Cisco Systems

Intelligent Government – The Next Wave

Network based transformation in **Education**

Cisco Public Services Summit @ Nobel Week 2002

Coherent and comprehensive strategies by Governments across Europe, the Middle East and Africa have no doubt played a significant role in developing the use of ICT in education in an attempt to drive up standards through the funding and provision of new technologies. What is now needed is more radical thinking about how these technologies can be used innovatively, how teachers should be trained to rethink their role and how educational structures can be made more adaptable to welcome and embrace the changes that need to be made in order to take full advantage of the potential of global access to information, knowledge and experts.

Contents

Summary of Key Points

- Most governments are implementing policies to ensure teachers are confident users of information and communications technology (ICT), schools and colleges are equipped with networked technology and ICT becomes integral to the learning process;

- There is a strong awareness of the digital divide between countries across the region and steps are being taken by various agencies to address the needs in developing and emerging economies;

- Within the European Union industry has been working with the European Commission to support the eLearning Action Plan published in 2001 to ensure connectivity, content, learning and skills for the Information Age are developed;

- Education is changing but not fast enough to meet the needs of society. On the whole any new artefacts have made little impression on classroom and traditional teaching remains very much as it was at the turn of the century. ICT is poised to make a significant difference and there are some exemplary examples where this is happening – but not enough;

- School structures need to take cognisance of the fact that technology can change the curriculum and students' access to it;

- Assessment systems must move faster to embrace the opportunities that technology can bring to increase the range of ways in which learners can be assessed, so that more students have the opportunity to select the range of media to best demonstrate their knowledge and understanding;

- Teachers' roles need to change, acknowledging that the advent of the Internet means they can no longer exert as much control over students' access to information.

- The Internet means that learners can access real, live data and be engaged in authentic activity, and they can be more autonomous in making choices about how, where and when they learn;

- Educational content needs to address a real need and not simply replicate what traditional text does well;

- Educators, software developers and others involved in multimedia production need to wok together to produce content that is innovative, supports learning and extends access to knowledge to a wider group of learners

- Linguistic, cultural and pedagogical differences between countries make it difficult to prepare content for a global audience. Tools are needed that make content cheaply and easily adaptable to different markets;

- There are a wide variety of electronic tools available for use across the Internet. These tools need to be evaluated in relation to the subject, content and audience and a variety of tools used to match the individual demands of what is being taught. The Internet can be used as an encyclopaedia as well as for access to experts, dynamic representation of concepts and ideas, 3D imaging and modelling, interactive models demonstrating cause and effect, simulations, modelling concepts that are too fast or too small to be seen with the naked eye. Additionally, the Internet can support asynchronous and synchronous communications through text, audio and video, and provide a platform for exhibiting and assessment of students' work;

- New learning models have to be developed that make technology ubiquitous. The development of the term e-learning to describe the use of networked multimedia technology to support learning encompasses a multitude of scenarios and tools that enhance and support the teaching and learning process, and provide flexibility in terms of where, when, how and what to learn, and who to learn with;

- Elearning can bring about affordable, personalised learning and the flexibility will bring more choice and opportunities to learn to individuals

- The development of virtual and corporate educational institutions will challenge traditional institutions, but learning could be enhanced and supported by the various types of institutions working together

Introduction

This white paper establishes the status of the implementation and integration of information and communications technology (ICT) into teaching and learning by educational institutions in Europe, the Middle East and Africa. It suggests what needs to happen in the short term in order for ICT to really make a difference and to improve the quality of education across this region, which is probably the most diverse in the world. It examines some of the government initiatives to encourage the use of ICT in all sectors of education. The paper then looks across how these initiatives are developing in schools, how they might develop and what factors need to change in order to make ICT pervasive and ubiquitous in all sectors of education. Because of the broad topic, the paper focuses on issues related to teaching and learning while omitting reference to the educational management benefits of ICT and the associated costs.

Chapter 1 ICT and Education - A Global Vision for the 21st Century

Policies, problems and opportunities for ICT in education in Europe, the Middle East and Africa

The extent to which information and communications technology may be used in education in different countries and territories depends on a wide variety of factors. Some of these are economically determined, some depend on the "cultural" context in which education takes place, and some are driven by the political priority accorded to education by respective governments. Some of the most obvious constraints are simply the lack of funds available to spend even on basic educational provision, let alone relatively expensive computer equipment for schools and colleges.

However, what is seen as common across all countries and territories is the potential that ICT has to transform the educational experience for both learners and teachers. ICT in education means creating new, dynamic, and interactive forums for learning and teaching. As in other areas of activity, the power of networked computing is a considerable and unanticipated force for change and for reconfiguring the traditional landscape. ICT in education also offers the opportunity for higher-quality educational experiences (in terms of both content and delivery) to be made available to more people, more easily. The Programming Council for Educational Research in the Netherlands, in its 2001 report described the impact of ICT in education as: " neither a revolution nor a ripple. In the long term, ICT in teaching and learning implies a structural and cultural shift in the constellations of roles and functions within the teaching-learning processes. Digitalisation will have a permanent and pervasive effect on education."

For this transformational power to be realised, however, certain minimal requirements need to be in place. Of course, the most obvious of these is access to computers and the Internet. Unsurprisingly, perhaps, figures from UNESCO show that the distribution of computing power is broadly comparable to the economic circumstances of different countries. Students in Western Europe, for example, are far more likely to have reasonable access to Internet-enabled computers when compared with their counterparts in the east.

The existence of such a "digital divide" is not the topic of this paper, though in the course of any discussion of education it is clearly the case that access to knowledge in a global economy in which such access in many ways defines prosperity or penury, can hardly be ignored. It is estimated that more than 80 percent of the world's population has no reliable access to telecommunications whatsoever and further, that more than 50 percent of the world's adult population has neither made nor received a phone call. The spread of basic communications infrastructure throughout the world is a vital precursor to the creation of more advanced applications and systems for education.

Nevertheless, much of the thinking behind and practical activity towards achieving change and improvement in education is predicated on the use and application of information and communications technology across the world in order to bring the benefits to as broad a range of people as possible.

Within the European Union (EU), the push to make better use of ICT is evident in many areas of activity, but perhaps none more so than in education and training.

The European School Net

The European Schoolnet (EUN) is a joint venture between 22 ministries of education of the EU, the European Free Trade Area and the countries of Central and Eastern Europe. At its inception in 1997, the EUN was charged with two main objectives:

- Set up a virtual multilingual European campus for learning and collaboration;
- Establish a European network for innovation and the exchange of information on ICT in education.

Since the creation of the EUN, it has become a major force and a forum for many of the present initiatives by individual ministries. A glance at the Web site http://www.eun.org/ provides an insight to the almost limitless variety of the educational projects that are being made available online, and collaborative learning projects that are only possible because of advances in information and communications technology.

Some of the projects and resources presently listed on the EUN website encompass subjects as diverse as: Distance learning for Children in Hospital; Coal Mining in the Castlecomer Area; Democracy in the Electronic Age; the creation of a virtual garden; fashion learning through building Web pages; Jewish Science Technology Network; the Petit Prince in Euroland; The Human Body-Experiment Experience, Cultural Awareness; Bridges; Graphics – in fact, the range of topics that can be covered and investigated via Web-based learning is as unbounded as human curiosity itself.

As these sites show, the possibilities for the use of ICT in schools and for creating educational experiences is limited only by the imagination that educators can apply to their creation. However, the more fundamental problem lies in the provision of technology that allows educators to realise their aspirations to provide such content and educational experiences.

Figures collected by the EU directorate general for education and culture, Eurydice, show a broad discrepancy between the best and least well-equipped European countries in terms of pupil/computer ratios.

