



Education Departments' Superhighways Initiative

Group A: Curriculum Projects in England and Wales

Final Report

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The evaluation

1. This evaluation concerns seven curriculum-focused projects that were based mainly in the primary and secondary sectors in England and Wales. Two further projects in the group were located in Scotland, and were the subject of a separate report produced by the Scottish Council for Research in Education (SCRE). The projects were extremely diverse in scale, ranging from a single infants school with two machines to a group of around 30 secondary schools and sixth-form colleges exploring a range of technology. Projects also varied greatly in their organisational and technological structure, and their aims and objectives. What united the group was a classroom focus, with teachers and pupils exploring the potential of a range of ICT technologies to enhance teaching and learning.

Section 3

Cross-Project Observations and Recommendations

OBSERVATIONS

Professional development and training

Future development of initial teacher training and continuing professional development

1. Teachers' comments about training and their development were often of a general kind not specifically related to the Superhighways initiatives. This was because, from the start, it has been clear that the schools did not distinguish between the broadband uses of technology and other lower-level applications, such as the use of stand-alone CD-ROM and Integrated Learning Systems (ILS). Although none of the present projects in Group A were specifically concerned with teacher training, there were references by teachers to the general disappointment at student teachers' low levels of IT skills and awareness. The current consultation documents on a National Curriculum for Teacher Training do not address the issue beyond the specific requirements of basic IT competence and, generally, tend to emphasise word processing and do not consider the use across the curriculum of the wider resources available through Information and Communications Technologies (ICT). The NFER, on behalf of the Teacher Training Agency (TTA), has undertaken a national survey examining the role of IT in initial teacher training (ITT). The Interim Report is due to be published in the near future.
2. Currently, the TTA is also engaged on a consultation exercise on the future of INSET funding. One proposal envisages that some funds should be for specific developments. Account should be taken within these TTA initiatives of the likely impact on teaching of communications technologies.
3. In some projects, effective use was made of video conferencing for remote tutoring for teachers to support their professional development. There were also examples of the use of ICT to maintain contact between students and their Higher Education tutors. These are particularly important developments for teachers in rural areas.

Technical and educational training for users

Technical training

4. Technical training has generally been provided by external agencies, such as the suppliers or their representatives, or by the LEA. Much initial training addressed multiple topics, or a very superficial introduction to the technology. In many cases, resources back in the schools were not appropriate or available for immediate practice, so that teachers experienced a loss of confidence and needed to undertake re-training. This was both costly and time-consuming.
5. Problems have also arisen when teachers have attempted to cascade expertise to other colleagues. Where the favoured strategy, largely because of limited time and resources, was to work with selected groups of teachers on different applications,

there was insufficient opportunity to share newly-acquired expertise as the projects progressed. This meant that not all teachers using the system were aware of the full potential. There was also some resentment from teachers who were excluded from training and who perceived their colleagues to be at an advantage. Some special needs teachers, for example, felt that the requirements of their particular pupils were not given sufficient attention.

6. Those co-ordinating the projects generally gave little thought to policies which would bring about closer integration of the different activities. Policy issues of this kind should be given more attention during the initial planning stage.
7. In some cases, those responsible for disseminating the technology have begun to appreciate that one of the most effective means of achieving their objective was through pupils rather than through teachers. In three of the projects, BEON, Kent and Rosendale, we saw examples in primary schools of peer tutoring, both within and between year groups. We saw examples of pupils who were much more confident than their teachers, in some cases obliging the more reluctant to come to terms with the new technology. Although we have no direct evidence, it is likely that teachers within a secondary school culture will be more resistant to this process.

Educational training

8. Our observations of initial training for both pupils and teachers have shown that there was a strong emphasis on developing technological skills divorced from any meaningful educational framework. The most effective educational training was less concerned with skills acquisition *per se* and more with exploring the use of various applications in a purposeful and relevant learning context. The starting point of training should not be the technology, but the needs or interests of the learner. Training should therefore focus upon using technology for learning, rather than learning to use the technology. This suggests that the best trainers are not technicians, but those with an understanding of the ways in which technology can enhance the learning process.
9. A similar argument applies to the implementation of IT at an institutional level. In general, the use of the technology in schools has followed one of two approaches. In some of the smaller projects, the project arose out of an educational problem requiring a technological solution. The Rosendale Odyssey is a particularly apt example of the latter approach where, despite a short period when teachers felt they lost control of the project, they retained a clear view as to the project's purpose and desired educational outcomes.
10. In the larger projects with commercial sponsors, the technology was provided for the schools which then found uses for it. This might best be described in terms of a technology solution looking for an educational problem. In this approach, there was greater evidence of uncertainty about the educational purposes to which the technology should be put. Commercial sponsors tended to assume that schools would be sufficiently knowledgeable to be able to select appropriate uses and therefore responded to the teachers' requests somewhat uncritically. Schools, on the other hand, tended to feel that they must demonstrate an interest in as many applications as possible, irrespective of whether they wished to use them, in order to justify the sponsor's investment.
11. In this situation, an 'honest broker' with expertise in educational applications and a sound knowledge of the culture of schools is essential. In the past, this would have largely been provided by an LEA but the current situation, in which most LEA advisers spend a high proportion of their time working outside the authority on OFSTED inspections, tends to preclude such a service. An alternative has,

therefore, been to use consultants but this has proved costly. In the BEON project, the employment of an expert team from Exeter University was possible only because it was paid for by one of the commercial sponsors. The teachers regarded Exeter's input as singularly successful because, as one headteacher put it:

They not only knew about the technology, but they also knew about children.

A similar development is now taking place in the ConnectEd project using Guilford College of Further Education.

