Chapter Four

Information and Communications Technology in Education

Introduction

In this chapter, I will offer a brief historical background of the developments in computing over the last fifty years that is intended to set the context of my enquiry. I argue that these developments have implications for teaching and learning in higher education. I explore findings of an international study that deals with the current uses of ICT in teaching and learning in higher education and highlight its implications for my enquiry e.g. its conclusion that institutions need a strategic view or policy on the use of ICT. I set out my findings from a quickscan of the literature on good/best practice that relates ICT policy to practice in the contexts of teacher education. The benchmarks that the scan offer supports my argument that ICT can shape new ways of teaching and learning in the context of the professional development of teachers. As Oblinger and Rush say, "*These new tools challenge the education establishment to rethink itself and education as well*" (Oblinger & Rush, 1997, p. 55). It is appropriate that I adopt a critical stance to the appraisal of my own pedagogy and that this should be informed by insights arising from researching into my own practice in the use of ICT to optimize the teaching and learning process.

Developments in Technology

Rapid advances in human computer interaction have contributed new tools and technologies that provide new opportunities for teachers and learners. The purpose of this chapter is to explore relevant developments in Information and Communication Technology (ICT) and the implications for learning and teaching in the context of

professional development of teachers. In Ireland and the UK in recent years there has been a reduction in funding for education whilst at the same time an increase in demand for wider access to students, often termed 'disadvantaged', or from lower socio-economic backgrounds, students with disabilities, and second chance learners. National and international reports on higher education highlight that staff-student ratios are worsening. In this context of fewer teachers and more students there has been a drive by policy makers, organisations and education providers to realise the potential of ICT to enlarge learning opportunities.

Fifty years ago saw the invention of a computer, which modern computing is founded upon with ENIAC (electronic numerical integrator and computer) at the University of Pennsylvania. ENIAC was the world's first electronic digital computer. It had 30 separate units, plus power supply and forced-air cooling, and weighed 30 tons in total. Its 19,000 vacuum tubes, 1,500 relays, and hundreds of thousands of resistors, capacitors, and inductors consumed almost 200 kilowatts of electrical power, took up a large room, cost millions and had the processing capabilities of a modern pocket calculator. But ENIAC was the prototype from which most other modern computers evolved. From ENIAC grew the computer industry, which allows us to be connected and able to receive and transmit text, sound and pictures instantaneously over the globe.

In 1965, Gordon Moore, co-founder of Intel, observed that the number of transistors per square inch on integrated circuits had doubled every year since the integrated circuit was invented. Moore predicted that this trend would continue for the foreseeable future. Microprocessor performance has been approximately doubling

every 18 months. If we look back to how word-processing was done on 8080

processor machines and on the 286 machines, it was very much the same. But with

the introduction of the 386 machines, the point-and-click interfaces superseded the

keystroke commands. With the Pentium processors, one can use voice to open and

close applications.

The 1980s saw the introduction of desktop personal computer (PC) and the1990s saw

the arrival of the Internet on existing narrowband telecommunications infrastructure

that had been designed for telephones. Telecommunications involves the exchange of

information in any form, for example, voice, data, text, images, audio, video, and that

information can be transmitted over computer-based networks. The narrow

bandwidth however, confined transmissions to asynchronous modes of

communication.   In other words, outgoing and incoming communication could not

take place at the same time. Past technologies such as radio and television did not

allow us to interact over distances. However, the telephone was interactive but it only

allowed synchronous communication and only carried sound. Narrow bandwidth

meant that the dynamic communication that was possible in a traditional classroom

proved difficult to emulate online. Traditional classroom communications allowed

for rapid spontaneous interaction and face-to-face allowed subtle sensory cues, e.g.

gesture, expressions, position and voice to be communicated. The arrival of devices

such as PCs that could store, process and reproduce large bodies of data,

supplemented the library function in educational establishments and permitted a

limited dialogue between machines and their users. Advanced communication

systems that enabled each PC and its user to interact in real time with other PCs and

other users through the internet opened wide arenas of educational conversation that could eventually replicate and even extend most forms of classroom communication.

With the developments of the Internet and advances in networking a unique opportunity for interactive education emerged that offered at a distance and to a large number of people. These developments have opened up the possibility of collaboration with experts worldwide. The added value of the internet and its potential to deal with different forms of representation, such as, graphics, audio, video and moving images opens up to other forms of representation beyond text.