Figure 1: Primary schools ratio of pupils per computer and pupils per computer with Internet connection. Source: Basic Indicators on the Incorporation of ICT into European Education Systems. Facts and figures 2000/01 Annual Report. Eurydice, DG Education and Culture

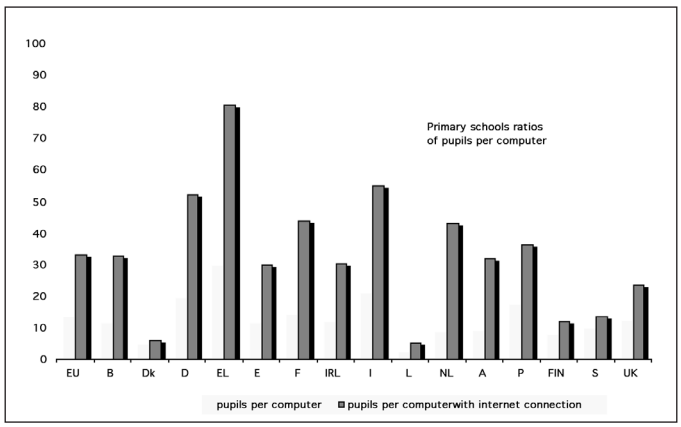
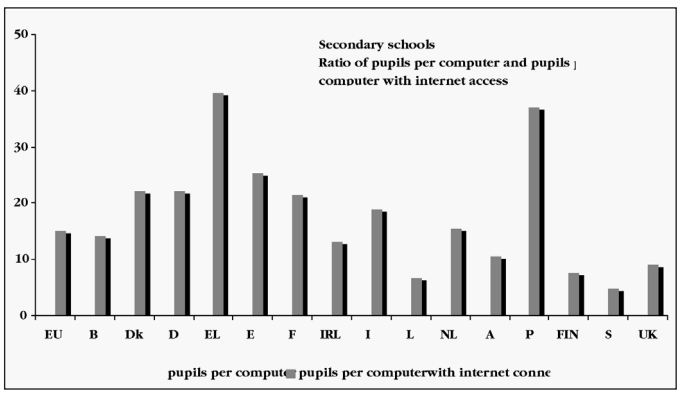


Figure 2: Secondary schools ratio of pupils per computer and pupils per computer with Internet connection. Source: Basic Indicators on the Incorporation of ICT into European Education Systems. Facts and figures 2000/01 Annual Report. Eurydice, DG Education and Culture



Selected National Initiatives in Europe

Although the EU has been a significant driver behind the adoption of ICT in schools, individual member states have been investing heavily in implementing policies to ensure that students have broad access to computers in school.

Belgium

A number of major initiatives in Belgium have been implemented among the three main linguistically defined groups. The overarching aim of policies is to foster greater ICT participation in schools, and to ensure the widest possible access to ICT among all students. In order to achieve these aims, ICT is now part of compulsory education in Belgium.

Denmark

The Danish government is committed to providing all schools with reliable and inexpensive Internet connections as well as creating intranets for schools. Danish schools enjoy one of the best computer-to-student ratios in secondary schools in the EU, with one computer for every two students. The Danish government has also pioneered and funded a raft of more experimental and cutting-edge educational projects, including the development of a virtual university and the Danish Learning Lab, an experimental institution examining the acquisition and development of skills in business, educational institutions, and organisations through computer technology.

Germany

A joint venture between Deutsche Telecom and the federal government aims to provide all schools with free Internet connections. The federal government has also funded research and development of educational software for use in schools at all levels. A three-quarters of a billion euros project, “Inclusion, not exclusion. Information technologies in education and training” is a broadly based scheme designed to create opportunities and facilities for additional and lifelong training.

Greece

The Greek government has initiated a number of pilot projects in public-sector schools. These include a pilot project for primary education - the Island of Phaeakes through which of 12 schools were provided with Internet-linked computerised laboratories. In secondary education, an infrastructure modernisation programme aims to ensure that all schools will be networked by 2006.

Spain

The process of devolving power to the autonomous communities in Spain means that many different initiatives have been instigated within the distinct regions. Thus, the individual communities are responsible for the funding and supply of hardware and software to schools, and the central government role is more advisory, responsible along with the autonomous communities for the uniform implementation of agreed policies. As part of a broadly based 2.5 billion euro strategic initiative for the development of the information society in Spain, the education sector has benefited from considerable investment in ICT. In particular, the Aldea Digital programme has equipped more than 2500 rural schools in sparsely populated areas with Internet access and additional IT resources.

France

A national educational initiative in France has been implemented as part of a wider programme to "bring France into the information society". The educational aspect of the initiative has three main strands: encouraging the use of ICT in schools, including both as a teaching aid and a tool for students, developing a central network, Educnet, which means linking all schools together as well as providing links to local authorities and businesses, and encouraging the production of educational and academic content for teachers.

Ireland

Ireland aims to have a minimum of one computer per classroom in all schools, and aims to increase the use of ICT in the classroom by teachers. All schools are connected to the Internet, and since 1998 (when the programme was launched) nearly all teachers have been trained to at least a basic level in ICT. Ireland is also working on the development of a national network that will foster the creation of tools specifically designed for the Irish curriculum.

Italy

Italy aims to have one computer for every 10 school students, and to have all schools connected to the Internet. In addition to these general aims, a number of more specific projects aimed at boosting the use and applications of ICT in schools have been created by the government, including a scheme to provide zero-interest loans to students in order that they can purchase their own PCs.

Netherlands

The government's aim to modernise the entire education system in order to improve all aspects of the education provided by the state. The creation of Kennisnet ("The knowledge net") allows all schools and educational institutions to access multimedia sources of information, as well as collaborate and confer online. The government of the Netherlands has invested heavily in the development of IT provision in the education sector, and is one of the leading member states in this regard.

Finland

Finland's national strategy is to ensure that all citizens are able to acquire a high level of ICT skills and knowledge. The second phase of the national strategy is to create a society in which everyone has the skills deemed by the government to be necessary for participation in the information society. This means that a great many organisations and institutions have been brought into a partnership to encourage Finnish citizens to develop these skills. In particular, significant efforts have been made to provide teachers with training in the use of ICT. The Finnish government has also embarked on the creation of a virtual school and a virtual national university.

Sweden

The National Programme for ICT in schools aims to ensure the use of ICT in all levels of all schools. As part of the plan, all teachers who receive ICT training are given a computer, and particular efforts are made to ensure that teachers are given an incentive to focus on the use of ICT in schools. Sweden has also created Distum, a national agency for the promotion of distance education. The main objective of Distum is to boost the use of ICT in distance education.

United Kingdom

The National Grid for Learning aims to connect all educational institutions with museums, libraries and community centres in order to establish a broad network of knowledge and educational resources across the whole country. By 2004 the UK government aims to have one computer for every five students in secondary schools and one computer for every eight students in primary schools. In 2002 it is expected that a connection to the Internet will be in each school with at least 20 percent of schools in each area connected at broadband level. Thus all schools can take advantage of Curriculum Online which is intended to "help drive up standards in schools and reduce teacher workload by offering teachers easy and effective access to a wide range of digital learning resources across the curriculum". The British Educational Communications and Technology Agency (Becta) has been established as the Government's lead agency for ICT in education. It supports the UK government and national organisations in the use and development of ICT in education to raise standards, widen access, improve skills and encourage effective management. Most teachers have received training in the use of ICT for teaching and learning, and there is a national curriculum in ICT for initial teacher training. Among other projects of note, the UK's eUniversity aims to offer a wide variety of courses online from any UK higher education institution.

The ICT Gap: North and South, East and West

In less wealthy countries, the development of ICT in education has been slower, almost entirely because of the lack of resources available to procure the appropriate technology. Recent OECD figures (Education at a Glance 2002), for example, show that in urban areas of the United Kingdom (that is, cities with a population of more than one million), there are on average eight students per computer in secondary schools. Similar numbers are reported for elsewhere in the EU. Sweden shows the lowest ratio, with just four students per computer. But for urban schools in the Russian Federation, for example, that ratio rises to 62 students per computer, and these statistics say nothing of the relative sophistication of the computer technology to be found in each of these two countries. The percentage of 15 year-old students who were able to say that they used a computer almost every day at school is also instructive. Nearly half of all students in Denmark use a computer every day at school compared to only 5 percent of students in the same age range in the Russian Federation sample.

In the same survey, school principals were asked to say to what extent the lack of computers in school hindered learning. 55 percent of principals of schools in the Russian Federation surveyed said that the lack of computers hindered learning "a lot" with only 3 percent claiming that learning was hindered very little by the lack of computers in their schools. When asked the same question only 5 percent of principals in France said that their students' learning was hindered by a lack of appropriate computer technology.

An even starker divide between access to computers in Eastern and Western Europe emerges in the comparison of students who are able to use a computer at home to do schoolwork or to supplement their learning. While 90 percent of Swedish 15 year olds reported being able to use a computer everyday at home, only 15 percent of students in the Russian Federation were able to do so.

These significant differences in access to computer equipment are the most obvious retardant on the ability of governments to pursue the deployment of ICT policies in schools and across the educational sphere, and to derive the benefits that the adoption of ICT can offer.

