ABSTRACT The article examines the non-technical factors which successfully lead to an integration of information and communications technology (ICT) into the curriculum. Drawing upon evidence gathered through the United Kingdom Education Departments’ Superhighways Initiative, it argues that ICT represents a different and potentially transformative technology for schools and colleges. By comparing institutions which successfully integrated ICT during the project with those which were less successful, it identifies four personnel factors which were important dimensions of the integrative school: teachers’ attitudes prior to the innovation, the role of the ICT coordinator, the attitude of senior management and the existence of adequate support and training. It concludes that the interplay between these four factors provides the necessary, but not sufficient conditions, for a successful deployment of Superhighways technology in the curriculum.

Introduction

The impact of the ‘Information Superhighway’ on education and teachers is only in its infancy. While many schools and colleges throughout the world are pushing ahead with establishing connectivity to the Internet and exploring the potential of information and communications technology (ICT) in many ways, others are bemused by the hyperbole surrounding the Internet and either refuse or restrict access to the Web. However, for all schools and colleges in the United Kingdom (UK), the prospect of connection to the Internet is becoming a reality as the Labour Government presses forward with its National Grid for Learning (Department for Education and Employment, 1997) and the aim of establishing connectivity in all schools and colleges by 2002. With 1998 designated as UK NetYear, the salience of the Superhighways in teachers’ lives is set to grow (Tilke,
1997). As part of UK NetYear, the National Grid for Learning aimed to establish an architecture of services and networks, linking educational institutions, libraries and the Government to share information and resources.

The successful introduction of information technology (IT) (as opposed to information and communications technology) into schools and colleges has been identified as a product of both human resources (personnel factors), such as teachers and IT coordinators, and technical factors, such as the availability of hardware. As Hoffman (1996) argued, ‘dropping and dipping’ (dropping hardware into a classroom and dipping teachers in a little training) does not work. The reaction of teachers to IT generally has been one of relatively slow accommodation and resistance to change (Department for Education, 1993; Williams & Moss, 1993). The constraints on the use of computers have been well documented (see, for example, Ritchie & Rodriguez, 1996). Teachers themselves are often identified as one of the main limitations on the successful use of IT in the classroom. This is often seen as a result of their fear of the computer or a lack of skill or understanding of how IT can enhance the educational experience of students (see, for example, Ritchie & Wilburg, 1994). The problem for many teachers in adapting to the use of IT in their work is that it demands change in attitudes, knowledge and classroom practice at the same time (Fullan, 1991).

It is important to remember that the resistance of teachers is only one barrier to integrating IT into the curriculum (Yeomans et al, 1995), but it is a central one. However, other personnel factors have also been identified as inhibiting or enabling the integration of IT into the curriculum. Hoffman (1996) identified ‘Eight Success Factors’, ranging from the technical factors of ‘facilities and maintenance’ and ‘availability of technology’ to personnel factors such as:

- the existence of staff development and technical support;
- strong administrative support;
- the role of the technology coordinator.

Becker (1992, quoted in Stuhlmann, 1994) also found that support from a full-time technology coordinator and access to training were important factors in the creation of ‘exemplary’ users of IT in the classroom. Kortecamp & Croninger (1996) argued for the use of a mentoring system when introducing new technologies, so that more experienced teachers could assist novices with the demands of introducing new technology into the classroom.

Somekh (1996) believed that an important personnel factor in the introduction of new technology was the differences in attitude which teachers brought with them to the innovation. This was not just a question of experience with or interest in IT, but also the wider and differing discourses concerning education which teachers held and which they
brought to the issue of introducing new technology. The Apple Classrooms of Tomorrow (ACOT) project (see, for example, Dwyer et al, 1991) showed that the introduction of IT resulted in conflict between teachers' deeply held beliefs about schooling and their awareness of the new modes of learning which IT encouraged. Waggoner (1994) argued that the perceptions of members of the different faculties within an institution were important for their receptivity or otherwise of innovations in IT. However, he also argued that support and encouragement were needed from management in allocating the time and resources to the various faculties to develop programmes which integrated IT into the curriculum. This is reinforced by the experience of teachers and mentors in the HP Telementor Program, where the lack of support of the school structure is one of the factors cited for a lack of impact of the Program on students (see Hewlett-Packard, 1998).

In terms of teachers' reactions to IT, therefore, it is possible to identify some important dimensions leading to a positive or negative response to the introduction of new technology:

- teachers' attitudes prior to the innovation;
- the role of the IT coordinator;
- the attitude of senior management;
- the existence of appropriate support and training.