Implications for institutional organisation and administration

12. Some of the points made about training also apply to the organisation of any initiative in general. Where there was slow, or in some cases almost no, progress, this was generally accompanied by poor co-ordination and a lack of forward planning. Even in the most successful projects, there was often no clear vision of where the initiative was going. These were, of course, exploratory projects, and so this was to be expected to a large extent. There are clear lessons to learn from this, however, for those that follow. In particular, there is a clear need for a thorough consultation and planning phase prior to the initiation of any project. This process should include:
 - the clear identification of curricular and/or professional developmental objectives
 - careful consideration of the type, level and location of ICT required to meet those objectives
 - consideration of the training requirements of staff, including relevant support staff, and pupils
 - setting up of a well-defined and accountable management/co-ordination structure
 - identification and allocation of adequate technical support
 - the development of a medium-term plan to carry the initiative beyond the start-up phase.
13. During the period of the EDSI evaluation, a great deal of attention has been given to the potential for local schools to communicate and work together. However, the contemporary culture of schools is not conducive to co-operation. Neighbouring schools compete for pupils as a means to increase their resources. A school with expertise in the use of broadband technology is, therefore, less likely to offer a service to other nearby schools. There were notable exceptions, however, as in the Dyfed project, where one of the aims was to support the KS3 geography curriculum for isolated rural schools through video conferencing.
14. Another shared use has been to support greater continuity within transfer. Headteachers in several of the projects also talked about the potential for transferring greater amounts of information, for example Records of Achievement, and the monitoring of particular pupils or groups of pupils, for example pupils with special educational needs, between feeder and transfer schools. Potential also exists for the electronic transfer of information from ITT institutions, for example test results and course details, to the DfEE, in response to their recent request for such data. It was, however, too early in these projects, which were mainly concerned

with aspects of curriculum use, for any major developments aimed at easing administrative procedures, either within or across schools.

15. We also found numerous examples of e-mail and video conferences between primary and secondary pupils, and between secondary teachers and primary children, and there is clearly considerable potential in this area. However, a major concern in three of the projects was the issue of continuity and progression for highly computer-literate primary school children, who transfer to a secondary school where IT provision is limited, and where low levels of skill on entry are assumed.

Decisions on location, number and types of workstations and network points and LANs

16. Decisions of this sort were dependent on a number of factors; the number of workstations, the geography of the school, the type of technology and the likely pattern of use. The siting of workstations also has an effect on physical organisation of groups of learners, and this issue is discussed elsewhere in this report (see paragraphs 37-41).
17. Schools were often restricted, for example by the geography of the building or lack of space, in their choice of suitable sites. This was especially true for video conferencing, which ideally required a site where users did not disturb, or were not disturbed by, other pupils. In many schools, decisions about these issues had to be taken quickly and with little guidance as to the most effective distribution, so that teachers sometimes found themselves with machines and/or access points in unsuitable locations.
18. An important issue concerning the number of workstations is the relationship between quantity and quality. In the BEON project, for example, we have argued that the sheer volume of technology in the schools brought about a dramatic cultural change, to the point where ICT became simply part of the 'background', and enabled a high level of access. Nevertheless, the quality of the learning was extremely variable across the schools.
19. More typical was the experience of many schools which had just one or two workstations with narrow- or broadband connectivity. Although in some of these schools, notably in Birmingham and Powys, the limited number of machines significantly affected their success, these difficulties were compounded by organisational and technical problems. The evaluation shows that elsewhere the number of machines alone was not a barrier to effective and innovative practice. The critical factors were how teachers planned schemes of work which fully incorporated the use of ICT, and whether its use was structured.
20. The effectiveness of the technologies in developing pupils' learning is, therefore, much more dependent on the teacher's skill in integrating ICT into their curriculum plans than on the volume of technology. Having said this, once commitment for ICT was established, a high priority for most schools was to expand and extend access.

Security issues connected with access to networks by learners and tutors

21. We encountered only two instances of security breaches, one where a pupil managed to find his way beyond a walled-garden environment, and another of a pupil attempting to access an unauthorised area. We have no other evidence of non-sanctioned access to files or mailboxes, nor of illicit copying of software. While we cannot state absolutely that there were no further problems of this sort, none were observed or reported. Since the main use of the technology was for developing

curriculum activity, confidential administrative information was rarely placed on networks which were accessible to pupils. There were cases where teachers shared a mailbox with their pupils. Schools generally solved this by vetting all mail, but this was time-consuming. Another solution was for teachers to have their own mailbox with a shared facility for a class of pupils.

Changing role of the teacher, the tutor and the co-ordinator

22. There are three main issues here:

- the role of the school IT/project co-ordinator
- the role of the teacher
- pupils as teachers.

The role of the school IT/project co-ordinator

23. In most schools, the role of project co-ordinator within the school was taken by the IT co-ordinator. In some schools, however, there was a policy decision to appoint co-ordinators who were curriculum specialists, for example in secondary schools, or who had some responsibility for curriculum co-ordination, in primary schools.

24. Research into the effectiveness of curriculum co-ordinators (for a review, see O'Neill J. and Kitson, M. (1996), *Curriculum Management: Co-ordinating Learning in the Primary School*, London: Routledge) shows that the role involves being a resource for subject knowledge, an expert pedagogue skilled in disseminating good practice, a facilitator, a problem solver and a conciliator when conflicts arise between colleagues. Co-ordinators who are not part of the management team within the institution can rarely satisfy these various demands, not least because there is a tension between their role as curriculum leader and their role as a classroom teacher. These responsibilities are often compounded in the case of the IT co-ordinator, who is expected to fulfil all of these roles and more.

25. The problems faced by curriculum co-ordinators also apply to the introduction of broadband technology. Teachers who took on the additional role of project co-ordinator experienced a considerable shift in responsibility and status, similar, in the larger-scale projects in particular, to those expected of senior managers. Co-ordinators had to develop a significant external relations role, so that they were responsible for organising visits by partners and sponsors, meeting demands of commercial and independent evaluators, dealing with public relations activities, and communicating with technicians.

26. More progress was made when the co-ordinator had a clearly defined role within the senior management structure, or the evident and explicit support of senior management. For example, close involvement of a senior manager was a specific requirement in the Dyfed project. In some secondary schools, such as those in the ConnectEd project, project co-ordinators were given a degree of autonomy as budget holders for the project, and they also had the confidence of the senior management team.