As the full potentiality of human computer interaction is developed there is likely to be a further explosion of the use of multimedia and the ability for people to communicate in more dynamic ways. Myers (1996, p. 3) points to the emerging technologies that are a result of research in human-computer interaction. These extend from the mouse pointing device, windows, computer applications such as drawing, text editing and spreadsheets and hypertext, and to the new technologies of the future, such as multimedia and 3D, gesture recognition, natural language and collaborative learning technologies. Myers believes that user interfaces will most likely be one of the main 'value-added competitive advantages' of the future, as both hardware and basic software become commodities. Indeed his prediction is being borne out as one can see that yesterday's advanced system is today's commodity. Further advances in technology such as, high-resolution displays, 3D graphics and animation, handwriting and speech input, and natural language understanding are likely to improve the end-users interface. We are still witnessing the pursuit of a developmental paradigm whose eventual outcomes can only be guessed at.

Bandwidth is integral to the opening up of new technologies for teaching and learning. Broadband allows for greater speed in communications and greater flexibility. The International Society of Ireland report on 'Ireland's Broadband Future' (2003) highlights that current communications by computers/other devices have hitherto been restrained by the lack of bandwidth/broadband for network intensive applications. They point to developments in consumer devices, which require networking for interoperability. This allows the many different end users to use the different types of computer systems, software packages, and databases provided by a variety of interconnected networks.

The report 'Ireland's Broadband Future' (2003, p. 71) traces the waves of development that have taken place: The First wave (1985 - 1995) centered on email. In this case, the internet is connected as a stand-alone application on specific computers. The network is subservient to the computer. The Second wave (1995 - 2005) focused on the Web. In this case, the applications and services are accessible by anyone using the World Wide Web. Organisation, data and application are location specific and the computers become dependent on networks. The Third wave (2005 - 2015) is expected to involve Networked Applications. Here, the technology trends are towards more extensive use of Internet, digital fiber-optic, and wireless technologies catering for high-speed local and global internetworks for voice, data, images, audio, and video communications. This will have huge advantages for education. In this case, the data and applications are uncoupled from specific locations or machines and can be accessed and directed from many locations. The computer is subservient to the

network. Data and application exist in 'cyberspace' this means that they are completely in the network and are not attached to any specific machine or location.

Computing and communications industries have merged with the networking of computers. Wireless access to the Internet is growing. With the agreement on a standard wireless application protocol (WAP) there are many developments of wireless Web applications and services. These developments will raise the wirelesss transmission speeds to allow for streaming video and multimedia applications on mobile devices. This brief overview suggests that telecommunications and network technologies are developing dynamically internetworking and bringing about new ways of doing work in business, education and society.

Developing uses of technology in higher education: A comparative study

In contrast with the evident potentiality and dynamism of the new technology, studies of its impact upon teaching practices in higher education indicate that, as yet, teachers in general are making use of email and web resources but more advanced technologies, such as online learning environments and wireless solutions are only being used to a limited extent. Few in higher education are dealing in a practical manner with the new technology's central ideas about the handling of knowledge.

An international comparative study on Models of Technology and Change in Higher Education was carried out by the Centre for Higher Education Policy Studies and the Faculty of Educational Science and Technology of the University of Twente in the Netherlands (Collis & van der Wende, 2002). The aims of the study was to investigate the scenarios that are emerging with respect to the use of ICT in higher

education and, to see whether future developments can be predicted and strategic choices made on the basis of these scenarios. The study applied an international comparative methodology across seven countries surveyed: Finland, Germany, Norway, the Netherlands, the United Kingdom, Australia and the United States of America (USA). The methodology involved a multi-level and multi-actor approach, and addressed the various actors active at various levels within the higher education institutions. These included decision-makers, instructors, and support staff. A questionnaire was developed to gather the data.

The following four scenarios have been studied in different contexts and have been identified for educational delivery (Collis & Moonen, 2001, p. 199). These scenarios were used within this study. The study recognised that institutions will not choose only one of the scenarios, but that it is useful to identify the scenarios most representative of the educational delivery currently, and in future, in institutions.

The scenarios include:

1. Scenario A: *Back to Basics*. The current scenario for the traditional post-secondary institutions i.e. quality control of a cohesive curriculum experienced in the local setting.
2. Scenario B: *The Global Campus*: This involves quality control of a cohesive local curriculum, available globally.
3. Scenario C: *Stretching the Mould:* This refers to an increase in flexibility without changing the underlying pedagogical model within the institution.