However, the very real gap between countries in Eastern and Western Europe should not create the impression that there is a lack of political will to achieve the clear benefits of ICT in those countries where the lack of resources is a very real barrier to progress. Countries in the former Soviet bloc have each outlined strategies to create greater access to ICT in schools and to train teachers more effectively in the use of ICT. The Czech Republic, for example, has committed to provide 75 per cent of all teachers in secondary schools with the requisite skills to use ICT as a teaching resource by the end of 2005. In addition, the Czech government has instigated a 50 million euro programme to develop the Czech Information Society aimed at helping Czech citizens to acquire the skills and expertise necessary for making full use of the Internet and associated technologies.

The Middle East and Africa

Differences in the relative affluence of countries in the region impact on the extent to which ICT is used in schools in the same way that these differences in national prosperity are reflected in policies within Europe. In sub-Saharan Africa, for example, nearly 40 per cent of all children under the age of 10 (according to UNESCO figures) receive no schooling at all. Many schools lack electricity and other basic facilities, so the introduction of ICT is going to take many years. However in some parts of the sub-continent there are a number of initiatives that are equipping classrooms with computers, Internet access and training teachers, notably in South Africa. SchoolNet Namibia was recently awarded a prize for an exemplary role model for the sustainable introduction of computers in schools across Africa. The project introduces computers into schools across Namibia, using open source and free software solutions. It has set up free Internet services in partnership with local government-owned telecom agencies in solar-powered computer labs. A number of international agencies including Imfundo (www.imfundo.org) and World Links for Development (www.world-links.org/english) also support ICT related development initiatives in this region. Imfundo is located at the UK Department for International

Development and works in a unique way with the private sector to bring scaleable and sustainable ICT-based education solutions to improve the quality of education and to address the need for universal primary education. World Links for Development is a US based non-governmental organisation, originally funded by the World Bank, that provides a set of educational technology-related services, specifically geared towards Ministries of Education, other non-governmental organisations and international development agencies working in developing countries. These services range from basic school connectivity solutions, to teacher professional development, and training programs for both policy-makers and local communities interested in launching educational technology initiatives.

In the Middle East, particular advances in the use of ICT have been made in the Gulf States. Dubai's Internet City, for example, is a regional beacon of excellence in the research and development of new and emerging communications and computer technologies. To support such development of the commercial potential of the Internet in the Middle East, the Gulf States have created an ambitious programme to educate and train the next generation of IT workers. In Abu Dhabi more than 20 schools are to be provided with advanced IT infrastructure as part of a national IT learning project sponsored by the Crown Prince of Dubai, Sheikh Mohammed Bin Rashed Al Maktoum. The schools will be equipped with an IT laboratory that will allow students to use the Internet and a variety of multimedia applications. All the laboratories are connected through a WAN, allowing collaboration between schools in the Gulf States.

The development of ICT in education in Israel has also moved apace since the first national plan for 1994 - 1998. Recent documents from the Ministry of Education and the Parliament's Committee for Education emphasise the need to enhance the learners' and teachers' learning and knowledge handling skills, and lifelong learning skills; the need to ensure reliable accessibility to Internet contents and tools; and the need to support research and development fostering the creation of both basic research knowledge and quality learning materials and opportunities.

Elsewhere in the region, the ability of the internet to allow students across broad geographical areas to have common access to content and learning tools has been realised in the creation of the region's first virtual university: the Syrian Virtual University.

Figure 3: The Syrian Virtual University will offer accredited degree courses from a number of different institutions in the region.

E-Learning - the EU Educational Priority?

Cisco Systems, IBM, Nokia, Smartforce and SanomaWSOY together with the European Commission staged an e-Learning Summit in 2001, which brought together for the first time leading commentators and practitioners of e-learning from both the public and private sectors. The purpose of the Summit was to discuss ways that e-learning could be expanded and enlarged across the EU in response to the European Commission's e-Learning Action Plan. The European Commissioner for Culture and Entertainment, Viviane Reding, said at the launch of the summit: "e-learning and innovation in education and training are key to delivering a new European Information Society." The aim of the e-Learning Summit was to explore that basic aim in detail; to examine how the public and private sectors could work together to achieve it; and to enumerate the steps that EU member states need to take in order to achieve the aim of making the EU "the most competitive and dynamic knowledge-based economy in the world".

This aim lies at the heart of EU policy, and many initiatives across the whole range of activities are underway in the drive towards achieving that aim. However, in no sphere of interest is there more activity than in the education and training arena.

The summit proposed ten recommendations that encapsulate the steps needed to create the environment in Europe in which e-learning will prosper, and developed a set of actions and indicators to suggest how they could be achieved.

1. Connect everyone and everything from everywhere
This includes all schools connected to the Internet and being fully networked. Eventually, all teachers and students' homes would be connected, in some way, to the Internet.

2. Adopt and participate in the development of open standards for e-learning.
E-learning needs to develop with maximum interoperability and open standards across Europe. Openness should foster a climate of sharing whilst respecting the intellectual property rights of content creators and owners.

3. Focus e-learning research on pedagogy, e-content and user-friendly interfaces and devices.
E-learning initiatives must focus on the imperatives of better content, teaching methods and an enhanced experience for the learner rather than be driven by technological developments.

4. Create the conditions to sustain a commercial market for e-learning content development
Educational institutions and providers must have the budget to acquire digital content, and the private and public sectors must find ways to work together to overcome any barriers that may exist to their effective cooperation in the creation of suitable digital content.

5. Increase investment in the continuous professional development of educators. Enhance their status. Help them develop an understanding of and pedagogy for e-learning.
The role of the teacher at the centre of the learning transformation needs to be recognised and reinforced at policy level. Teachers must be given every opportunity to enhance their own skills and knowledge in order to create conducive e-learning environments for learners.

6. Develop flexible curricular and assessment frameworks to provide individuals with the skills they needed for participation in the Information Age.
The ICT skills gap in Europe needs to be addressed with some urgency. Educators, government and industry need to work together to create and implement initiatives that will reduce the shortage of IT professionals and create a workforce that is digitally literate.

7. Expand e-learning communities and forums.
Those given the responibility of creating and delivering successful e-learning need to have and develop the forums within which they are able to communicate their successes, network their knowledge and share experience. Collaboration is a key strength provided by networking technologies, and it must be applied to the development of e-learning.

8. Provide financial incentives to promote the take up of e-learning.
Any number of financial and fiscal levers could be used to encourage individuals and employers to make use of e-learning. Individuals need to be encouraged to take responsibility for their own learning, and employers need to see the benefits in seeing that this takes place.

9. Leverage financial instruments to support e-learning
Funds for development of e-learning and appropriate teacher training should be aimed at those countries where the availability of funds is most scarce.

10 –Explore the potential of public private partnerships
Public private partnerships (PPPs) between industry and government will play a vital role in the development of e-learning. Investment in the longer term must be conceived in ways that provide benefits and incentives to both the public sector and private business investors. This requires the development of models of private and public investment in infrastructure, and the creation of benchmarks and best practice for PPPs.

An eLearning Industry Group (eLIG) has now been formed in the wake of the Summit to work on developing initiatives around the recommendations in support of the eLearning Action Plan and four project groups have been established.

Chapter 2 The Changing Face of Education

New Learning Solutions

ICT is not going to make teachers redundant but will inevitably force the profession to re-shape its future role. So far the introduction of new technologies over the last century has had little impact on the nature of education and the relationship between teachers and students. In 1900 the introduction of the slate meant that learners no longer had to carry reams of paper, but otherwise teaching remained the same. By 1960, programmed learning machines were joining books in the classroom, and in 1975 paper tape loops were introduced, while seven years later the newest artefacts were microcomputers. These tools enabled learners to work on their own without the teacher managing each step of the learning process, allowed learners to learn at their own pace, to learn new facts, skills and concepts or to reinforce those previously taught. The emergence of networked computers and the Internet in the 1990s with increased access to information and opportunities to collaborate and communicate with teachers and learners beyond the classroom, school, university or college marked a significant development in educational opportunities that are not always exploited to their full potential. As holograms and virtual reality become commonplace in educational settings and other hitherto unknown technologies emerge, will these tools really have a significant impact on teaching, learning and the nature of schooling? In five years will educational institutions be significantly different from today and what form will they take in 2020?

Will school structures change?