The role of the teacher

27. Pupils' access during lessons to the Internet, or to 'live' e-mail, means that teachers may have less control over the information the pupils are processing. This was observed, for example, in A-Level sociology classes, where data from the Internet were significantly more up-to-date than conventional resources. The teacher's role then has less to do with direct instruction, and is more concerned with training pupils to search efficiently and review information, and with encouraging

conceptual understanding of the materials used. While some teachers, accustomed to exercising control over their pupils' access to information, saw these Internet searches as a waste of time, others saw such activity as developing research skills. A key difference between these two approaches was that the latter provided a structure or scaffolding by which the pupils could regulate their own learning.

28. The shift away from direct instruction was also a consequence of increased differentiation. In training a class to use a standard application, for example word processing, it is relatively easy to ensure that all pupils work at the same pace by requiring them from time to time to return to a specific point in the program. The Internet, however, enables pupils to access a vast array of data which, because of different interests and varied conceptual understandings, inevitably leads to wider differentiation. Thus, the teacher's role as class instructor diminishes as they concentrate instead on supporting and developing pupils' problem-solving strategies.
29. In general, most progress was made where pupils worked individually, although this does not necessarily mean isolated activity. There was clear evidence of co-operation and sharing of information between individuals, often concerning site addresses and search routes. A number of poor examples of collaborative groupwork were observed, however, particularly where there were several children to a machine, with the majority not actively engaged in the activity at hand. A more useful approach was to structure the activity so that one or two pupils used the computer, while the others worked on related activities.
30. In the specific case of video conferencing, the desktop model used in the schools was generally unsuitable for anything other than individual or small-group work, and teachers need to be clear about the specific role of each pupil in the exchange.

Pupils as teachers

31. In two projects involving primary schools, peer tutoring, in which children taught other children how to use various applications and equipment, became an accepted strategy. In some cases, not only pupils, but on occasions teachers, were referred to more competent children for instruction in how to use an application or piece of equipment, or, as in the Kent and Dyfed projects, to instruction manuals written by children for other users.
32. The use of pupils in the role of tutors has had important implications for the development of the school's IT strategy. As pupils become more effective teachers, there is less need for computer suite arrangements where a whole class of children is simultaneously instructed in technical aspects of various applications. Placing computers back in the classroom has focused the teachers' attention upon curriculum issues. Perhaps more so in primary than secondary schools, this has led to increased use of Internet material within cross-curricular topics. This trend has been driven largely by pragmatism rather than by ideology since, when using computers in single-subject applications such as OILS, teachers were constantly having to interrupt the teaching of the class to assist the group of pupils working at the computers. Topic work provides a more easily-managed environment in which more competent children can, by careful distribution across groups, assist the teacher.

Access issues

Ease of access to networks by learners and tutors

33. Where difficulties other than technical ones were encountered, it was largely as a result of the particular means of access. Networks designed especially for educational users, such as CampusWorld, RM Internet for Learning, or locally-

created networks, such as those in the ConnectEd and Satellite projects, offered different routes to the WWW. The commercially-organised networks incorporated varying levels and types of security against children accessing inappropriate materials, and this issue is discussed elsewhere (see paragraphs 42-47). Access to networks is also governed by the number and distribution of workstations and data speed, both of which are also discussed below (see paragraphs 37-41 and 64-66).

34. Many schools operated an open policy, where pupils had access to the networks during breaks, before and after school and so on. Pupils were highly motivated to use the technology during these times, so that managing access was the chief concern for schools. Although schools varied in the degree to which they allowed recreational as opposed to curriculum use during these periods, most recognised that a major advantage of this use was that it developed IT and networking skills.
35. A variety of systems for regulating such access were in operation, from privileged access or 'honour systems' to 'first-come, first-served'. Booking systems operated in very few schools and, where they did, they proved time-consuming and difficult to monitor. There were also some difficulties with a 'first-come, first-served' approach, since it was often the more dominant or assertive pupils who gained access. This also has implications for gender issues, since it often meant that boys took control of access. In some schools, mainly primary, Internet access was used as a form of extrinsic motivation, so that pupils were awarded, or in some cases denied, access according to the standard of work or behaviour. The same approach was also used to encourage, incidentally or as a result of a deliberate policy, attendance and punctuality, so that children could and did come in early to school to use the technology.

Learners at home or in the workplace

36. Although home-school links were among the original aims of a number of the projects, they were never fully realised. In the Kent project, a few teachers did have the use of school laptop computers and modems, enabling teachers to access the WWW. Towards the end of the evaluation, some pupils with special needs in the same project were given PCs at home, with Internet access. They reported that it was helping them with homework tasks, and developing IT and networking skills. These were positive, but very recent initiatives and, therefore, it is too early to identify any measurable effects. Teachers in some schools were also part of the Multimedia Portables for Teachers Project, the findings of which are to be reported in the near future (see Report F2-3).

Physical organisation of groups of learners

37. Some schools had a large number of computers, while others had only one or two machines. In the latter situation, the logical solution was to place the workstations in a central location, often a library or resource centre. In the larger projects, a decision to house the computers in a dedicated room was often governed by a traditional emphasis on teaching pupils IT skills via whole-class sessions.
38. However, as projects have progressed, there was, in some schools, a change in perspective as teachers integrated ICT resources into their teaching and learning. The location of computers, in these instances, was being re-organised, for example siting some PCs in or near the classroom with a 'mini-suite', often situated in the library, to facilitate small-group work. This diffused model of distribution was less common with subject-specific applications or resources, such as Integrated Learning Systems.
39. Nevertheless, giving over whole rooms to the use of ILS militated against flexibility, and forced a particular kind of lesson organisation upon the teacher. A much more useful strategy was where a smaller number of workstations, typically

around eight or 10, allowed groups of pupils to work on the programs independently, while the teacher worked with remaining pupils on other tasks.