What makes these personnel factors more important with the introduction of ICT (as opposed to just IT) into schools and colleges is that it is likely to reduce the choice that some teachers apparently make to avoid using IT altogether. Moreover, ICT is not just another add-on technology but is arguably qualitatively different from other information technologies. There has always been a recognition that IT impacts upon teaching and learning. The introduction of IT has been shown to lead to more individualised programmes of instruction, less didactic delivery and an emphasis on problem solving and cooperative learning situations (Hoffman, 1996; Baker, 1993 for an example from the United States). The Superhighway, with its potential for global communication, both vicariously through the Internet and directly through communications applications such as email and video conferencing, is of a different order to previous technological innovation in schools (see HistoryCity, 1998 for an example of an innovative use of ICT). It offers the ability to extend the reach of the student from the classroom to the world at large, which opens up access to experts and expertise which has until now been inaccessible (Levinson, 1990). As Norton & Sprague (1996) noted: 'The emerging electronic technologies pose an enormous challenge to teachers because their use demands considerable shifts in their pre-existing knowledge, attitudes and behaviours' (p. 94).

In particular, ICT presents a challenge to the traditional role of the teacher as instructor and provider of information. Rather, the availability of the Superhighway impels teachers towards a different pedagogical role as facilitator and skills developer, in which the teacher helps the student to a
greater understanding of the application and evaluation of information available via the new technologies (Davis, 1995). The crucial factor here will be the ability of teachers, through their training and support systems, to design courses which incorporate the potential of the Superhighways technologies in ‘a carefully planned curriculum-related activity for their workplaces’ (Collier & LeBaron, 1995, p. 319).

Superhighways technology is therefore potentially a ‘transformative technology’. That is, exposure to and deployment of the capabilities of Superhighways technology contain the possibility of a fundamental change in the way that education is conceived and delivered to students. As Muffoletto (1996) argued: ‘Through computer delivered instruction, distant education, and eventually the virtual teacher, the classroom and the school will be transformed. Teachers as we now know them will be different’ (p. 145).

However, a note of warning about the transformative capacity of the new technologies has been sounded by Rust (1991) in arguing that they exist in the context of a social and commercial environment which is not always conducive to the empowering potential of an open worldwide network. The reaction of teachers to the potential contained within the new technologies is likely to be an important factor in the liberating or constraining effects of exposure to them.

Our research, carried out as part of the Education Departments’ Superhighways Initiative (EDSI), can throw some light onto these issues, in particular, the factors which affected teacher responses to the introduction of Superhighways facilities into schools and colleges and some of the effects it had on their classroom practices. The EDSI Project was a multi-agency evaluation, sponsored by the UK Government, of a large number of Superhighways projects and supported financially by leading information technology companies, universities and participant schools and colleges of further education (post 18 years). There were a number of evaluation teams and the Leicester University research team covered seven different projects and 51 schools and colleges, geographically dispersed and including students in primary (ages 5-11 years), secondary (ages 11-18 years) and further education. The basic premise of the projects was that schools and colleges would be provided with connectivity and the facilities for broadband access and each project would seek to explore different aspects of the potential of the connection for teaching and learning. There were thus different focuses in each of the projects, though generally the main aspects explored were:
- access to the World Wide Web;
- the use of email facilities;
- video conferencing;
- CD-ROM as a tool for learning;
- multimedia authoring.
Research was carried out by the team in all 51 schools and colleges involved in the seven projects. Each institution was visited at least twice over the year that the projects were running and in the most advanced schools and projects, three visits were made. The team used common standardised data collection instruments on every visit. These included different interview schedules for project coordinators, for teachers involved in the specific projects and for students/pupils who had been participating. Standardised observation data of pupils/students using Superhighways technology were also collected, as well as standardised questionnaires about student use of ICT. Students involved in Superhighways activity also kept logs of individual sessions, covering the whole range of the new technologies, both simple and complex.

The evaluation allowed the researchers to investigate the factors which facilitated or hindered the use of ICT, the reaction of teachers and ICT coordinators to broadband connectivity and the effect that ICT had on classroom practice. In particular, two of the projects were more ‘open’ than the others, in that the schools involved were given the necessary equipment and then on the basis of ‘let a hundred flowers bloom’ were left to develop programmes of ICT on their own. The result was that there was a great deal of variation in the deployment and use of ICT in different schools, ranging from no use at all to intensive developments in deployment and use in teaching. The evaluation therefore provided an opportunity to compare those schools which were able to maximise the potential of ICT, those which made more limited use of the facilities and those which made minimal use of connectivity. The three groups of schools can be represented as follows in Table I.