Fundamentally the structures in schools remain the same today as they did when mass schooling was introduced. Students are arranged in classes according to their age, perhaps set according to their aptitudes in one subject or another, usually mathematics or English. They are taught in primary schools mainly by one teacher, and in secondary schools by a range of subject specialists in fixed blocks of time. In some countries they are divided at the age of 14 or 15 as to whether they will follow a technical or vocational route, or an academic route, often selected according to academic ability.

In an article published nearly ten years ago entitled *Computer meets classroom, classroom wins*[1], Larry Cuban provides an explanation as to why new technologies have not changed schools as much as other institutions:

> First, cultural beliefs about what teaching is, how learning occurs, what knowledge is proper in schools, and the student-teacher (not student-machine) relationship dominate popular views of proper schooling. Second the age-graded school, an organisational invention of the late nineteenth century, has profoundly shaped what teachers do and do not do in classrooms, including the persistent adaptation of innovations to fit the contours of these age graded settings.

1 Cuban, L. (1993). Computers meet classroom: classroom wins. Teachers College Record, 95(2), 185-210.

Evidence of this is borne out in interviews conducted by the author with students in a secondary school. When asked to imagine a time when they were sitting at a computer feeling bored, one student described an event in which he was "typing up notes from the board". The teacher was certainly appropriating the technology to his own view of teaching.

Cuban cites as an example the overhead projector, which was first introduced in 1932 and became a "mainstay" in most classrooms as recently as the 1990s - a tool which he says "extends what teachers ordinarily do and is even better than a chalkboard. Teachers can still lecture, explain and ask questions of the entire group at one time". The overhead projector took nearly 60 years to become embedded in classroom practice, yet it was just a tool that enhanced what teachers already did. How long will computers take to become as commonplace? And if they are to change teaching, will the pace of change be slower, or will schools respond rapidly (relatively) to the challenges of the workplace? Ten years ago, in this article, Cuban examined three "impulses" for using the latest technology in schools. The first is to bring schools in line with the workplace, so that students are prepared to compete in the job market. This impulse is derived from "the turn-of-the-century social role of public schools to prepare students for vocations and the proposition that in an increasingly high-tech world graduates must know how to handle electronic machines".

The second impulse is premised on a social constructivist[2] philosophy in which computers support students working together on self directed activities to create understanding. The final impulse is productivity, which Cuban explains as "teaching more in less time for less cost" and can be traced back to "the origins of public schools in the early nineteenth century as a consistent goal for schooling ever since".

Another reason why schools have changed so little with the advent of new technology is that access within school was hitherto extremely limited. Both Cuban and others[3] calculate that the amount of time any student spends at a computer in school averages between 4 and 6 per cent of the student's total teaching time. Thus the impact on the curriculum and the way teachers teach is bound to be very small until this percentage increases. The recent advent of mobile and wireless technology may well herald a significant change.

As ICT becomes pervasive, more needs to be done to ensure personal ownership of the technology by teachers. Assessment structures and curriculum development must also reflect the contribution of ICT to teaching and learning. Evidence from research studies should be used to redefine the curriculum. Do we still need the present curriculum structure when information available to our students goes far beyond the limits imposed? Examinations boards must also make informed decisions about new forms of assessment using ICT, including online testing and acceptance of multimedia offerings in all its formats, including simulations, audio and video, Web pages and collaborative work. Revamping the school system will work only if there is a complete overhaul of the curriculum, assessment tools, and the way schools are structured.

2 Within a social constructivist philosophy learning is believed to be connected with the sociocultural context in which learning takes place. Learners construct knowledge rather than acquire it, and they do so through interaction with others (Vygotsky, 1978).

3 For example, Passey, D. (1999) Paper presented at MACE conference, July 1999, Coventry, University of Warwick

Teacher confidence

Many research reports[4] have demonstrated clearly that for effective use of ICT, teachers need to be confident and familiar with technology - they have to perceive a reason to use it and be convinced of the benefits. Computers have to be easily accessible, case studies of good practice need to be available, and teachers ought to facilitate the development of increased student autonomy and offer opportunities for authentic learning. There is considerable evidence that students' learning is more robust and that their knowledge and understanding increased where ICT is used in ways that promote learners to work together and where the teacher is less didactic.

However, for students' learning to develop in this way, teachers' views of learners have to change and their teaching has to move towards a social constructivist perspective in which they encourage knowledge sharing. ICT alone will not change teachers; it is a fundamental view of learners that needs to change, but ICT can be a catalyst. The evidence from the Education Departments Superhighways Initiative in the United Kingdom indicated that the use of ICT could make learners more autonomous - they can take more responsibility for their learning, and they can make decisions about the direction of their learning. One example of this is the use of email to write for authentic audiences.

Two 10 year old students in a primary school are writing an e-mail to a contact in another country, they have been asked to send some information. The children compose the message together. When they have finished they re-read it, they check the spelling, the grammar and the sense of meaning. Their teacher is surprised at the final product which she vets before the children send the message The attention the children have paid to detail is much greater than would have been the case had the same children written the piece for the classroom.

Source: Selinger, M. (2001) Authentic tasks and the Internet in schools. In M. Leask (Ed), *Issues in teaching and learning with ICT*. London, Routledge

The teacher is there to provide support and guidance. There is however a need to provide underlying support to teachers to help them accept the potential of technology for learning. The use of ICT can alter teachers' views of learners but it takes time to match teaching to this new view. It is likely that some teachers will need more support than has been anticipated and provided for in the current initiatives for teacher training in the integration of ICT into subject teaching. This is discussed in more detail later.

4 Selinger, M., Littleton, K., Kirkwood, A., Wearmouth, J., Meadows, J., Davis, P., Taylor, J., Lincoln, C. and Lochun, S. (1998) Educational Internet Service Providers Project, Final evaluation report, London, DfEE

Development of educational content in ICT environments

High-quality educational content motivates both teachers and students to use ICT. Too much content is premised on a linear model of learning and becomes e-reading so does not make full use of the technology. Traditional content providers in this sector have been slow to address the challenge and seem unlikely to do so until the market potential has been clearly demonstrated. But clearly the growth of the market is being constrained by the lack of solid content. The question is whether the market will respond in time when demand has built high enough or whether state intervention will be required to stimulate the market – the sector is already rife with hidden state subsidies.

The sector is turning to new sources of content from the entertainment industry, the press, museums and galleries, the universities, businesses and business schools, or elsewhere. Here the challenges are even greater as ready content is not available and the commercial elements threaten to introduce both inappropriate content and insufficient continuity. Some teachers have looked to the Web for content and there is a great deal available, but considerable work and intermediation is required to render the content classroom ready. Work on defining a set of standards to tag content to make searches more relevant is well underway. Until now, the market for electronic learning materials has been restricted by incompatible formats and supported platforms; standards for learning content mean that any compliant content will work with any compliant application, vastly increasing the range of materials available to educators and students.

A similar conundrum has appeared around most attempts at continuous and coherent curriculum development – a massive investment of time and resources is needed to build a course from beginning to end, so the tendency is to start with initial pilots. But teachers are unlikely to commit themselves and their classes to embarking on one of these courses when the forward path is non-existent or unclear, or when it does not meet national curricular requirements. Much that is currently available tends to ignore or avoid the requirements of coherent course building and focus on examples where a one-off or highly modular approach seems appropriate (how an internal combustion engine works…). This is really just a new way to present maps and diagrams, and it leaves most of the challenges of e-learning untouched. There is, additionally, a trade-off between preserving teacher creativity and reducing their workload. Pre-packaged, custom-made courses can lead to a perception that teacher intervention is unnecessary, and good teaching techniques are discarded. Courses need to allow scope for individual teachers to add their own input and to make modifications, and they should encourage teachers to make judgements about adaptation based on their knowledge and understanding of the capabilities of the students they work with. One solution suggested by latest research is that e-content should consist of fairly small, reusable modules rather than larger monolithic units. Teachers can adapt smaller modules or learning objects more easily to correspond to their pedagogical approach and teaching style.

It is increasingly apparent when looking at the work that has been done so far that this area requires (and largely lacks) a new kind of approach. Providers are needed who are technologically adept, understand education and are proficient at design. Fabulous graphics that make no useful educational point are as pointless (and common) as deeply well founded educational content that is impenetrable to most and therefore useless. But designers, educators and technologists tend to look at the world in very different ways and it is rare to see an approach that is not weak in one - if not two - of these areas. All three have to be captured for effective work to be accomplished, and it may be that the generation who can combine them is only just arriving on the scene.