40. We have seen some interesting initiatives where this process had begun, for example in the secondary schools in the Kent project. Nevertheless, there is a tension between the increasing perception in primary schools that the most effective means of operation with limited equipment was through greater integration of subject matter and the tendency in secondary schools to operate within subject boundaries.
41. There were signs that some secondary schools were beginning to consider a shift to an integrated curriculum more commonly found in primary schools. This was partly in response to exploration of Internet resources and other on-line databases, which are not neatly packaged into National Curriculum areas, and where the ability to move from one site to a linked resource allows exploration of associated cross-curricular material. In BEON, for example, the secondary school was re-organising the location of some of its machines, seeing the potential of the WWW to bring about increased collaboration between subject departments. Similarly, a secondary school in the ConnectEd project was actively exploring cross-curricular links in integrating both IT and ICT into schemes of work. This is not to say, however, that the potential does not exist for within-subject exploration of the WWW, and there were numerous examples of excellent work in nearly all curriculum areas, and particularly in science and geography.

Practical issues of use

Measures taken to monitor and protect pupils and other users from exposure to undesirable applications

42. The debate about what constitutes an inappropriate application or site raises difficult issues. Whereas there is substantial agreement that pupils should be denied access to offensive and/or unlawful materials, reaching a consensus on the best way of achieving this is more problematic. ‘Walled-Garden’ environments, such as CampusWorld, had general support from teachers for younger pupils in particular. However, in one school, a pupil had quickly managed to find a way of circumventing the ‘wall’, illustrating that this is not an infallible system.
43. Even so, as projects have developed, ‘protection’ became increasingly to be seen as ‘limitation’. This led on occasions to disenchantment with the system, for example, where information was not available, or hypertext links to outside the walled garden were denied. Teachers then have either to take time to log in themselves using their private password or, if under pressure, to disclose their password to the pupil, thus potentially undermining the security system. Since these criticisms are mainly about the limited content of protected environments, they can be addressed, and this model may yet be the best way forward for younger learners. Filtered access, such as that offered by RM’s Internet for Learning, and some browsers, such as Microsoft’s Internet Explorer, allow access to a wider range of sites, but with an element of control over unsuitable materials. This was regarded as a much more flexible approach, more suited to older learners.
44. Schools also used various software, such as Net Nanny, similarly designed to screen out undesirable materials. These allowed schools user-defined controlled access to sites, images, search terms, as well as a number of system security functions. In addition, subscription to some proprietary software, such as Surfwatch or Cyber Patrol, provided for regular updating of information on unsuitable sites. Other software, such as Internet Watchdog, provided records of use, screen shots and so on.

45. Some schools favoured an intranet solution. This had the advantage of increasing access and speed, as well as reducing costs, since such systems operated off line, while allowing the schools control over materials. It also ensured that the material was available when required, which is not always the case with such a dynamic resource as the Web. However, this is potentially a very time-consuming operation and, to some extent, defeats the object of accessing the Internet. Such approaches tended to work best as an additional, specialised resource rather than as an alternative to the WWW.
46. As we have suggested elsewhere (see paragraph 38), some schools are moving away from the 'dedicated suite' model of distribution to more flexible arrangements, for example small numbers of machines in different classrooms or departments. However, this militates against the supervision of pupil use, particularly in schools that operate open-access policies. One solution to the difficulty of maintaining constant supervision, operated by some schools, was what might be called 'virtual surveillance'. The possibility that searches or e-mails might be monitored or recorded acted as a powerful deterrent.
47. While screening mechanisms of one kind or another were generally regarded as appropriate for younger learners, the tension between maintaining vigilance and encouraging pupils to develop responsible attitudes becomes more acute for teachers of older pupils. The solution, preferred by a few schools, was to provide open access, where pupils were allowed access to networks, but under close supervision. As systems become more accessible, however, complete control becomes more difficult. Those that favour these more open approaches, therefore, argue that it is preferable to teach responsibility, rather than operate a form of censorship. As one teacher put it, when discussing systems for controlling pupils' access, 'the most effective tool is education'.

Technical issues

48. The need for a reliable technical environment is fundamental for the success of any ICT initiative. Three of the projects, ConnectED, Powys and Birmingham, demonstrated clearly the effects on the project of technical failure. Lack of compatibility between various elements of networked systems had a serious impact such that, in Birmingham, for example, two of the six schools made little progress during the period of the trial, and in ConnectED, a great deal of time was lost in resolving these issues. It is to the credit of many of the schools that they were prepared to persist in the face of such difficulties.
49. Unreliable or intermittent connectivity was also responsible for a loss of commitment and enthusiasm for the initiatives in some schools. In Powys, part of the problem was the reconfiguration of the Rural Wales Wide-Area Network (WAN), with resulting under-capacity for some months. Problems were also experienced with the interface between cable and local area network (LAN). In Kent, the speed of the internal network was insufficient to match the capacity of the high-speed connection, which reduced speed of access. In ConnectEd and again in Powys, there was incompatibility between the management software of the two network components which often denied access altogether. Since testing for this eventuality would be standard practice in a normal commercial environment, the problems experienced here were not simply technological. To a certain extent, difficulties were a result of technical inexperience in schools on the one hand and suppliers' unrealistic expectations about teachers' expertise on the other. In ConnectEd, for example, connectivity worked in some schools and not in others, and success appeared to be as much a function of the individual people involved, both educational and commercial, as a technical issue.

