Information and Communication Technologies and the Changing Role of the Teacher

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ABSTRACT  This paper examines the changing role of the teacher in the use of educational Information and Communication Technologies (ICT). Several key issues are explored, including the effects of ICT on teaching and learning, the changing role of the teacher in constructivist learning environments, and the new skills teachers may be expected to acquire in order to make fruitful use of the new technologies. The author argues that the introduction of ICT into schools is raising fundamental questions about the nature of teaching and learning, and may even be challenging our conception of ‘time and place’. The paper offers evaluation of ICT uses in elementary schools in the USA and primary schools in England. It concludes with descriptions of emerging technologies (including relevant website addresses) and the possible contribution these may make to promoting ‘any time, any place’ learning opportunities for the future.

Introduction

Teachers are living in a time of general uncertainty where rapid changes in professional practice are commonplace. The present situation has arisen due to a number of factors, including economic instability, technological innovations and political initiatives. One of the most pervasive changes in professional practice is emerging as a result of the implementation of Information and Communications Technologies (ICT). All change is accompanied by uncertainty, but change can also be instrumental in raising important questions, and this field of enquiry is no exception. One essential question currently being asked is: what will be the long-term impact of the introduction of ICT into the classroom? Another equally important question being raised is: what kind of skills will teachers need to acquire in order to be effective in an ICT supported learning environment? Change may bring uncertainty, but the introduction of ICT into the classroom brings one thing of which we can all be certain—teachers will need to adapt to change if they are to survive and keep pace with new methods and technologies. This paper will address
these two important questions by highlighting the experiences of teachers using ICT in the South West of England, and offering some further examples of established ICT teaching and learning applications in schools in the USA Midwest. The paper concludes by discussing current and future trends in learning technology development.

**ICT and Learning**

A great deal of research and development has been conducted to bring Information and Communication Technology (ICT) to its present state of learning application. Although ICT has been an integral part of the National Curriculum for over a decade, some commentators argue that there is still no consistency in its use (Selwyn & Bullon, 2000). In the context of teaching and learning, Jones and Knezek (1993) argue that ICT should be seen as a means of improving efficiency in the educational process. However, this may be a limited view, given that ICT is changing the very nature of teaching and learning. For adherents of the new technologies, the introduction of ICT into the classroom has engendered an entirely new and positive dimension to the art of teaching. Moreover, it has been shown that the use of computers in education can generally help to improve memory retention, increase motivation and generally deepen understanding (Dede, 1998). ICT can also be used to promote collaborative learning, including role playing, group problem-solving activities and articulated projects (Forcheri & Molfino, 2000). Yet the use of ICT requires a great deal of investment from teachers in terms of time, effort and general commitment. The issues are concisely summed up in the following statement:

‘Network technology creates enormous possibilities but demands high levels of skill from its users. The issue is not just technical mastery of network use, but above all the cognitive skills of presenting and developing meaningful questions, and interpreting information by integrating it with previously accumulated knowledge and giving it an appropriate context.’

(Sinko & Lehtinen, 1999, p. 17)

Generally, ICT seems to be encouraging new approaches to working and learning, and new ways of interacting (Balacheff, 1993) and a large percentage of teachers have shown enthusiasm to learn more about it potential (Williams et al., 1998, 2000). However, not all teachers have welcomed the widespread introduction of ICT in schools (Bradley & Russell, 1997). Consequently, a host of new questions have been posed regarding the evolving nature of pedagogy.

**Some Key Questions**

Whether or not changes in pedagogy are contingent on trends and innovations is a contentious point. The important question however, is: what will be the long-term impact of ICT on the teaching and learning process? It is well documented that using computers changes the nature of motivation to learn (Forcheri & Molfino, 2000), but will there also be adverse effects? Furthermore, teachers will need to
acquire new skills in order to promote quality learning opportunities in an ICT rich learning environment.