Who are the content players in e-learning and in education?

There is little doubt that the leading market for e-learning in schools is the United States. But even here the development of content specifically designed and enabled for these new environments is patchy and fragmented. At present, the U.S. market for e-learning materials for schools is served by a number of traditional and non-traditional publishing and content creation businesses. The size of the U.S. educational content (all media) market has been estimated by the U.S. Commission for Web Based Education to be some $4 billion annually. At present, however, the proportion of those markets that can be characterised as online material is small.

The overall market in the EU for educational materials is slightly, but not significantly, smaller than it is in the United States. However, the European market for online material is even less well-served, but there are signs that the creation of content specifically developed for a web-based environment is of increasing interest to publishers who have, to date, relied on more traditional media for the bulk of their revenues. In addition, the push for an inclusive approach to education

throughout Europe means that the market for the provision of specifically created online content should grow quickly.

In its report, " The Power of the Internet for Learning"[5], The US Commission for Web-based Education identified "the lack of compelling content" as a major constraint on the development of e-learning in schools:

> All too often, discussions about web-based learning tend to fall back on a simplistic faith in the power of technology. Of course interactivity is a powerful draw for teachers and students alike. But dazzling technology has no meaning unless it supports content that meets the needs of learners.
>
> Some of the content currently available on the Web is excellent, but much of it is mediocre. Challenges await content developers and educators in producing, distributing, cataloging, indexing, and evaluating good online content. They must address gaps in this market, find ways to build fragmented lesson plans into full courses, fully develop the promise of post-secondary educational opportunities on the Web, and assure quality in this new environment.

Three of the key issues that determine the success of an e-learning environment are:

(i) Quality of the content and source materials;

(ii) Web-site design

(iii) Degree of collaboration and interaction that the material and delivery platform allows

That these three qualities exist in abundance on a multiplicity of sites on the Web is not a matter for dispute. However, their coincidence on sites and services in the market for schools is less common.

Traditional educational publishers in Europe are moving into the sphere of e-learning, but progress is slow. Equally, start-ups that are adept at using the technologies that allow e-learning are trying to move into the educational space by acquiring or, to some extent, creating unique content of their own. There are, of course, many and complex reasons why the rush to embrace the educational potential of the Internet has largely, to date, been confined to corporate and higher education. And the dwindling enthusiasm for investment in the sector generally has meant that numerous start-ups specialising in Web-based education are struggling in a far more difficult business environment than was the case two years ago.

Nevertheless, the commitment shown by many governments to ensure greater access to educational resources for all regardless of social, economic or in some cases geographical constraints, means that publishers must look to the Web as a medium for expanding their markets and for developing their product range.

5 The Commission for Web- Based Learning final report: "The Power of the Internet for Learning; From Promise to Practice",

The particular demands of the Web as a publishing medium mean producers have had to think beyond simply dumping digitised content onto a Web page. E-learning creates a demand for media-rich and interactive content, which a simple repurposing of existing texts is unable to supply. Publishers have, therefore, had to begin building content from the outset in order for it to fulfil users' expectations of the material.

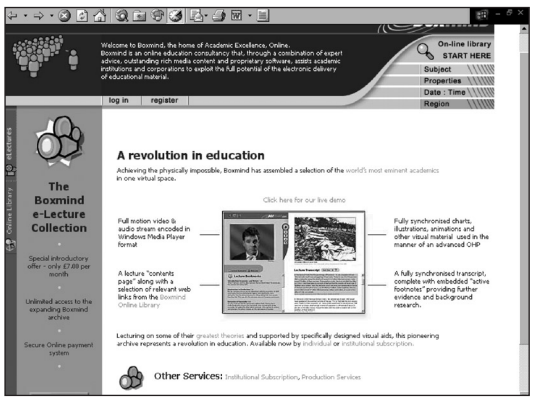
Some publishers have focused on created digital versions of existing textbooks and other educational resources, whilst others have moved into the distribution channels and platforms that control access to digital products. McGraw Hill, for example, has launched the Primis Online e-bookstore, which allows teachers to create their own textbooks from the more than 230,000 pages of digitised textbooks and other digital resources that McGraw Hill has made available through this site. Many sites that act as portals to educational content for the schools market have been created, such as www.teacherxpress.com in the United Kingdom. This site was developed by Cambridge Minds, part of the Logotron group.

But finding or creating the appropriate content remains the biggest challenge to all educational service providers. To date, European publishers have been slower to react to the opportunities that e-learning presents to them. There is also a significant push at local, national, and European government levels to create an environment conducive to the proliferation of e-learning applications and content, including the e-learning Action Plan[6], published at the end of March 2001 by the European Commission.

Initiatives outside the publishing and traditional education fields

In addition to the e-learning content vendors and creators and the traditional publishers moving into Web-enabled educational solutions, a wide range of Web sites seek to provide educational materials and interactive environments. New Zealand children's book publisher, Wendy Pye Publishing, provides literacy and numeracy learning materials to the United Kingdom portal www.learn.co.uk. In the United Kingdom, the BBC Online Education service provides material based on the needs of all students following the UK National Curriculum. Other services, such as the Homework Elephant portal (www.homeworkelephant.co.uk) provide links and resources for UK school children requiring help with their homework. For the higher education market, sites such as Boxmind (www.boxmind.com) offer a variety of specially created, media-rich content and links to other sites as well as giving academic institutions access to authoring software for the creation of "e-lectures" (see Figure 4).

Figure 4: Boxmind



6 The eLearning Action Plan, Designing Tomorrow's education. COM(2001) 172 final, Commission of the European Communities.

Other such initiatives are on the increase but the European market remains fragmented, and some years behind the United States in terms of the provision of comprehensive material and services that address the national and regional needs of specific user groups.

It is hardly a revelation, however, that the progress of e-learning tools and content is so disjointed. The principal factor underlying such fragmentation is the lack of a European-wide system of education. Because each country in Europe provides a distinct and separate education system to its citizens, it is not surprising that the nature of e-learning is similarly disjointed and at different stages of development across the continent. Language issues also play a part and because the development of electronic educational content is expensive, a limited market size reduces the potential for such development. As Web-based content development tools become cheaper, this barrier will be removed. Attention also must be paid to the differences that exist between the pedagogical, cultural and social differences that underlie the learning experience in culturally distinct territories.

Cultural setting for learning

Various degrees of resistance to the use of technology - and the extent to which it is seen variously to supplant, threaten or enhance the traditional pedagogical apparatus - is key to creating successful e-learning environments and tools in different markets. In a study carried out by SRI Consulting, countries were rated on various cultural factors that determined their suitability for adapting to e-learning. The United Kingdom was ranked as most suitable, with 81 points, other countries that ranked as highly suitable included Sweden, Ireland, Norway, Finland and Germany. However, at the other end of the scale, Spain, Japan, Malaysia, South Korea and Portugal had scores that indicated these countries to be three times less likely to adopt e-learning with ease.

The study found, for instance, that the U.S. vision of learner-driven, personalised, granular content does not appeal in Southern Europe. There is a clear implication from this that the e-learning providers in those countries will experience great difficulty in exporting their services beyond their own boundaries.

Academic Robin Mason, in her paper "European Trends in the Delivery of Virtual Education" elucidates some of the subtle cultural barriers that may inhibit the spread of pan-European el-earning initiatives:

In turning to the unique aspects of the European scene, by far the most notable is the mix of languages. Virtual education is linguistically sensitive, making even the concept of a pan-European course fall at the first stumbling block. English is the de facto common language for much cross-country online teaching in Europe, but this practice inevitably excludes many southern European participants. A number of models have been tried on EU-funded projects to handle the language problem: teaching material in English, but tutoring in the local language; simultaneous translation of video-conference presentations; focus around three central languages. But it is evident from the examples given below, that many of the virtual initiatives remain within one country, use English only, or partner with same language countries outside Europe.

There are also cultural difficulties with pan-European courses. While many centre on linguistic misunderstandings, others operate at a more subtle level. They are particularly evident in online text-based discussions where the intricacies of human interaction highlight differences in modes of address, approaches to collaborative work, tone of voice, and attitudes to assessment. Of course, these differences can be found in teaching situations whether face-to-face or online anywhere in the world, as all countries become more multicultural. In Europe, they are the norm rather than the exception.