50. What was common to each of the projects that suffered serious technological difficulties was an inadequate period of planning and consultation prior to the commencement of the programme, which would have enabled some of these problems to have been identified early and strategies for resolving them implemented before schools attempted to use the systems. In ConnectEd, for example, the only requirement to be accepted into the project was for a school to have a LAN. The quite reasonable assumption on the part of the schools was that it would be simply a matter of connecting their network to the cable connection. On the other hand, the commercial sponsors were operating on the reasonable assumption from their point of view that all the schools' LANs would be of a sufficient standard to be connected easily. In BEON, beyond some initial teething problems, these difficulties did not generally arise, since the schools shared the same technological environment.
51. Technical systems require technical experts to ensure their proper installation and continuing maintenance. In BEON, where such expertise was available through a telephone help line, those problems which did arise were generally quickly and efficiently solved. Some projects, for example BEON and Dyfed, had an element of remote technical assistance. In Dyfed, problems were often solved by the Centre technician checking settings remotely and using the video camera to view the physical set up, for example to check that signal cables were correctly connected. Other projects had much less support, and the solution for some schools was a qualified or expert technician or systems manager on site.
52. As technical demands become more sophisticated, and dependency on technology grows, adequate and reliable technical support will become essential. It will be increasingly important for schools to have back-up systems in the event of technical failure. In BEON, for example, no such alternative existed, so that when the network failed, schools had no access to files, which were located on external servers, and were thus unable to continue until functionality was restored.
53. The lack of adequate support contributed to projects failing to fully meet objectives, and to teachers and pupils becoming disillusioned and demotivated. Although there were some notable successes, even here the schools were reliant upon external agencies for help and support, such as the sponsors or the Local Authority. In some projects there were discussions about the possibility of schools collaborating to finance, or share, technical support, either on a cluster basis, as in BEON, or between secondary and primary, for example in Kent. Such arrangements may also have helped to resolve some of the problems which dogged some projects, notably Powys and Birmingham.

Future directions for suppliers

54. In Group A projects, the main issues have been educational not technical. Schools want a basic service which connects them into the Internet as cheaply as possible and with as broad a band as possible, and software which is differentiated so that it can cater for a range of learners. Much of the information on the Web is pitched at a reading age which is too difficult for the average Key Stage 2 primary pupils, is varied in academic quality, and does not readily fit into National Curriculum areas. The main technical problem for schools has been the incompatibility of existing systems with those introduced by the suppliers, hampered in some projects by lack of access to technical support. Interconnectivity not only with the Internet but also with other systems is, therefore, a priority for schools.
55. Ideally, schools would favour a fully-managed service, since their prime concern is to use the technology for teaching and learning, not to run and maintain it. However, such a service is not without drawbacks, as discussed later (see paragraph 73).

Future directions for the education service

Creating productive networks at local, national and international levels

56. There is clear potential for creating productive networks at a local level, although the current emphasis on competition tends to restrict the range of joint activities in which neighbouring schools are willing to engage. The waning influence of many local authorities does not help this situation.
57. The development of local networks was, therefore, patchy. While there was some evidence of schools co-operating, such as using e-mail distribution lists to post problems and solutions about issues concerning the Superhighways initiatives, the strongest links were between schools which were not in competition for pupils. In particular, relationships between primary feeder schools and their related secondary schools were enhanced by a sharing of the technology. Some secondary schools also forged links with local businesses, offering cheap access to Superhighways technology or developing Web sites for local enterprises as part of pupils' curriculum work. Also, as the projects were coming to an end, there were examples of some schools and colleges forging links with local groups, such as TECs, local businesses, universities and Local Education Authorities to generate the funds to continue connectivity.
58. There was clearly potential also for developing both human and technological networks between the school and its local community. A number of schools were exploring the possibility of opening 'cyber-cafés' for parents, for example, or, in rural areas in particular, setting up teleworking facilities. One or two schools were also considering the possibility of becoming, in effect, Internet Providers, by providing cheap access to the WWW. However, while there were many exciting potential developments, none had reached a point where they were implemented.
59. There were few examples of productive co-operation at national and international level, partly because of the delays experienced in installing many of the systems. As a result, many schools were only just, at the end of the evaluation, coming to terms with the potential of the new technology. With one or two exceptions, links have been concerned with initial exchanges of personal information rather than with fully-developed curriculum matters. One problem here is knowing exactly where to go for information in order to establish links. In two projects, for example, staff in the modern languages department wished to establish video links with a French school but could not discover whether or not a suitable partner was available. There is a need for a clearing house so that schools could be put in touch with one another in the same way that partner searches are available for Higher Education institutions which wish to collaborate on European Union projects.

Teaching and learning issues

Potential value of electronic communication

60. Although the time-scale has been such that it has not been possible to undertake formal testing of pupils, we have seen numerous examples of excellent work produced as a result of their engagement with the technology. This improvement in pupils' work has occurred both in structured situations, where the pupils are directed towards materials and activities by the teacher, and in individual access to the technology. The quality of pupils' coursework has been enhanced by the opportunity to use ICT. For all pupils, including the less able, it appears to be a powerful motivator and there is evidence from their work that it produces improved basic literacy skills. It also provides opportunities for independent learning to pupils of all abilities. As such, the Superhighways has a 'levelling' effect, opening up IT to previously resistant or reluctant groups. This effect also means that pupils who

are academically less able and/or less confident can develop IT and networking skills which are equal to, and in some cases greater than, those of their more able peers. This has had a powerful effect upon their self-esteem and enthusiasm to engage with their work.

61. Exchanges within clusters of schools, as in BEON and Kent, have been extremely productive, and this also has implications for the transfer process. Equally important is the assertion by a headteacher that the new technology can ‘open the pupils’ eyes’ to a wider world, creating better understanding of the problems that others face and thereby putting their own situation in context. Pupils have the opportunity for conversation with native speakers of a similar age. At a time when concern is being expressed about the role of schools in transmitting moral values and good citizenship, the new technology, even if it only raises the awareness of other people’s points of view, must be of benefit. Notwithstanding the difficulties of making contacts with others, the technology has enormous potential for forging cross-cultural links and promoting global understanding. Indeed, it is a feature of globalisation and will be an important element of the market place of the future.
62. There are also signs that teachers are beginning to rethink their teaching strategies and are placing greater emphasis on using the technology to teach pupils strategies for thinking creatively and for problem solving, rather than merely using the Internet as a source of information. However, the Internet in particular has other potential than simply acting as a virtual and vast library, not least the fact that materials are immediate and up-to-date, and teachers are beginning to recognise this. Despite the constraints on time which teachers faced, they were keen to explore ICT and develop new ways of employing it effectively. This includes previously technophobic teachers, who have been converted to the use of IT through exposure to the Superhighways.
63. In many projects, e-mail is only now beginning to be used for educational rather than social purposes. For the most part, pupils have used it to exchange information about their school, classroom, etc. Undoubtedly, there is strong potential to extend e-mail provision into educational activity so that it widens pupils’ horizons. As one headteacher said:

The advantage of using computers in the way we are doing is that it shows children that there is life beyond the school gates. They learn about others and about other children’s problems.