<table>
<thead>
<tr>
<th>Integrative schools</th>
<th>These schools:</th>
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<tbody>
<tr>
<td></td>
<td>• integrated the use of ICT into their programmes of study</td>
</tr>
<tr>
<td></td>
<td>• were exemplified by planning for implementation in many curriculum areas</td>
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<tr>
<td></td>
<td>• had a well-respected and independent ICT coordinator</td>
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<tr>
<td></td>
<td>• had whole-hearted management support for the project</td>
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<td>• had a forward looking ICT policy</td>
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<tr>
<th>Adjunct schools</th>
<th>These schools:</th>
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<tbody>
<tr>
<td></td>
<td>• used ICT as an addition to the normal curriculum programme</td>
</tr>
<tr>
<td></td>
<td>• were exemplified by a limited number of enthusiasts</td>
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<tr>
<td></td>
<td>• had an over-stretched ICT coordinator</td>
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<tr>
<td></td>
<td>• had initial, but unsustained, support from management</td>
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<td>• had a reactive ICT policy</td>
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<tr>
<th>Opportunistic schools</th>
<th>These schools:</th>
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<tr>
<td></td>
<td>• made minimal use of ICT</td>
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<tr>
<td></td>
<td>• were exemplified by indifference or hostility by teachers</td>
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<tr>
<td></td>
<td>• had an ICT coordinator located within an IT department</td>
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<tr>
<td></td>
<td>• had limited management support for the project</td>
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<td></td>
<td>• had little planning for ICT on a whole-school basis</td>
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Table I. School reactions to the Information Superhighway.
While technical factors were important in determining whether a school became an ICT-rich environment or not (for example, one school was never able to establish connectivity successfully because of a hardware mismatch), we wish to focus on the personnel factors at work in these environments to try to establish what made for successful implementation. We shall do so under four headings: teachers’ attitudes; the role of the ICT coordinator; senior management; support and training. We are not suggesting that these are the only four personnel factors at work, or that the individual situation of specific schools was not important. For example, the single school involved in one of the seven projects received much more secure and frequent technical support from the commercial sponsors than some of the schools in the larger projects. The potential for integration was therefore greater in this single school. Nevertheless, across the project institutions, the interplay between these four factors emerged from our data as important in influencing which category a particular institution ended up in.

**Teachers’ Attitudes**

The challenge posed to teachers’ attitudes by information technology is so acute because IT demands that teachers learn new skills and alter the way that they operate in the classroom (Prawat, 1992). In the past, the required acquisition of IT skills before teachers could effectively incorporate applications into their programmes of study may have militated against the use of IT. However, in some project schools, enthusiastic teachers commented on how easy the IT skills needed to use the Internet were to acquire compared to other IT applications they had tried:

> I’ve been on lots of different (IT) courses and I’ve never made time to use what I have learned. Apart from the Internet being a lot more exciting than some of the other things around, it’s really easy to use and that’s the one thing that has helped me to use it. (Teacher from an adjunct school)

Nevertheless, the pre-existing attitudes of teachers can hinder the adoption of ICT. In one adjunct school, a ‘strength’ of the school – its stable and long-serving staff – was also identified as its weakness in terms of innovation and especially the adoption of ICT. The strategy of cabling up the staffroom to allow teachers to access the Internet in relative privacy from the students had produced only a limited amount of movement by the staff.

Stuhlmann (1994) argued that ‘the key incentive for use was the desire to create an environment where students engaged in their own learning and used computers effectively’ (p. 200). In one opportunistic school, the limited use of ICT by the teachers was explained as a result of the very academic nature of the school. Because the timetable was highly structured and geared towards examination subjects, there was little time or inclination to
use ICT, learn new skills or incorporate innovations in teaching. The use of ICT in this circumstance was limited to the IT department, as a means of improving the IT examination results.

On the other hand, there were also many examples of technophobes who had been converted to computers through exposure to ICT. The mechanism here seems to be that where the information accessed meets the teaching needs of the teacher in a relatively direct way, then that teacher gains confidence in the utility of ICT. For example, one English literature teacher, through accessing sites relating to Old English poetry on the Internet, became adept at search strategies in her subject. Initial support from an IT-experienced mentor (Pratt, 1993) was important in producing this transformation from using IT as a ‘personal productivity tool’ (Waggoner, 1994) to using ICT as a teaching tool in the classroom.