The great debate about how teachers should adapt current teaching skills to accommodate the introduction of ICT is only just beginning. In the meantime, teachers now have to grapple with how to apply new technologies effectively to teaching and learning. The necessary changes will be comprehensive, embracing teaching methodology, assessment of learning, tracking of progress and record keeping, communication, and curriculum evaluation.

The potential of the distributed nature of technology-supported learning, and the impact it creates on both learners and teachers will also become crucial issues. The concept of shared resources, and shared working spaces, and particularly the notion of collaborative learning may be particularly difficult for some teachers to accept. Most critically, the question of the extent to which teachers relinquish control and let learners drive their own learning may create the greatest barrier to the adoption of ICT in the classroom. In order to address some of these key issues, a brief summary of the work done to date is presented, with highlights of some of the more notable applications of ICT in British and American classrooms.

The UK Experience

The UK government has for the past decade been actively encouraging schools to embrace ICT as a fundamental part of the fabric of the curriculum. In 1998–1999, the UK government’s funding for ICT development in schools, known as the National Grid for Learning (NGfL) finally began to have a tangible impact. NGfL funding has resulted in a growth of connections to the Internet in primary and secondary schools. In March 1998 only 17 per cent of primary schools in the UK had Internet access. By March 1999 this had increased to 62 per cent and in the same period there was also an increase of Internet connectivity in secondary schools from 83 to 93 per cent (DfEE, 2000, p. 18). Many secondary schools and an increasing number of primary schools are now developing their own school websites and announcing their presence in cyberspace. The use of web pages to post school news and homework assignments is now becoming common practice, as will be the submission of work via e-mail from the child’s home to the teacher’s mailbox. These practices are already well established in many Australian and American schools.

This, however is just the first step toward introducing ICT into schools. It is expected that all British teachers will be offered training in the use of ICT by 2002, and the UK Government has committed to spending £230 million to drive this training initiative forward (DfEE, 2000, p. 18). British teachers are also being actively encouraged to purchase personal home computers, with a further fund of £20 million being offered to support this initiative. Teachers can expect to purchase a computer and peripheral equipment at approximately half the retail price for exclusive home use. Through these initiatives it is envisaged that many more teachers will be encouraged to explore the possibilities of ICT, and increase their confidence in the use of computers and networked resources. It is possible that
entirely new working practices will evolve, where teachers work in a more collaborative manner, both with their own colleagues and with children.

Finally, schools in some specially designated pilot areas are being encouraged to work together in clusters using ICT based communication methods. This approach enables schools to collaborate, sharing expensive teaching and learning materials, which can be made available cost effectively to larger distributions of children. This method of working will also enable key staff to provide on the job (or ‘just in time’) training to their colleagues from a centralised resource base (DfEE, 2000, p. 19).

**What ICT Brings to the Classroom**

Many are predicting that ICT will bring about major benefits to the learner and the teacher. As we have seen, these will include sharing of resources and learning environments, and opening up classrooms as well as the promotion of collaborative learning and a general move towards greater learner autonomy. I shall briefly discuss each of these benefits in turn, offering examples of each.

**Shared Learning Resources**

One of the most striking examples of ICT in action in American schools is the use of video systems to relay television programmes and digital information throughout an entire school and even between schools in the same district. In the Faribault Schools System in Minnesota, this integrative approach to the regional sharing of learning resources is enabling elementary schools to minimise expenditure by concentrating time and effort into creating centralised services. Students and teachers enjoy the facility to share information wherever they are in the school. Strategically placed television monitors provide details of timetables, projects and assessment, mealtime menus and a host of other useful up-to-the-minute information. There are also regular play-outs of short films and videos created by the children, and some schools can use several channels for broadcast purposes.