In many projects, links have been made or extended with schools in other countries. In most projects, video conferencing has been less widely used, although there have been many examples of successful use, particularly for remote tutoring. It can be, however, an expensive resource, since expert tuition, often on a one-to-one basis, is costly. Some courses, for example in the two Welsh projects, were delivered to small groups, typically around four to six, and these were considered to be far more cost-effective.

The importance of speed

64. Schools with dial-up access experienced delays which, when aggregated over a year, cut down the availability of the technology. However, many of the main delays occurred as the result of heavy traffic elsewhere so that, for example, schools were often frustrated in the afternoon when attempting to use the Internet, irrespective of the nature of their connectivity. What seems at least as important as the speed, therefore, is the rationale which drove the school to embrace the technology in the first place. A good example of this was ConnectEd, where connectivity varied from 64K to 2Mbps. The relative progress of schools was

determined much more by the identification of curricular objectives than by the capacity of the connection.

65. Similarly, in the Kent Project, two of the three schools initially had no cable connectivity as originally anticipated, and therefore started small with a single workstation and narrowband access, in contrast to the third school which had 16 workstations with broadband access to the WWW. Our observations during this phase, however, suggested that the technology was as embedded into the programmes of work in the two 'lower-tech' schools than the more technologically advanced partner. Although the schools have since expanded and upgraded their facilities, they are nevertheless convinced that a limited-access, low-cost solution is feasible.
66. This is not to say, however, that speed is unimportant. While a relatively basic set up is not, in itself, a barrier to innovation, there are clear limitations to this model. As the technology progresses, it is likely that multi-user, broadband access will become increasingly important, as ICT becomes integrated into the curriculum.

Implications for those with special educational needs and those from ethnic minorities

67. One of the key successes within the project has been the benefits to disenfranchised learners, both pupils with learning difficulties and also the gifted. For pupils with learning disabilities, the levelling effect has been one of the most exciting developments. Boys and girls of all ages, abilities and backgrounds are displaying equal and high levels of expertise with ICT, and willingly and confidently share and discuss their skills and knowledge with others, including their teachers. It is difficult to think of another area of school life, let alone the curriculum, where this occurs. Far from being a solitary or isolating experience, ICT appears to be a positively socialising activity. For gifted children, the opportunities opened up by the Web have allowed them to explore ideas in ways which would have been very difficult within the classroom context. Teachers agreed that the medium was a powerful motivating influence, particularly on pupils with low self-image who were often reluctant to learn. In one special school, for example, a 14-year-old boy produced three pages of writing as a result of an investigation using the Internet, whereas before he had never written more than four lines on any topic. In a primary school, children took obvious pleasure in exhibiting their illustrated stories when before, without the aid of software packages, few children in the class would have shown an interest in it.
68. In the Dyfed project, video conferencing between teenage children with special needs, particularly those who had difficulty with social skills and interpersonal relationships, was very effective, not only in improving their conversational skills, increasing their articulation of words and developing their listening skills, but also making them aware of personal appearance and self-presentation. Teachers reported that pupils who would rarely speak or hold a conversation face to face quickly became confident talkers across the video link, and that this new confidence transferred into face-to-face contacts.
69. We have already stressed the value of the technology for pupils with special educational needs, but the technology also supports previously disenfranchised learners and enables pupils to produce work of a matching quality in appearance and style to that produced by more able pupils. The Internet also provides opportunities for pupils from different cultural backgrounds to understand each other better, and for accessing authentic materials. As pupils become more confident in the use of the technology and begin to make both national and international links, such shared understanding should increase.

70. With one or two notable exceptions, teachers were less impressed with programs designed to support learning in basic skills for pupils with learning difficulties. The ILS program used in these projects was simply not robust enough to allow pupils to work independently of the teacher. The alternative solution of special classes for pupils with special educational needs also created problems, mainly because of the amount of routine help needed from the teacher in operating the system, leaving little time for direct teaching. By far the most effective way of working was through peer tutoring, particularly across ages, where older pupils, often of only moderate skills, were able to assist younger pupils with learning difficulties. Our experience confirms findings from elsewhere that literacy skills of both pupils are improved, and that responsibility given to the older pupil is undertaken seriously and results in improved behaviour and co-operation.

Costs and cost effectiveness

71. Within the time constraints available within the project, it has been impossible to evaluate cost effectiveness in a rigorous way. In all our interviews, schools, although committed to the technology, told us that they did not have enough objective evidence of its educational effectiveness in such a short time. Decisions about costs were equally difficult.
72. It has, therefore, not proved possible at this stage to identify specific cost effectiveness at an individual school or project level. However, the diversity among the Group A projects offers a good opportunity to compare and contrast different models of implementation, and the general cost implications which might flow from them.
73. The BEON project had a number of merits in terms of cost, most notably the predictability of buying into a ‘package’, which also obviated the need for schools to concern themselves with technical issues, leaving them to focus mainly on teaching and learning matters. Such a solution was extremely costly, however, and schools were somewhat dependent on the providers, not only in terms of the quality and usefulness of the service, but also in terms of decisions about future directions and tariffs. While it is accepted that costs are likely to reduce over time, the case for replicating this model across other groups of schools remains to be proven.
74. Although, like BEON, ConnectEd involved major commercial players, there was a huge variation among schools in terms of their IT provision and technical expertise. In this respect, it represented a much more realistic model since, in most schools, IT provision consists of a mix of old and new, sometimes incompatible, stand-alone and networked computers. There was initially little sense of coherence between the parties involved in the project, and much time and effort was expended for little progress although, towards the end of the trial, some schools made significant advances. The real costs of the service were beyond school budgets, despite the offer of a substantial reduction for continued connectivity, albeit with a dramatic drop in capacity.
75. The Kent Project allowed two of the schools to experience ‘starting small’, with a single workstation and dial-up access. Both were convinced that this offered a viable and affordable means for schools to get on line at minimum cost. However, all three schools in the project, regardless of their starting position, went on to prioritise expanded and upgraded provision as the benefits of ICT became clear. Thus, while the small-scale approach may be a strategy for start-up initiatives, it cannot be considered a feasible solution to the problems of integrating ICT across a school or group of schools.
76. In the Rosendale Odyssey, the school actively sought mainly local sources of technical and curricular support supplemented by funds from charitable trusts. The

