Higher bandwidth connections (for example via a leased line, microwave link, satellite broadcast etc.) are currently much more expensive both to install and run, though continuing developments in communication technologies suggest that this may improve in the medium term. In the short term a cost-effective route to providing Internet experiences is through the use of an Intranet, though the limitations imposed by this strategy should not be overlooked.

Implicit in this is that the cost of the connection is neither the only, nor usually the most important, concern. Others that follow from the introduction of a high bandwidth connection include:
- The higher cost of access to an Internet Provider.
- The costs of large numbers of email addresses imposed by most providers.
- The costs of routers and servers.
- The costs of upgrading, extending or even installing networking round a school.
- The costs of maintaining and upgrading computers; it is increasingly the case that the modern browsers required to support up-to-date Internet technologies require relatively powerful computers.

A further, often hidden, cost is that of establishing and maintaining expertise in a very complex and fluid area of computing technology.

Publications for schools from UKNetYear (1998a,b) go some way to detailing these costs and suggesting ways of working with business and their community to meet them.

It is, in principle, easy to give all staff and pupils e-mail addresses. (The explosion in the last 12 months of ‘free email for life’ offers has been interesting. Many of these explicitly claim to ‘solve’ the problem posed by the NGfL targets, but all are web based which we do not believe is an effective approach to email delivery, even where schools have permanent Internet connections.) However to make use of these addresses requires that teachers be given adequate training so that they can use the software both effectively and appropriately. Use of the Internet as an information resource poses similar training requirements. The UK Government, in its NGfL proposal, has set a target that by 2002 all teachers will “…generally feel confident, and be competent to teach, using ICT within the curriculum.” (DfEE, 1997b:24). In order to meet this the Government is currently implementing plans to provide targeted ICT training for every serving teacher (450,000 in total) and to ensure that all newly qualified teachers are ICT trained.
Adequate infrastructure and training are necessary requirements for the effective use of the Internet in schools, but form only part of the overall requirements. Schools will need to develop strategies that allow staff and pupils the access to Internet computers that is needed (Taylor, 1997), taking into account the peculiarity of schools (in comparison to other organisations where the Internet is widely used) that their highly structured day precludes, for much of the time, easy access. These are likely to include:

• Providing all teachers with easy access to a physically local computer that has an Internet connection, even if ‘a computer on every teacher’s desk’ is not always practical (for example in a workshop).
• Ensuring departmental involvement by providing networked access to curriculum areas.
• Making much larger numbers of computers available for ‘free access’ outside lesson times.
• Developing ‘public clusters’ that are not used for teaching and are therefore available to permitted users during lesson times.
• Methods for ensuring that access is suitably supervised (by either human or electronic means).

The NGfL needs to be directed towards supporting schools in using the Internet effectively in their teaching and learning, it thus needs to address two problems that pioneers have been facing:

• A lack of material clearly directed towards the UK National Curriculum.
• The difficulty of finding good general material to use with pupils (and restricting access to the irrelevant or unsuitable).

The availability of accessible (both in terms of their readability and their ability to respond rapidly) and appropriate (to the learning we are trying to achieve) resources to support teaching and learning has been a particular difficulty for design and technology in comparison, for example, to mathematics or science. This has been due both to design and technology’s lack of an established history as a discipline and significant differences in its curriculum structure between the UK and other countries.

The design and technology community clearly has the responsibility to define what sort of content is (and is not!) required and to suggest criteria for the development of ‘gateways’ giving access to such material. Suggestions for this include:

• Support for product analysis through the provision of up-to-date product information on a range of similar products.
• Case study material, that is either current or in more detail than is possible with paper based products, to broaden pupils’ perspectives.
• Information about manufacturing processes in a wide range of industries. At present this is sparse as most manufactures’ sites are a mix of advertising and ordering information (there are exceptions; the M&M’s site will tell you how they put the lettering on the sweets!).
• Ordering information and on-line ordering. This might have clear advantages for teachers (anyone who has taught knows the difficulties of trying to get through to a busy order line in snatched moments of a teaching day!).
• Pupils engaged in (particularly technical?) design might have the ability to search an on-line database for latest information or a component with a particular characteristic.
• Technical information and support. For pupils this needs to avoid being simply an ‘electronic text book’ since (certainly with current technology) such information is most effectively delivered via paper or CD-ROM. ‘Ask an Expert’ schemes have proven their worth in other disciplines but are expensive to initiate, though longer term efficiency can be achieved through the development of FAQ (Frequently Asked Questions) lists.