**Shared Learning Spaces**

Networked computing facilities create a distributed environment in which learners can share work spaces, communicate with each other and their teachers in text form, and access a wide variety of resources from internal and external databases via web-based systems through the Internet. In Broadclyst Primary School in East Devon, pupils as young as 8 years old use networked software to communicate with each other and their teacher, from the classroom or from home, whilst 10 year olds converse with ‘pen pals’ in other countries using e-mail. Using these shared systems, pupils develop transferable skills such as grammar and syntax construction, keyboard techniques and written communication skills, whilst simultaneously acquiring knowledge of other cultures, languages and traditions. Furthermore, children are able to make links between internal thinking and external social interaction via the keyboard, to improve their social and intellectual developments in the best construc-
tivist tradition (Vygotsky, 1962). The children in this school are quickly mastering the ability to communicate effectively using these new technologies because the experience has been made enjoyable in an unthreatening environment, and there are immediate perceived and actual benefits for both pupils and the teaching staff.

Opening up the Classroom

Resources can also be accessed outside the school. For example, the excellent BBC Education website offers educational materials for all ages from pre-school through to adult and continuing education [See www.bbc.co.uk/education]. As Joo (1999) points out, the Internet takes teaching materials outside of the classroom and into the communities. This in turn ensures that entirely new relationships between teachers and pupils, teachers and parents and between teacher and teacher will be forged. We can expect that teachers will soon be required to adopt the role of mediator between student and knowledge.

The Promotion of Collaborative Learning

Riel (2000) argues that much of what we now see as individual learning will change to become collaborative in nature. Reasoning and intellectual development is embedded in the familiar social situations of everyday life (Donaldson, 1978) so the social context of learning has a great deal of importance. Collaborative learning is therefore gaining an increasing profile in the curricula of many schools, with ICT performing a central role. Schools in the UK are already starting to use discussion lists, and other forms of computer mediated communication (CMC) to promote collaboration in a variety of learning tasks and group projects. CMC techniques enable wider participation, transporting children beyond the boundaries of their own school experience.

The Move Towards Autonomous Learning

Computers—and the power they bring to the student to access, manipulate, modify, store and retrieve information—have the potential to promote greater autonomy in learning. Inevitably, the use of ICT in the classroom will change the role of the learner, enabling children to exert more choice over how they approach study, requiring less direction from teachers. Students will be able to direct their own studies to a greater extent, with the teacher acting as a guide or moderator rather than as a director (Forsyth, 1996, p. 31). This facilitation will take on many facets and will also radically change the nature of the role of the teacher as we currently understand it. Consider, for example, the students at one Devon primary school who are able to use a software-based music laboratory in their free time to write, record and produce their own music CDs. Microphones and keyboards have been purchased to encourage the creativity that the children are discovering within these self-driven extra curricular activities. Minimal teacher management is required, as
the equipment is very user friendly, and pupils generally access these facilities during their break periods or after school.

**A Move towards Electronic Management of Learning Spaces**

Teachers manage a wide range of information on a day-to-day basis, including attendance records, assignment grades and test scores, information about each individual child, classroom schedules, lesson notes and resource lists. ICT applications such as spreadsheets and relational databases can and will simplify and rationalise many of these tasks, freeing up teachers’ time which can be better spent in lesson preparation, teaching and action research. Centralised record keeping will ultimately enable schools to better manage learning spaces, activities and resources.

**Engineering the New Role of the Teacher**

As already stated, teachers have been polarised in their acceptance of the new educational technologies. Whilst some have enthusiastically integrated computers, CMC and the Internet into their classrooms, others have been cautious in their welcome, and a few have simply ignored the technologies. There is a level of justifiable cynicism based on previous experience of computer based applications such as computer assisted learning (CAL). Ironically, some enthusiasts have inadvertently damaged the reputation of ICT by poor classroom practice—using the technology for the sake of its novelty value, or failing to think through the issues before implementing the technology (Littlejohn *et al.*, 1999).

With the inevitable proliferation of ICT in the classroom, the role of the teacher must change, and there are four key reasons why I believe this must happen: Firstly, the role of the teacher must change because ICT will cause certain teaching resources to become obsolete. For example, the use of overhead projectors and chalkboards may no longer be necessary if learners all have access to the same networked resource on which the teacher is presenting information. Furthermore, for pupils distributed throughout several classrooms—which will become more common place—localised resources such as projectors and chalkboards become redundant and new electronic forms of distributed communication must be employed.