project grew from a clearly-defined curricular objective to become an ongoing, cross-curricular project, which has already reached well beyond the school itself. From this carefully-defined and planned beginning, there was a natural development as pupils and staff became more experienced and enthusiastic. As such, it represents a highly cost-effective model for other schools, particularly those in the primary sector.

77. In the Birmingham Knowledge Superhighways Project, the situations of the participating schools were very varied. No external funding was made available for the initiative, and most of the schools were reluctant to fund ICT provision without clear evidence that it would be of educational benefit. While this may represent something of a circular argument, it is likely to be the way in which many schools, particularly those without a history of strong commitment to IT, will view the prospect of investing in an ICT future.
78. A similar situation pertained in Powys, where the schools were very varied in terms of both their status and their IT provision. Given the local nature of the initiative and the isolated situation of the schools, this kind of project has somewhat restricted relevance in commercial terms, and sponsorship would not appear to be a viable option. The project was initiated by the LEA, which is committed to the project's continuation. However, with the advent of local government reorganisation, and constant political pressure to curb Local Authority spending, it is difficult to see how this situation is to be resolved without a re-ordering of spending priorities.
79. In Dyfed, the opportunities for these small, rural secondary schools to enhance and broaden the curriculum via remote tutoring was a considerable incentive to participate in the scheme. The service was made available to the schools in return for their commitment of senior staff time and money. The project was progressive, in that a stepped approach was taken which involved successive groups of schools over two years. The costs of the service to schools, already relatively low, were offset further by savings of travel costs and on supply cover. The project, therefore, proved to be extremely cost-effective.
80. Across the projects in Group A, the evaluation has shown that, as the educational potential of ICT has become increasingly evident, so the majority of schools wished to expand, or at the very least maintain, their existing facilities. However, once specific project funding came to an end, the true cost of broadband and/or medium-band connectivity proved to be beyond the budgets of most schools. This was true even where connection was offered at concessionary rates, sometimes also accompanied by a reduction in bandwidth.
81. The contribution that individual schools can make is clearly related to size, since larger schools are more able to manipulate budgets to accommodate expanded provision. The problem is, however, far more acute for primary schools and smaller secondaries. Typically, Group A sponsors costed their services for a primary school at the equivalent of between one and 1.5 teachers. For this money, the school was provided with computers, software packages, service and connectivity. The typical primary school with a budget of around £500K usually allocates between 10% and 15% to resources. To pay for the service would require 50% of this resources budget, which is unrealistic. The only alternative is to cut down teaching staff or support staff.
82. For this reason, most schools have looked for cheaper solutions and have approached LEAs, universities and cable companies. In one case, in return for subscribing to its service, one cable company offered to provide all local telephone calls free-of-charge, a considerable saving. Over time, the minimum requirement for schools would be to have a computer in every classroom attached to the Internet, with shared servicing and subscription arrangements through a local federation of

schools or through the LEA, TECs or local businesses. However, there are constraints against schools working in this way and the current re-organisation of local government and the creation of newer, smaller LEAs is not likely to provide support for such ventures in the near future.

83. The different projects represented a variety of ways of supporting ICT initiatives, including retaining or increasing the numbers of pupils, and partnerships of one kind or another with commercial organisations. However, as the number of schools developing ICT provision increases, these are likely to be self-limiting strategies, since there are only so many pupils, and so many sponsors, to go round. Discussions with providers lead us to conclude that, for perfectly legitimate commercial reasons, funding is most likely to be available to 'leading-edge' schools, or those with an entrepreneurial ethos. Schools outside this exclusive circle, and this is likely to be the majority, are likely to find themselves struggling to get a first foot on the ladder. Schools were already facing serious cuts in their budgets, typically resulting in a reduction of between one and two teachers in the next academic year. In this climate, contemplating the loss of staff, or a reduction in essential resources to pay for commercial services, without hard evidence of the gains achieved, was never a serious option. It is difficult to see any way forward, therefore, other than for the provision of central funding.

Implications for industry-education partnership

84. All the projects in Group A involving commercial and educational partnerships experienced difficulties in the initial stages because of a clash of cultures, and also misunderstandings by each party about what the different partners were able to deliver to the agreement. Schools did not understand why they could not have additional software when commercial partners had provided such a costly amount of equipment. Commercial partners could not understand why, when they had provided so many resources, schools did not immediately use them to the fullest advantage. A further complication existed when there was more than one commercial partner. When problems arose, responsibility for dealing with these was sometimes passed from one partner to another.
85. During the lifetime of these projects, power relationships have tended to change. At first, schools were anxious to comply with their sponsors' wishes, even when they thought they were educationally unsound, lest the support they were receiving should be taken away. However, by the time the projects were due to end, schools had begun to realise that they were in a stronger position since, if partnership ended in acrimony, sponsors would have no examples of good practice to show prospective clients when endeavouring to promote their services. In this way, both sides have come to realise that they need each other, and a more co-operative responsive partnership has developed which augurs well for the future. An example of collaboration between sponsor and teacher was in the BEON project, where a head of department worked with the software designers to improve the program. This was an instance of both parties recognising and learning from the expertise of the other.

RECOMMENDATIONS

Implications for professional development and training

86. Recommendations for professional development and training include:
- The TTA and other agencies concerned with professional development should take into account the implications of the Superhighways in the

development of initial teacher training programmes, and in support of INSET, particularly the impact of the new technologies on pedagogy.