Many universities are moving more towards a form of 'Stretching the Mould' and offering more flexibility for participants.

4. Scenario D: *The New Economy* involves individualisation and globalisation. This is seen to be the way forward. However, there is no evidence of it in traditional universities.

Three main themes with associated conclusions consistently appeared in the results.

1. **Conclusion 1: Change is slow.**

   • There is much evidence to suggest that higher education institutions do not anticipate radical changes in teaching practice resulting from, or related to, the use of ICT. Gradual changes have been taking place and universities are 'Stretching the mould'.   However the changes are slow moving and are as a result of shifts in thinking within the teaching academy rather than the wholesale adoption of new methodologies from the world of ICT. 'Stretching the mould' refers to increased flexibility without altering the underlying pedagogical model within the institution.

   • New teaching configurations, in parallel to the on-campus mode, either in the form of distance learning or of students seeking learning opportunities emanating from other institutions, are likely to occur but will not replace the dominant model. However, institutions that have a clearer view on their mission with regard to special target groups e.g. lifelong learning or international students tend to show higher levels of use of ICT and greater willingness to subscribe to its methodologies.

2. **Conclusion 2: ICT in teaching and learning: Widespread but part of a blend**

- It appears that ICT has become part of a new blend of on-campus delivery systems e.g. use of email, word-processing and the web have become part of the teaching and learning process. The use of e-mail and web resources is now more frequently used in educational practice. However conference systems i.e. online learning environments, or wireless solutions are used to a limited extent. The technologies are being used more for course preparation and out of class activities than for communication and in-classroom activities. The lecture still remains the 'core medium' of instruction and institutions continue to focus chiefly on teaching the traditional student group. Small doses of ICT are injected into the system without bringing about any radical re-think.

3. **Conclusion 3: Instructors: Gradually doing more but with no reward**

- Instructors are making some instrumental use of ICT but not actually changing their ways of teaching even though, in using ICT, they often make significant departures from established teaching norms. The study shows that ICT instructors have significantly lower perceptions than the decision-makers and support staff in their institutions as to the Institutions' commitment to support and provide incentives for ICT use. There are no reward structures in place to ensure that instructors do more than gradually 'stretching the mould'.

Outcome of study

The findings of the study show that the traditional campus-based model still dominates, i.e. the 'Back to Basics' model. 'Stretching the Mould' model is growing in importance, despite the fact that there is no deliberate plan or policy in place. However, the report suggests that 'Stretching the Mould' is the model most likely to grow in higher education institutions and there will be central policies in place to 'Stretch the Mould' scenario.

Web-based systems are seen to bring about more efficient practices but are still not replacing the traditional methods of teaching i.e. lecture. ICT has become part of the blend of on-campus delivery i.e. ICT is being used to complement traditional on-campus settings.

The instructors are stretching the mould with regard to their use of ICT. When instructors know that using ICT will count towards promotion and tenure or are integral part of regular staff assessment then there will be a strong incentive to use ICT for more than complementary support of traditional core practices. Instructors who are the ones closer to the 'front line' in terms of delivery and technology use, are still less positive than other groups surveyed in this study i.e. Decision makers and Support staff.

Institution wide technological structures are now in place. However, rich pedagogical use of the technological infrastructure is still in development. The strategic use of ICT for different target groups still needs to be considered explicitly. Institutions are still focused on school leavers as their target group. However, many institutions lack a

strategic view on using ICT for these new groups of learners and the development of institution-wide ICT strategies is still in development. It is clear that the strategic use of ICT for the diverse range of students in higher education will require explicit policy developments.

If new policies are adopted and new strategies devised, emphasis will then have to be directed toward the appropriate pedagogical use of the technology infrastructure that may become increasingly available. How to secure the richest pedagogical use of that technology infrastructure will move centre stage as one of the most important issues to be addressed. This, and the use of e-learning in general, are matters that are treated in the study by Van Merrienboer *et al*. (2004, p 13). These authors point out that the central concept in handling of e-learning currently tends to center up 'content'. The authors regret that forms of e-learning that emphasise the active engagement of learners in rich learning tasks and the active, social construction of knowledge and acquisition of skills are rare. In other words, the potential of the new technology to transform the teaching/learning environment is still far from being realised in the institutions of higher education.