Design and technology teachers teach across a wide range of materials particularly, though not exclusively, at KS3. Many need support that should be met through further training. While the core of this may well be ‘face-to-face’, distance learning materials as well as peer-tutor and peer-peer support using computer mediated
communication (CMC) technologies can provide support.
• Support for distance manufacturing. This is beginning to be developed both with the support of companies (e.g. Denfords) and through schools making local arrangements, but there are enormous logistical difficulties to overcome.
• Support for group designing across a distance. At the moment assessment structures dissuade teachers from allowing pupils to work collaboratively, despite the ability to work in such a way being in high demand in industry. CMC allows a wide range of individuals to work together - for example across the boundaries of primary, secondary, further and higher education, or with partners in industry.
• Support for strategic skills. At present the focus of such developments have been Java based CAD tools. It is likely to be some time before the use of such software across the web is more effective than using local disc-based programs due to the latter’s better speed and feature richness. (Though if such tools are free schools may choose to use them despite these weaknesses!)
• Other support for design work may make more effective use of the medium by supporting and improving the various decision-making processes (e.g. identifying needs and likes, specifying, generating ideas, choosing between alternative solutions, planning, and evaluating) that pupils engage in during design work.

Not all will agree with all the items in the previous list and many may wish to add further items. What is important is that the community engages in debate about what is desirable, comes to a measure of agreement as a result and, true to its traditions, engages in the design and realisation of tools that make the best use of the medium (within the constraints described here) to support the highest quality of learning in design and technology.

References
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- UKNetYear (1998a), UKNetYear buyers guide, BESA, London.

- UKNetYear (1998b), UKNetYear ‘how to’ guide, BESA, London.

## Experimental Connectivity Matrix

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Number of simultaneous computer connections possible</th>
<th>Distribution of computers connected</th>
<th>Connectivity Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 (at a time)</td>
<td>Staff Area</td>
<td>Restricted</td>
</tr>
<tr>
<td></td>
<td>Fewer than 1 per 20 users (via proxy server)</td>
<td>Pupil/Public Area</td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td>More than 1 per 20 users (via proxy server)</td>
<td>Computer suite</td>
<td>Experimental</td>
</tr>
<tr>
<td>Analogue Dial-up Connection (28.8k or faster)</td>
<td>Maximum school size &gt; 200</td>
<td>Distributed Public Cluster</td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td>1 (at a time)</td>
<td>Staff Area</td>
<td>Restricted</td>
</tr>
<tr>
<td></td>
<td>Fewer than 1 per 20 users (via proxy server or router)</td>
<td>Pupil/Public Area</td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td>More than 1 per 20 users (via proxy server or router)</td>
<td>Computer suite</td>
<td>Experimental</td>
</tr>
<tr>
<td>Digital Dial-up Connection (ISDN2 64/128k)</td>
<td>Maximum school size &gt; 400</td>
<td>Distributed Public Cluster</td>
<td>Localised</td>
</tr>
<tr>
<td></td>
<td>1 (at a time)</td>
<td>Staff Area</td>
<td>Restricted</td>
</tr>
<tr>
<td></td>
<td>Fewer than 1 per 20 users (via router)</td>
<td>Pupil/Public Area</td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td>More than 1 per 20 users (via router)</td>
<td>Computer suite</td>
<td>Experimental</td>
</tr>
<tr>
<td>Permanent Digital Link (128k or above)</td>
<td>Maximum school size &gt; 400</td>
<td>Distributed Public Cluster</td>
<td>Localised</td>
</tr>
</tbody>
</table>

### Dictionary
- **Restricted**: Only connection available to staff
- **Experimental**: Connection with limited general availability to pupils and staff
- **Localised**: Low or intermediate speed connection fully available across a limited network within the constraints of bandwidth, a fast connection with restricted open-access availability
- **Mature**: High or intermediate speed connection fully available from at least one connected computer per 20 users

### Notes
- Not possible at this level of connectivity
- Possible for a small number of individuals
- Possible for all