- Where feasible, training should be given in one application at a time rather than in a range of uses. Where training is provided by external agencies, it is most effectively carried out when trainers not only have expertise on the technical capabilities of the system but also have some understanding of the schools' culture into which the technology is to be introduced.
- Prior to training taking place, schools should conduct an 'audit' so that, whenever possible, educational problems define the choice of training in specific applications, rather than providing a general training and then requiring teachers to find educational uses for the applications provided.
- Where only a proportion of a school's staff are to receive initial training, a policy for the further dissemination of the various applications to the remainder should be drawn up and widely communicated. This should be done before the initial selection of staff for training to avoid any negative attitudes among those not chosen.
- Training policy should also make provision for some time after initial training for opportunities for trained staff to disseminate their expertise in the use of the technology to less-experienced colleagues.

Links with outside agencies and commercial sponsors

87. Recommendations for these include:

- The Government, Local Education Authorities and commercial companies should negotiate to implement a national strategy for connecting schools, colleges and initial teacher training institutions, and for establishing financial support for training and running costs.
- The development of such links should take into account the need for technological compatibility between the various networks.
- Where a number of partners, commercial or otherwise, are involved in a project, there should be clear lines of communication from the outset. Schools are entitled to know who is responsible for what, and who to go to for support and advice. In the absence of this kind of framework, there is a tendency towards diffusion of responsibility, so that problems remain unresolved.
- An agency such as NCET should establish a bank of case studies of good practice with Superhighways technology and disseminate these in a variety of ways. This should avoid unnecessary duplication during the start-up phase of Superhighways initiatives, with all the mistakes and frustration this engenders.
- SCAA should co-operate with other agencies such as NCET to incorporate opportunities for Superhighways education into programmes of study for the National Curriculum and to subject cores for post-16 curriculum areas.

Implications for school management

88. School managers should take the following issues into account:

- Schools should take active steps to integrate Superhighways technology across all curriculum areas in a planned and staged way, through the School Development Plan.
- Schools should develop a policy on restricting access to ‘unsuitable sites’ which takes into account the age and educational needs of the pupils.
- Schools should, where possible, disperse their Superhighways networks through curriculum areas, or in the case of primary schools in classrooms, rather than providing dedicated areas.
- Schools and colleges should drive forward the implementation of any Superhighways technology by designating a member of senior management to have specific responsibility, including financial control of a budget, for development in this area.
- Schools should actively seek links with local organisations, including other schools, to exploit the potential of Superhighways technology effectively.
- Schools should consider issues of equity in planning access to Superhighways technology.
- Schools should investigate the cost benefits of making their ICT facilities available to the local community during out-of-school hours.

Implications for teaching and learning

89. Teaching and learning implications include:

- Whenever feasible, peer tutoring, including cross-age tutoring, should be used to improve the technical competence of pupils.
- Within a classroom with limited access, group work, using the Internet, should, where possible, be incorporated into curriculum activity, so that pressure on computers can be reduced and pupils waiting their turn can work on other aspects of their topic. The alternative of having large groups sitting at each workstation tends to reduce time on task and increase disruptive behaviour.
- Once pupils achieve sufficient technical competence to access the Internet, a key task for the teacher is to provide a framework or scaffold by means of which pupils can structure and develop their own learning.
- The emphasis in teaching should be on problem solving and the acquisition by pupils of creative-thinking strategies rather than on knowledge transmission. For this reason, the use of whole-class teaching involving direct instruction is likely to be less effective than the use of alternative strategies based on models of collaborative and individualised learning.

Cost effectiveness

90. Considerations of cost effectiveness include:

- Connectivity should be achieved at the broadest width possible with a view to future developments in Superhighways technology. The

possibility of providing ring-fenced funding for cabling all schools effectively should be considered.

- The training of co-ordinators charged with supporting teachers' use of the new technology should be a national priority and not a cost to the schools.
- In drawing up a schedule of costs, account should be taken of the contribution teachers make in non-teaching time to the managing of ICT-related activities and in running clubs and extra-curricular activities, and in the provision of technical support needed to maintain the system.
- Cost-effectiveness studies should recognise the long lead time needed to bring about effective integration of an innovation into schools and be planned accordingly.

Pupils with special educational needs

91. Recommendations about provision for pupils with special educational needs include:

- Schools need to recognise the considerable benefits in learning and motivation which the Superhighways offer pupils with learning and behaviour problems, and prioritise accordingly.
- When introducing Superhighways applications, SENCOs should receive specialist training separately from other teachers and should be consulted throughout initial planning stages.
- Special Web sites with suitably evaluated material should be set up for the use of pupils with learning difficulties and also for specially gifted pupils.

Collaboration between schools

92. Ways forward for collaboration include:

- Collaborative activity should develop from mutually-agreed curriculum-based needs.
- Collaboration is likely to be more successful if the participating schools are at similar levels of ICT development and staff expertise.
- Collaborative projects need to have a lead figure with overall responsibility for driving the project forward and disseminating new knowledge among participants.
- The use of communications technology to facilitate transfer from the primary to the secondary phase should be explored.
- If necessary, schools should look for ways of jointly funding a network manager, who should be given appropriate training and be responsible for the smooth running of the system.

Video conferencing

93. Suggestions for the use of video conferencing in schools include:

- The use of video conferencing for small-group teaching should be increased, particularly the provision of expert teaching for gifted pupils and INSET provision in shortage subject areas.
- Ways should be investigated of providing video conferencing which can be operated effectively with whole classes or in large INSET settings at a cost schools can afford.
- Exemplars of effective practice in video conferencing should be widely disseminated in order to help other schools avoid some of the problems seen during the present evaluation which led some teachers to abandon its use.

International links

94. International links between schools could be enhanced:

- An agency such as NCET should seek to establish and widely advertise a bulletin board/meeting place for the creation of contacts with other schools across the world, but particularly with schools in the European Union.
- Similar efforts should be made to establish an on-line international directory of education-related addresses to enable Internet, e-mail and video-conferencing exchanges.