Secondly, ICT is almost certain to make some forms of assessment redundant. Low level (factual) knowledge for example, has been traditionally tested by the use of multiple choice questions. In an ICT environment, computer based testing can be used which instantly provide the teacher with a wide range of information associated with the learner’s score. Comparisons of previous scores and dates of assessment will indicate the extent of a child’s progress. The measurement of the response speed of key presses may pinpoint problems, indicate hesitancy or reveal areas of lack of understanding. Each pupil can be allocated an individual action plan database stored in electronic format into which each successive test result can be entered automatically.

Thirdly, the role of the teacher must change in the sense that it is no longer
sufficient for teachers merely to impart content knowledge. Teachers must complete the move from being lecturers to becoming organisers and enablers (Sinko & Lehtinen, 1999, p. 143). It will become crucial for teachers to encourage critical thinking skills, promote information literacy, and nurture collaborative working practices to prepare children for entry into the world of work. This will be a world in which no job is guaranteed for life, and where people switch careers several times, or even engage in several careers simultaneously, in what has been referred to as the ‘portfolio career’.

One of the most ubiquitous incarnations of ICT—the Internet—gives access to an exponentially growing storehouse of information sources, almost unlimited networks of people and computers, and unprecedented learning and research opportunities. The Internet is a network of networks, providing opportunities for inquiry-based learning where teachers and students are able to access some of the world’s largest information archives (Wheeler & Magee, 1997). Students and teachers are able to connect with each other, learn flexibly, and collaborate with others around the world. Generally speaking, geographical distance is no longer a barrier, and the age of the ‘borderless’ provision of education is upon us (THES, 2000). Teaching strategies and resources can be shared through communication with other educators and may be integrated across the curriculum. The Internet provides a wealth of information so extensive that it is now impossible to comprehensively track the amount of information available. Unfortunately, misinformation and inaccuracies are similarly present in great numbers on the Internet so one of the new roles of the teacher within the electronic classroom will be to separate out quality information from misinformation. Identification, classification and authentication of electronic information sources will thus be critical new tasks for teachers.

Finally, teachers must begin to reappraise the methods by which they meet children’s learning needs. The Internet can be an excellent way to adapt information to meet the characteristics of human information processing. Traditional methods of imparting knowledge, such as lectures, books and this journal article, are characterised by a linear progression of information. Human minds are more adaptable than this, using non-linear strategies for problem solving, representation and the storage and retrieval of information (See for example Collins & Quillian, 1969; Collins & Loftus, 1975). Hypertext software enables teachers to provide their students with the non-linear means to match non-linear human thinking processes (Semenov, 2000, pp. 29–30). Another key role of the teacher, therefore, will be to design courses with non-linear elements, thereby exploiting hypertext features.

In order to put these new roles into context, we can examine some case studies of actual ICT based learning environments in elementary schools in the United States.

**The U.S. Experience**

As has been previously detailed, schools in the United States are investing in centralised media systems that will enable information to be broadcast to many schools at one time. Personalised learning is also encouraged. In Minneapolis, an
entire year of 90 students on one externally funded project were each loaned a laptop computer (Frank, 1999). Flexible ways of working and learning were observed, as students came to terms with any-time any-place learning. Teachers monitored activities, facilitating rather than directing, in order to encourage the most creative uses of the mobile technology. During the entire project only one laptop computer was lost when it was accidentally left on a public bus.

Networks of Apple Macintosh *iMac* computers are also much in evidence in US schools, where children are instructed from the first grade onwards. Large screen video projection facilities are used to guide the students, application sharing is used to take control of individual or grouped workstations to provide tutorials, and each student is given a personal e-mail address. Similarly to their UK counterparts, American children as young as 7 years old are being encouraged to seek out, and maintain correspondence with overseas pen pals. Students as young as 5 years old are learning to use ICT as a regular resource to think and communicate, thereby enhancing the learning process. The role of the teacher here also, is to enable rather than to control learning activities.