In secondary schools, the difference between teachers of different subjects was not an important factor in the use or non-use of ICT. We found examples of incorporation across most syllabus areas, even in areas which might stereotypically be thought of as resistant to IT. However, there were some differences in the way that different subject teachers used aspects of ICT in accordance with their needs. For example, modern languages departments were more likely to be exploring video conferencing as a means of making contact with native speakers in other countries. Teachers of sports studies and film studies, on the other hand, were more likely to access related Internet sites, because of the difficulties they faced in obtaining up-to-date textbooks in their fields.

However, in all the integrative schools and colleges, the existence of a whole-school policy on IT and the way that it was to be delivered were important in engendering a positive attitude towards its use amongst staff. Even here, there were some teachers who were more enthusiastic than others, but the existence of a cohort of regular users was vital to the integration of ICT into schemes of work and most teachers’ practice in the institution (Becker, 1992). The enthusiasts were appreciated for their ability to warn others of the pitfalls of using ICT indiscriminately and for showing routes to successful integration into lessons. They were less important for the teaching of ICT skills such as search strategies. In this area, teachers preferred to develop their skills through hands-on experience rather than more formal training sessions.

The Role of the ICT Coordinator

The central role of the ICT coordinator in encouraging the classroom use of IT is well documented (Paul, 1994). However, the existence of a specialist ICT coordinator is not of itself a sufficient or necessary condition. One integrative school relied on the IT expertise of a maths teacher who was made project coordinator and who was allowed little time to carry through
the ICT project. The coordinator in this instance succeeded in encouraging dense use of Superhighways mainly at a personal cost in terms of the time and energy he put into it. Nevertheless, the activities of a supportive management who were evolving strategies to support his efforts (such as requiring all departments to integrate ICT into schemes of work at the rate of one course per year), and who were public in their appreciation of his work, helped to push forward integration.

In another integrative institution, the ICT coordinator was established as the equivalent of a head of department and was given a great deal of freedom to plan ICT activities and draw in staff as appropriate. Significantly, he had been given his own substantial budget to manage, both for hardware and training, which enabled him to support the introduction of ICT in a systematic and realistic fashion. The result was that targeted staff were given the time and skills to integrate ICT into their lessons and to plan how they might go in the future, with guaranteed access to connectivity. In another integrative school, the role of project coordinator was deliberately given to a curriculum expert rather than the IT coordinator, to emphasise the learning rather than the technical dimension.

In one adjunct school, the ICT coordinator had introduced many strategies for involving reluctant staff in ICT, such as running open sessions and supporting those staff who expressed an interest. However, the ICT coordinator also recognised the difficulty of shifting the culture of the school, especially as he was effectively denied easy access to other departments through timetable constraints and there was little planning by senior management to introduce ICT in an effective way.

Most of the ICT coordinators were also instrumental in restricting access to some of the facilities of ICT provided. Usually this was because of their fear of losing control over the use and abuse of some of the opportunities. For example, one adjunct college restricted email access to staff only as the ICT coordinator was concerned with the material that was being sent out in the college's name. Even in integrative schools, access was often limited in some way or another, such as only allowing chat-line activity beyond the school day or using cyber software to restrict the areas where students might go.

**Senior Management**

In one opportunistic school, the senior management had decided to enter the project as a way of getting free access to the Internet for a year. There had been no planning about what to do with the technology once it was installed, and the management left the IT department to its own devices during the course of the project. As a result, the use of ICT did not extend beyond the department, except for the occasional sixth former (16–18 years) who expressed an interest.
In integrative schools, the support of management was vital for the long-term future of ICT. After the project was over, connectivity would have to be paid for. Supportive managements had looked ahead to identify what levels of funding would be required for different levels of connectivity and had actively explored alternative cheaper service providers. As a consequence, those involved with the project, both teachers and ICT coordinators, had confidence that their efforts would not be cut short by a premature withdrawal of connectivity. Equally important was the encouragement of management to continue to develop ICT facilities and use and to budget for improvements in the hardware and software needed to maximise potential. In several integrative schools and colleges, senior management were planning to extend video conferencing and email facilities and to use them for administrative and recruitment purposes.

The most developed integrative institutions had very ambitious plans for ICT and their future. In one school, plans were almost complete for the development of a lifelong learning centre, sponsored by commercial firms. Another school had plans for developing a cybercafe for use by parents and others beyond as well as in the school day. Thus, in a climate of innovation in which senior management strongly supported ICT initiatives, there were incentives for staff to become heavily committed to innovative practice using ICT. Waggoner (1994) argued that ‘certainly, the investment of time to investigate the potential of technology ... can be sizeable; if the institutional reward structure is not supportive, it is unlikely that many (staff) will risk such an undertaking’ (p. 183).