The report suggests that two paths might be explored. The first path is evolutionary, the other is interventionist. The evolutionary path involves continuing the current preference for pragmatically 'Stretching the Mould' for teaching entry-level students in the traditional university settings, allowing courses to become more flexible. The use of well-designed course management systems should be able to support flexibility within courses. Web technologies will be used as complementary to the core

technologies i.e. textbook and lectures. However the use of web-based systems will stretch the core technologies.

The alternative path is the interventionist path. This will involve major changes in thought patterns and work routines. Reliance on 'Back to Basics' and 'Stretching the Mould' will diminish and there will be movement from 'Stretching the Mould' stance as the starting point towards aspects that can be describe as the New Economy.

Quickscan of good/best practice with respect to integration of ICT

Of more immediate concern to myself, and of relevance to my research, is the handling of ICT educational issues in those institutions that are engaged in teacher education. In 'The State of Affairs of Teacher Education in respect to ICT' Kirschner and Davis (2003) report on a quickscan of good/best practice with respect to the integration of ICT in the context of teacher education. I will discuss their findings as I believe that it has direct relevance to my own work, as many of my students on the MSc in Education and Training Management (ICT) programme are teachers. The report is a synthesis of twenty-six cases of good practice in implementation of ICT that were identified in teacher education across Europe, North America and Australia. The criteria presented in this report are useful for ICT programmes that could prepare teachers in higher education to work in pedagogical rich learning environments.

The methodology used in this study consisted of a quickscan of initiatives in the field of teacher training across the globe. Five experts in the area of Information and Communications Technology (ICT) and teacher education from around the world carried out their research using an asynchronous distributed research group which

made use of a web-based project environment for determining the reference framework, sharing relevant cases and web sites, discussing practices and collecting data. The reference framework developed was based upon Collis & Moonen's (2001) categories for ICT in teacher education.

In their study, they focus on ICT as a core technology. A core technology is defined as the main way of organising the learning experience; the component around which all other components are planned (Kirschner and Davis, 2003, p. 128). The use of ICT as a core technology focuses on 'learning how to use ICT' and 'learning via ICT'. The learning how to use ICT focuses on helping teachers gain competencies with ICT e.g. with specific software packages or the Internet. The learning via ICT refers to ICT use as a core technology for participation, i.e. mainly web environments as the tool used to support flexible learning for teachers.

Based upon this framework, three actions followed. First, the distributed experts made use of their knowledge of the field and their own professional networks to locate examples of good/best practice. Second, the project team developed two instruments for documenting the practices, namely a checklist and an evaluation form. Finally, the experts filled in the forms and supplied additional documentations so that the team in Netherlands could begin on the meta-analysis. This involved translating the results from the different studies into a common metric.

A particularly valuable feature of their analysis is their use of benchmarking to identify and catalyse good practice. The following five benchmarks of good/best practice were identified from the study. The use of ICT for a range of assessment

paradigms and the policy dimension of the use of ICT for teaching and learning were not always present in ICT programmes for teacher education. This is interesting and indicates that teacher-training institutions share some of the shortcomings, or limitations in their use of ICT as reported in the studies of higher education institutions previously referred to. In addition to providing a means of assessing the current state of thinking about ICT and teaching/learning processes in higher education, they provide a more widely applicable measuring stick for analysing the impact of ICT on teaching practices more generally and, on a yet wider context, offer insights into differing approaches to the handling of the whole teaching/learning process.

Benchmark 1 - Personal ICT competencies

Programmes for teacher training should enable aspiring and practicing teachers to become competent personal users of ICT. At a minimum, they should promote competencies in the use of applications such as word processing, databases, and spreadsheets.

Beyond this, a programme for teacher training should develop the learners' ability to use ICT effectively for:

- communication between and within student groups.
- communication between and with other teachers.
- continuing their own education once they have completed their studies including self-assessment of own learning and learning needs.

Benchmark 2 - ICT as a mindtool

Programmes for teacher training should train aspiring teachers to be able to make use of ICT as mindtools. Mindtools are computer programs and applications that facilitate meaningful professional thinking and working. 'Mindtools' can be in the form of email or discussion lists and also involve argument mapping and visualization systems. Mindtools help users represent what they know as they transform information into knowledge; they are used to engage in and facilitate critical thinking and higher-order learning (Kirschner & Davis, 2004). As a minimum, teachers should develop basic competencies to use mindtools for:

- cooperation (between teachers, teacher educators and student teachers);
- collaboration on pedagogical projects (with other teachers, experts and designers, etc.).