**Trends and Alternative Futures**

So, what of the future impact of information and communication technologies in the classroom? If it is difficult to predict future technological trends, it is almost impossible to foresee how these emerging technologies might be used in future teaching and learning contexts. The following quotations bear witness to this problem:

‘One day every town in America will have its own telephone’ (U.S. Mayor, 1880).

‘Within the next decade moving pictures will replace print’ (Thomas Edison, 1913).

‘I foresee a world market for maybe 5 computers’ (Thomas Watson, Chairman of IBM, 1943).*

‘I predict a time when computers will weigh no more than one and a half tons’ (Popular Mechanics, 1949).*

‘I foresee no reason for people to have a computer in their home’ (Ken Olson, President of Digital Equipment Corporation, 1977).*

(* Quotes taken from Riel, 2000, pp. 20–21)

One thing of which we can be certain is that ICT technologies will inevitably continue to proliferate, possibly to the point where they become personal technologies, in a similar fashion to the personal CD player or the mobile telephone. Indeed, the third generation of mobile telephones, released in 2000, connect via a network of low orbit satellites, and have the capability to connect with communication networks virtually anywhere on the planet, and also to receive high quality video and gain quick access to the Internet. These technologies will truly usher in the age of ‘any time, any place’ learning. The teacher’s traditional role of ‘classroom facilitator’ will be severely challenged by this promise, where children learning from home using
formalised electronic platforms for at least part of the school day may become a reality. Schools wishing to follow this distributed model must first consider the notion of the ‘digital divide’—the dichotomy between those families that have a home computer and Internet connections, and those that don’t. Furthermore, there are gender and cultural issues to consider in relation to the use of ICT and these have been well documented (Joo, 1999; Passig & Levin, 2000; Riding & Grimley, 1999). These social influences deserve fuller discussion but are unfortunately beyond the scope of this paper.

Wearable computer systems are already being beta-tested and several universities (notably MIT in the United States) have established advanced research programmes to explore the many possibilities and applications, particularly in teaching and learning [visit http://www.fae.plym.ac.uk/tele/tele.html]. The Internet, if bandwidth and costs will allow, will become even more ubiquitous than at present, providing vast, almost infinite quantities of learning material, stored around the world, and accessible direct into the classroom, workplace or home—in fact, anywhere. World-board systems will provide location specific information, working in seamless union with wearable wireless computer and communications technology. Operating from the basis of three co-ordinates—latitude, longitude and altitude—users will be able to access instant information about any place, artefact or event on earth. [Go to Margaret Riel’s slide show at: http://www.gse.uci.edu/mriel.html/wt6/sld006.html for more information]. Tele-immersion through the use of distributed virtual reality technology may eventually become a reality for some schools [see http://www.advanced.org/].

In the United States, Xerox and other companies are racing to be the first to produce a usable form of digital paper. A booklet, with pages no more than twice as thick as a normal sheet of paper, will act as a portable series of wafer thin computer screens. The spine of the book acts as data storage, containing up to 100 medium sized text books, downloadable direct from the publisher via the Internet [see a report at http://newsscientist.com/ns/19990515/papergoes.html].

Wireless, seamless, anytime, anywhere communication is on the horizon, and educators must be prepared for the changes this will bring to classrooms, as well as to society in general. The impact of these new technologies upon compulsory education will not be slow in coming.

Conclusions

Rapid changes in technology will ensure that ICT will proliferate in the classroom. It is predicted that there will be many benefits for both the learner and the teacher, including the promotion of shared working space and resources, better access to information, the promotion of collaborative learning and radical new ways of teaching and learning. ICT will also require a modification of the role of the teacher, who in addition to classroom teaching, will have other skills and responsibilities. Some will become specialists in the use of distributed learning techniques, the design and development of shared working spaces and resources, and virtual guides for students who use electronic media. Ultimately, the use of ICT will enhance
learning experiences for children, helping them to think and communicate creatively, and work collaboratively. It will also prepare our children for successful lives and careers in an increasingly technological world.

Notes on Contributor

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