The differences in pedagogical approaches to education are equally as daunting a barrier to virtual education as is language. Student-centred, constructivist notions about learning hold sway across mainstream educational providers in the U.K. and northern European countries (The Netherlands, Denmark, Sweden, Finland). Traditional, teacher-centred transmissive approaches still dominate thinking in France, Germany, and the Latin countries. The notion of virtual education can and does encompass both approaches and various technologies support one approach more strongly than the other. For example, video conferencing replicates the lecture and is appropriate to a teacher-centred approach, whereas text-based asynchronous messaging supports a student-centred approach. Just as so many technologies have converged on the Web, so both pedagogies are supported by it as well: closed-loop teaching material with multiple guess assessment on the one hand, and resource-based, interactive and collaborative courses on the other.

In a recent study of the Cisco Networking Academy Program which is developed in the United States, these issues were explored by the author in eleven countries across Europe, the Middle East and Africa. The underlying teaching and learning model is based on a constructivist view of learning and is a blended learning approach with e-learning materials in an instructor-led classroom setting. The hands-on labs are perceived as a pivotal element of the program, which give considerable emphasis to these labs. The Web-based materials were written to help students make sense of the labs and to provide a theoretical perspective. They make extensive use of flash animation, graphics and, more recently, video extracts and e-simulations and remote simulations. Extensive instructor training is delivered regionally using a standard instructor training model, and a global online community offers opportunities for the sharing of information and teaching ideas. Localised instructor communities and student communities will shortly be made available.

The study investigated and quantified the factors that affect the ways in which instructors teach the program, including how a U.S. model of pedagogy has been accepted or adapted into different cultures with varying pedagogical paradigms. It also focused on the constraints and effects on pedagogy that Web-based teaching can have when Internet access is limited, expensive or both. The instructor training model was also evaluated with respect to the findings.

The research indicated that cultural beliefs about teaching and learning have some impact on the way the program is taught. The pedagogical principles are based on a spiral curriculum model in which students are introduced to and work with new concepts. These concepts are then set in the context of earlier concepts that were previously taught in the program before the students go on to the next stage. This is perceived as unnecessary repetition in some countries because students are expected to work on assimilating new knowledge into exiting knowledge themselves. In other countries it is also thought to be unnecessary, because the instructors perceive it as their job to do this. The differences are subtle and do not cause much cognitive conflict, but nevertheless they do rely on the instructor to help students make sense of the underlying teaching styles within their own cultural context.

Where Internet access was limited or where student had difficulty studying the Web-based curriculum outside class for reasons of cost or lack of access, then it was not always possible for instructors to work with their students in the way they wanted. They felt that they had to give as much of the time allocated to theory to allowing students to read the curriculum rather than engaging the students in discussion and collaborative activities to help them learn about and understand the concepts being taught. In a few instances, regardless of how much Internet access students had, there were issues about the extent to which the web-based materials could do the teaching alone without intervention from instructors. In these classes instructors completely changed their pedagogy and made the resources the focus of the class rather than introducing students to concepts through instruction and discussion, and using the curriculum as a sophisticated textbook to support students' learning.

The constructivist philosophy was not always borne out in practice by some academies, except perhaps in the hands on activities, whereas in others there were some exciting activities in which students were collaborating on all aspects of the course. Some academies had good examples of constructivist activities in which instructors encouraged students to teach the principles of chapters to others; some exemplified good use of concept mapping, and in some there were extra problem solving tasks set in labs, in which instructors helped to scaffold students' understanding through the use of questions designed to focus their attention on troubleshooting techniques. Certainly in academies where instructors had a sound grounding in pedagogical theory, practices were more likely to include a range of teaching styles aimed at engaging students and maximising their learning.

The main conclusion from the evaluation is that instructor training needs to focus on making instructors fully aware that they are the most important element in the success of students following the Cisco Networking Academy Program. It is the instructors' role to make this global program culturally and pedagogically relevant for their students. Although the program is culturally neutral in that internetworking relies on international terminology and standards, how the program relates to an individual country's infrastructure will vary. Instructors have to ensure that students are prepared for work in their own country and they also need to make any adaptations to the presentation of the curriculum to ensure that students are comfortable in their usual learning environment.

As Web-based content development tools become less expensive and authoring tools easier to use, then other language versions of content will be developed, and cultural and pedagogical adaptations will be incorporated into the materials.

Government initiatives – the search for content creators

The publication of the eLearning Action Plan by the European Commission in March 2001 reinforced the Commission's commitment outlined in the adoption of the e-learning initiative in May 2000.

In relation to content, the action plan detailed the following proposals:

- Promoting exchange of best practice and pooling of member states' efforts in areas such as language learning, scientific and technical education, arts and cultural education; organisation of media events such as the eSchola week.

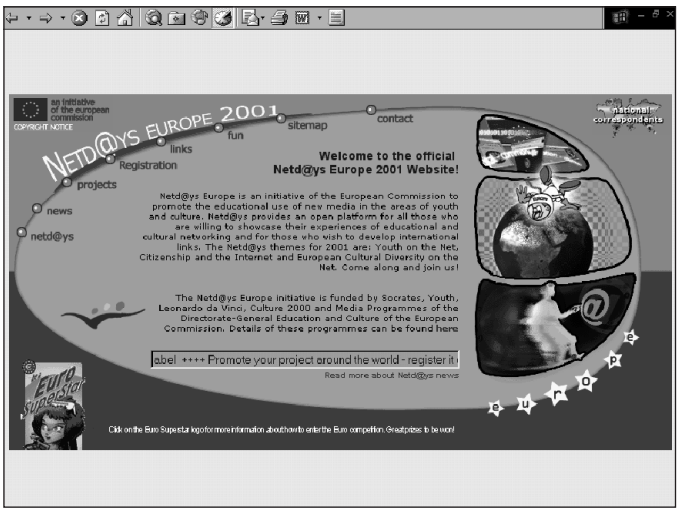
- Encouraging the development and distribution of quality educational content via the Socrates, Leonardo da Vinci, IST and eContent programmes.

- Support for adopting and developing production methods for innovative educational packages (including open source software).

Much of the emphasis in devising policies to bring the benefits of networked environments into schools has focused, to date, on the provision of the network capabilities themselves (that is, hardware) and the access to the appropriate communications technologies that will give teachers and students the capability to make use of e-learning. Less emphasis has been placed on the production of suitable content that, ultimately, will drive the adoption of e-learning and create the appropriate incentives for publishers and others to begin to designate resources for the creation of online materials.

The EU is funding a number of projects which are seek to bring networked communities together in order to create educational content that reflects the experience of schools across Europe encouraging private and public cooperation. Among these is NetDays (see Figure 5). The project is designed to allow schools and other organisations from around Europe to contribute to projects examining various aspects of life in Europe relevant to school-age children.

Figure 5: NetDays



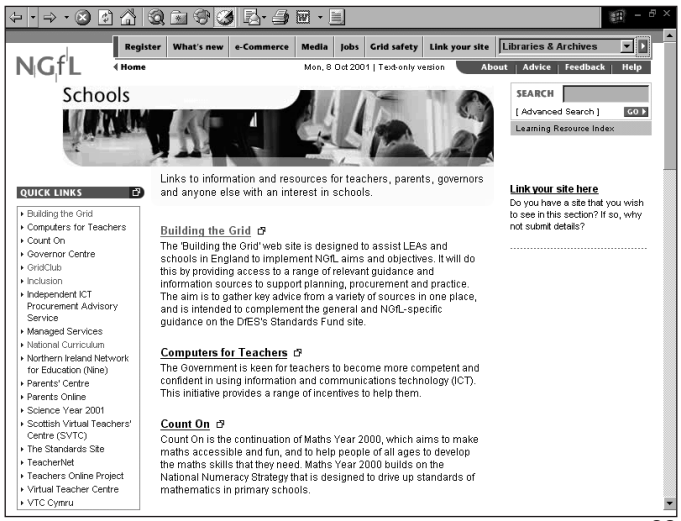
The EU's drive to create the "leading knowledge economy in the world"[7] is at the forefront of its efforts to achieve of high levels of "digital literacy" among the population of the EU. The provision of e-learning, and creating the conditions in which e-learning can thrive, are vital elements of the policies that will be implemented to achieve this. Though the EU has committed substantial funding to building the technological infrastructure for e-learning, it is likely that it is at the local level that most progress will be made towards suitable strategies for the creation, procurement and publication of content: "Schools, universities and training centres are urged to become local knowledge acquisition centres".[8]