Benchmark 3 - Educational/Pedagogical use of ICT

Programs for teacher training should train aspiring teachers to be able to make use of ICT within many different educational/pedagogical settings. Not in adApting (*sic*) their education to ICT, but in adOpting (*sic*) ICT into their education. As a minimum, teachers should develop basic competencies to use ICT effectively for:

- collaboration/cooperation in both synchronous and asynchronous environments.
- resource based learning (informing, asking questions, evaluating, comparing).

There is a need for teacher training organisations to deal with the pedagogical uses of ICT at classroom level for comparing and selecting resources such as:

- learning environments.

- project environments.

- collaborative environments.

- learning management systems.

- software.

It is also important that teacher-training programmes should familiarize and prepare aspiring teachers and teacher educators to appreciate the effects of ICT on:

- their own role as teacher;

- their students' ability to increase autonomy, authentic activity, learning styles, situated learning and motivation, enfranchising those who are out of the mainstream.

Benchmark 4 - ICT as a tool for teaching

The use of ICT as a tool for the tool's sake should be avoided. Aspiring teachers should not only grasp the theories governing the 'why and how' of using ICT, but will also develop competencies in:

- adapting technologies to good/better teaching such that the teaching/learning can change for the better.

- planning for relevant individual, group and whole-class activities.

- preparing and producing learning materials with the help of ICT.

- dealing with the possibilities/consequences of using ICT.

- teaching and learning specialist subject(s) with ICT.

- team teaching in situ or at a distance.

Benchmark 5 - Social aspects of ICT use in education

The authors assert that norms and values have been traditionally handed down from adult to children. There is a recognition that this is changing and children are also engaged at the cutting edge of societal change. It is important that teachers and teacher educators:

- engage as members of a (wired) school community.

- provide a role model of good ICT practice.

- learn to share and build knowledge.

- understand the implications of the Information Age on schools and schooling.

- realise and discuss the impact of ICT on society.

Additional Benchmarks - ICT in assessment and policy

The authors state that the use ICT for assessment and understanding the policy dimension of ICT use are not widely perceived as being a necessary feature of good practice at this time.

Summary of Benchmarks

These benchmarks offer a hierarchy that enables one to perceive at what point practitioners may begin engaging in and enabling critical thinking and higher-order learning through use of technology, using technology to collaborate on project work with teachers and other experts thus emphasising learning in interaction with others, building and sharing knowledge through technology, using technology in a meaningful way, being aware of the wider social implications of technology use. The importance of reflexivity is highlighted in the report.

This study offers a valuable analysis of the current state of play in the application of ICT in teacher training institutions. It is important to relate to the wider benchmarks being developed for ICT in teacher education. In my Doctoral research, I show how I am accounting for my own educational practice and developing standards of judgement from the ground of educational practice. I also show how I support teachers to carry out research into their practice by asking, researching and answering the question; 'how do I improve my practice?' The importance of the teachers and teacher educators researching is highlighted by Kirschner and Davis (2002, p. 141) "*reflexivity is essential and must be nurtured*"

Conclusion

ICT is developing at a rapid rate and one of the characteristics of ICT is its dynamism. This is reflected in Moore's law which states that microprocessor performance would double every 18 months. It is difficult to set limits to what ICT can achieve as it is a constantly shifting frontier. ICT has the potential to change the shape of the classroom; change the relationship between teacher and learner; offer new tools to support new ways of teaching and learning; open up access to knowledge across distances through developments in bandwidth. Oblinger and Rush (1997, p. 51) assert that technology allows a greater participatory and collaborative society. However, within higher education, the idea of active engagement of learners in rich learning tasks and the active, social construction of knowledge and acquisition of skills are still rare. I argue that there is a need to develop rich pedagogical uses of ICT that involves social, collaborative construction of knowledge. ICT offers more flexible and wider access to learning than was ever possible before. Higher education has been slow to break with the traditional 'mould'. Notwithstanding the good points relating to the

lecture mode, it is clear that higher education institutes need to develop policy with respect to how ICT can be used to improve teaching and learning and to widen access to learning in a lifelong learning framework. In my thesis, I show how teachers are developing the skills and creating their own multimedia and web based artefacts in order to improve student learning. I believe that through the process of developing ICT artefacts and supporting texts, teachers can get closer to the meaning of their embodied values. These values can become living standards of judgement by which teachers can judge their practice-based research. I now turn to the methodological approach I developed in my enquiry.