Our findings would certainly support this idea.

Support and Training

Initial training in the use of ICT facilities was provided by the commercial sponsors of the projects. In most cases, this took the form of hands-on sessions for key personnel from each school, which was then expected to be cascaded to other members of staff and to students. In many opportunistic schools, the amount of post-formal training was very limited; it was usually confined to a general invitation to drop in and see what was available. Many adjunct schools had an informal system of training in which potentially interested teachers were targeted and invited for training. The integrative schools were more formal in their cascading and often ensured that all staff and targeted students (if not all students) were provided with some training. Equally important was the provision of ongoing support in the integrative schools. Sessions on the Superhighways were usually supported by the ICT coordinator, or at the very least an IT technician.

In-school training for teachers proved problematic for many of the adjunct schools. The amount of time which was allowed by management to release staff for training was very limited, and follow-up support was often
non-existent. The result of this was that many initially interested teachers
dropped out of the projects, partly because of their own lack of time, but
also because they did not have the technical support and training which
they needed to sustain their involvement.

In the integrative schools, ideas about who should be trained were
much broader. In the most advanced institutions, training and support were
offered to the wider community beyond staff and students, including
parents, local businesses and feeder schools. In one instance, the money
generated by providing access to the community was used to fund the
position of the ICT coordinator. The wider remit of trainers in these
institutions meant that planning had to be more consistent and
forward-looking, rather than reacting to the individual needs of members of
staff. In these institutions, there were plans to develop these links on a more
systematic basis, such as using ICT for the transfer of records from primary
to secondary schools.

Another important distinction between adjunct and integrative schools
was the type of training which was carried out in the schools. While much of
the initial training focused on the provision of IT skills, integrative schools
moved from ‘learning to use the technology’ to ‘using the technology for
learning’ (Galton et al, 1998). Thus, integrative schools focused on the needs
and interests of the learner, rather than merely cascading IT skills to
members of staff. For example, a geography department was given training
which used the collection of material on the Kobe earthquake as a
framework. In adjunct schools, the focus of training remained on the use of
the technology rather than how it might foster learning.

**Conclusion**

What are the implications of these findings for the successful integration of
ICT into the school and the classroom? It is the interplay between the four
factors identified which moves an institution towards integrating the new
technology in an educationally useful way. The common thread among the
factors is appropriate support and training mechanisms, which are central
for effecting the change in culture which leads to integration. At the level of
the institution, integration is accomplished best where the senior
management are committed to the idea of ICT and willing to resource
Superhighways on a long-term basis. Their support for ICT in a public way is
important in encouraging the classroom teacher to get involved and devote
the time to the process of integration, despite all the other pressures they
may face. Senior managements in integrative schools were also aware of the
need for ongoing training and support for teachers, not just an initial
programme. Moreover, if the senior management had a vision of where they
wished to go with ICT, positive responses from staff were more likely to be
evident.
At the level of the staff, an independent and proactive ICT coordinator who has both financial responsibility and enough time and status to plan and implement strategies for integration is also important. The role of the ICT coordinator was also central in evolving systems of support for staff in using ICT, which facilitated consistent use of the new technology. However, the ICT coordinator also needed to have an appreciation of the curriculum and the pedagogical issues which the new technology raised, and not just a narrow technical view of the problems associated with integration.

The attitudes of teachers are central to the success of ICT integration. Teachers’ prior attitudes (often negative or fearful) are not necessarily a bar to successful integration. On the contrary, where teachers were given appropriate training and assistance to explore the learning opportunities of the Superhighway rather than just address the technical skills needed, they could quickly be converted to using it. Positive experiences of using IT in the past made the process of deployment quicker, but not by a long way. The crucial factor appeared to be time, in that teachers, excited by the potential in the new technology, consistently complained that they did not have enough time to explore, design programmes of study and evaluate their impact on their students.

Where ICT meets their own teaching needs and the learning needs of their students, where there are consistent systems of support and training, where enough time is set aside for teachers to begin to integrate ICT into their curriculum activities and where management are publicly committed to the deployment of ICT in an integrated way, the traditional culture of teachers can be changed. Where the appropriate systems of support are in place, then ICT can be experienced as a ‘transformative technology’ both for staff and for students (Comber & Lawson, 1998).

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