The UK's National Grid for Learning

The UK government published, as part of its National Grid for Learning programme, a consultation paper " Curriculum Online" (see Figure 6). The report explicitly acknowledges that the next challenge facing the providers of e-learning is the creation of suitable content that will, in effect, bring to life the investments made in infrastructure:

We now wish to ensure that progress in the provision of digital content matches progress in the provision of infrastructure and in teacher training. If we are to maximise the effectiveness of the use of ICT in schools, then it is clearly necessary for all of these to advance together, to take advantage of developing technology. It is now particularly important that digital resources are made available to support teaching and learning across the curriculum. The development of these resources offers both real educational benefits and significant commercial opportunities.[9]

Figure 6: The National Grid for learning has links to more than 280,000 indexed pages, making it the largest educational portal in Europe



7 Resolution of the Lisbon Council of Ministers

8 The eLearning Action Plan, COM(2001) 172 final

9 Curriculum Online – A Consultation Paper, Department for Education and Employment

The UK government's paper recognises several challenges that lie ahead in its drive to secure the content it needs. Not least of these is the relative immaturity of the market. To try to stimulate the development of the market, the paper outlines three approaches which the government believes could be implemented in combination with each other to greater or lesser extents:

- Stimulate the market by providing schools with electronic learning credits that allow them to purchase material from a central hub
- Procure content by funding a number of producers directly
- Contract a lead content commissioner, a single organisation or several organisations to commission content across the range of subjects and areas needed for the curriculum from independent producers

One of the greatest obstacles to the provision of successful content solutions for schools is the inherent diversity of the educational system itself and, therefore, the demands that different elements of the education systems throughout Europe place on the providers of such content. This fragmented nature of the market means that commercial producers and publishers find it difficult to take advantage of the demand from the marketplace. Experience in the United States to date shows that even with a far greater degree of consistency across the education system, commercial providers have tended to produce more general resources rather than attempt to address one or more of the almost infinite number of niche markets that the full range of subjects studied presents.

There is little doubt that there is a dilemma at the heart of the potential market for content. Producers have to feel satisfied that there is sufficient demand for content before making the necessary significant investments, while consumers are reluctant to embrace the undoubted possibilities or e-learning before satisfying themselves that the effort required to do so is matched by the quality of material available to them.

European governments' commitment to e-learning has been demonstrated by their willingness to invest in the infrastructure to power its adoption in schools. It is likely that a similar show of willingness and practical assistance will be required to stimulate the development of the market for content.

Development and impact of electronic tools

Across Europe governments are committing increasing resources to put curriculum materials online and to encourage the use of ICT in classrooms. The European Commission in its e-Learning Action Plan puts the connectivity of schools and the professional development of teachers as one of its priorities. In other countries whose ICT infrastructure is not fully developed, governments understand the potential of ICT for teaching and learning and are striving to implement policies to place more computers in schools, colleges and universities.

However at the heart of all this reform is the teacher. Without teachers' belief and commitment to using ICT and their efforts to find effective ways of integrating the technology into their teaching continued increases in expenditure will have little impact on classrooms.

As stated earlier, teacherless classrooms are not the answer, but more student autonomy and encouragement for students to take more responsibility for their own learning might be. Teachers need to re-evaluate their position in the classroom. ICT can be used in several ways. ICT can be a resource for teaching in the same ways as other resources such as books, videos and audiocassettes. Teaching can be through, with or about ICT and teachers' workloads can be reduced with the use of learner management systems that will allow them to maintain records of students, support the preparation of reports and manage timetables, for example. Students can learn in classrooms or at a distance and there are far more choices about where, how and when to learn than ever before.

The introduction of multimedia within computer-based environments has had a beneficial effect on student learning. The introduction of a full range of media to complement text and static images and to combine audio, video, and animation provides the learner with a richer learning environment that can provide greater support and develop deeper understanding. Additionally learners can select the medium by which they learn best, and they can demonstrate their understanding in more varied ways, thus providing opportunities for a greater number of students for whom traditional learning environments might have been prohibitive.

Multimedia and the Internet

Teachers can work with students in many ways using networked PCs and the Internet with its ability to provide access to the whole range of multimedia technologies. The Internet can be used:

- As an encyclopaedia
- As access to experts
- For access to dynamic representation of concepts and ideas
- For 3D imaging and modelling
- For interactive models demonstrating cause and effect
- For simulations
- For modelling concepts that are too fast or too small to be seen with the naked eye
- For asynchronous and synchronous communications through text, audio and video
- To provide a platform for exhibiting students' work
- For assessment purposes

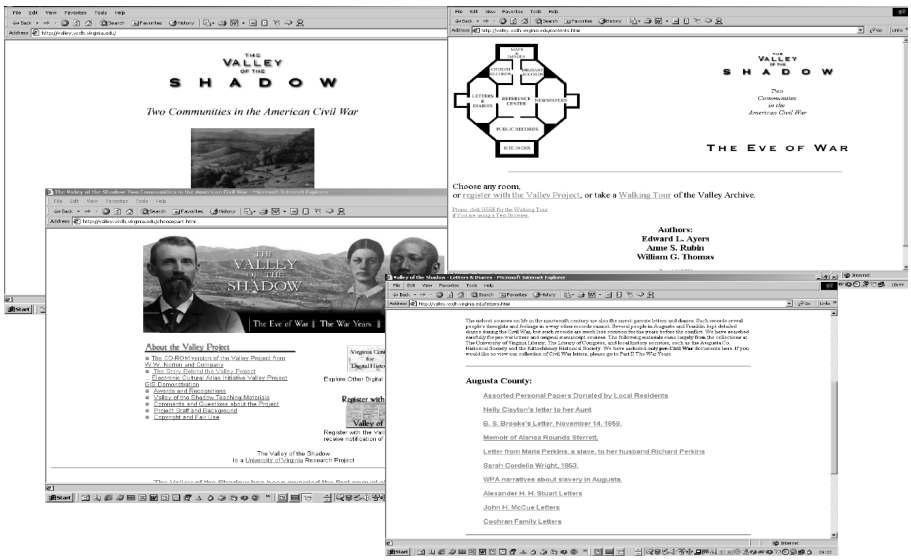
The ideas that follow involve teachers in different ways. Some sites can be accessed by students with very little teacher intervention, whereas others may require teachers to set up scenarios or to set clearly defined tasks that may have to be discussed and negotiated with students, and may or may not require intensive teacher intervention. Teachers also have to decide on which resources to use and to make decisions as to whether ICT, other resources or a combination of both are the most appropriate tools for the job. They may discuss this with students and involve them in the decision-making process. Some tasks may involve the whole class, whereas others may require students to work in groups or on their own.

The Internet as an encyclopaedia

When all the resources a student had at their disposal were library books and teachers' worksheets, asking a child to find out about the Victorians, or farming in France was not a problem. They would do their project with maybe four or five textbooks and help from their peers and their teacher. However, access to the Internet now means that such an open-ended question would be daunting to any student however studious or able. The wealth of information and the alternative ways in which it is presented, together with the bias of different sources, now means that students' tasks have to be more focused and tightly defined. Teachers need to ask different types of questions, and they need to help students ask questions of a more problems solving nature. Instead of questions such as "what did the Romans eat?" a student might be asked, "Why did the Romans lean when they ate?" They might be asked to compare reasons they found on the Web and to suggest which were the most plausible and why.

Some sites provide a wealth of resources on one topic. On notable site is the resource site for the American Wars of Independence http://www.iath.virginia.edu/vshadow2/ developed at Virginia State University in the United States (see Figure 7). Here is a range of authentic evidence in the form of letters, diaries, newspaper cuttings and official records for students to consult. On their own they are a rich resource but with a teacher's craft they can be used to build lesson after lesson of rich activity in which students can role play, explore evidence from a range of sources, and compare the differing emphases and biases, or use the information to take part in role play. The resources are little use without the teacher to structure a suitable activity.

Figure 7: The Valley of the Shadow web site



The ability to navigate the Internet is assumed, but limited research on the use of hypertext suggests that it is far from an easy skill. Again, teachers are important in helping students to stay focused on the task in hand if a somewhat unrelated aspect of a Web site catches their eye. Navigating back to the topic can be problematic, especially if Web sites are not well structured. Careful selection of search engines and the use of precise search terms also need to be taught.

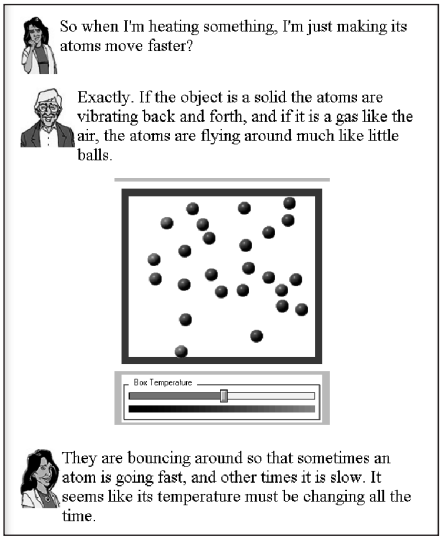
The Internet as access to experts

The notion of artists and authors in non-residence has been in existence for several years. It provides relatively inexpensive and easy access to experts who are passionate about the subject and can interact in ways with students that teachers are not always able to. They are practitioners with experience of their craft in the real world and they can motivate into the classroom without ever setting foot into it. These experts can also link students across schools. One example is the Glebe School Project, which involved an artist working on a digital arts project in schools in Brighton, United Kingdom led by Avril Loveless from the University of Brighton. Children in one primary school took digital photographs of each other and then used an imaging programme to edit out the background. An artist who came into their school supported their efforts. Their images were then sent to another school, where the students completed the background in which they thought the other student was situated; the artist supported these students remotely. In such cases the teacher is integral in setting up and supervising the activities in negotiation with the expert and supporting the students' work in the classroom.

The Internet for access to dynamic representation of concepts and ideas

Scientific subjects have been notoriously difficult to teach. Many concepts are too fast or too small to be seen with the naked eye and the opportunity to rotate objects and see through them is not possible in conventional textbooks. The development of graphic animation through computer modelling has meant that young children can see food being swallowed and digested; geographical contours can be shown by taking a picture of an area, looking at it from a bird's eye view and then drawing in contours, and the passing of electrical current can be modelled by some animation to illustrate how electricity is not "used up" when it passes through a light bulb (see Figure 8).

Figure 8: Applet thumbnails from the Atomic Lab
http://www.colorado.edu/physics/2000/index.pl



Although mathematics is often seen as a subject that is theoretical, evidence suggests that manipulables and physical embodiments make mathematics more concrete and, therefore, easier to conceptualise and understand[10]. In science lessons, students need to both observe and undertake experiments themselves in order to understand the inaccuracy of results, and to develop the notions of experimentation including the need to keep all except one factor constant so as to observe the effects of increasing or decreasing one variable at a time. Computer simulations can augment and enhance the students' understanding of experimentation. Through these media, students are able to observe experiments that are either too dangerous or too expensive to carry out themselves, that would take too long, or perhaps have ethical implications. However it is not to say that these should replace all practical work because simulations can reflect a simplified version of reality and mask the complexities of experimentation. It is the teacher's role to consider which experiments will be attempted in class and which will be simulations in the same way that they decide to demonstrate an experiment or let the class undertake it themselves.

10 Graham, A. (1994) E884; Learning to teach mathematics in the secondary school. Document 8. Practical mathematics. Milton Keynes, Open University

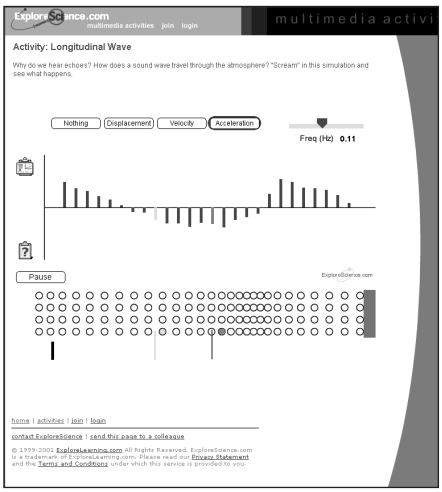
The Internet for 3D imaging and modelling

Imagine being able to explore platonic solids from wire frames to solids and rotating them in space without having to build them first. The technology enabled by the Internet has provided students with opportunities to see and manipulate virtual objects rather than imagine them. Models of body organs, buildings, landscapes and sculptures can all be manipulated by students thus making concepts much easier for them to understand. How this fits into the lesson and where it fits is again the decision a teacher must make. When do they use real models? When do they let students explore on their own? What questions do they take with them as they begin a task? These considerations all need to be negotiated and discussed with students at the start of a lesson or series of lessons.

The Internet for interactive models demonstrating cause and effect and for simulations

Explaining concepts to students through text and static images in a book can cause difficulties particularly when the concepts are dynamic. In the example shown in Figure 9 echoes are explained through a multimedia simulation that can be played and replayed in the classroom. Other simulations allow variables to be changed so that students can understand cause and effect and the need to control variables in any experiment. A teacher needs to set up the activity, to engage students in asking questions of the type "what would happen if?" and "what would happen if not?" and to ask students to make conjectures before performing the simulations. Without such structuring, students may click aimlessly and the value of the simulation or demonstration can be lost.

Figure 9: Explorescience.com



The Internet for modelling concepts too fast or too small to be seen with the naked eye

Understanding can be greatly increased with multimedia models of concepts that are too fast or too small to be seen with the naked eye such as cell growth, seeds opening or a chemical reaction.

The Internet for asynchronous and synchronous communications and collaboration through text, audio and video

Online collaboration in real time and asynchronously opens up possibilities for authentic activity with students of all ages. Anyone from the very young to the very old can share their experiences with students and teachers in other schools anywhere in the world thus broadening experiences and understanding of other cultures and lifestyles through first-hand interactions. Being able to read and write are no longer essential because video and audio enable sharing through any medium students choose to use. Video conferencing can be through proprietary systems or through free software such as *Net Meeting or Yahoo Messenger*; these software programs change the ways that learners interact with others. Students are no longer bounded by time and place, and certainly not by the school day. Learners text message their friends, phone them, send email or use chat rooms to work collaboratively on their homework, a scenario that has implications not only for the nature of homework tasks that teachers give their classes, but also for teacher and other formal assessment of student learning.

Students also take more care and more pride in their work when communicating ideas with others outside the classroom. In classroom situations students know that teachers expect mistakes and will correct them accordingly so they do not take as much care on spelling, grammar and conveying meaning to ensure their audience understands them as they do when communicating with others online. Working with students online also causes teachers to review their pedagogy in other aspects of their teaching when they observe the ways in which students react to a different learning environment where they are able to make choices and take more responsibility for their learning.

The Internet to provide a platform for exhibiting students' work

Too little emphasis is given to the Internet as a vehicle for students publishing and sharing their work, or working collaboratively on a joint production. Many young people write fiction with others over a wide inter -continental network taking on a persona and writing a collaborative piece of fiction. One student with Aspergers' Syndrome found the Internet to be an ideal vehicle for his hidden talents; at last he had a way of communicating with the outside world. He could be anyone he wanted to be through the development of an adventure story, and he invented a fantasy persona for himself. He contributed and was treated equally by his co-authors who knew nothing of his background or his condition.

The Internet to provide a platform for assessment

Assessment of students' work is usually a matter between student and teacher, or between peers in the same classroom, or it involves external assessment authorities. By publishing work on the Internet, students can solicit opinion from a wider audience. Drafts of work can be improved by subjecting them to scrutiny before submission for final assessment, and tools through which a dialogue can be established about a piece of work are available, such as *Digital Document Discourse Environment* < d3e.sourceforge.net>.

Virtual and Managed Learning Environments

Use of virtual and managed learning environments have grown in universities across the region with variable degrees of usage by staff. In the worst case scenarios they result in a series of lecture notes on line with the cost of printing and access transferred to students, and at best they provide an interactive environment in which student have access to further details from their teachers, interactive multimedia experiences and well moderated discussion forums. The principal components of a virtual learning environment include the following:

- Mapping of the curriculum into elements (or "chunks") that can be assessed and recorded
- Tracking of student activity and achievement against these elements
- Support of online learning, including access to learning resources, assessment and guidance
- Online tutor support
- Peer group support
- General communications, including email, group discussion and web access
- Links to other systems

Virtual learning environments (VLEs) are used to support a range of learning contexts, ranging from classroom-based teaching to off-line, distance learning and online learning.

Most of the VLEs currently available offer similar features, making it difficult to distinguish between them. A useful comparison of the five leading products can be found at www.chest.ac.uk/datasets/vle/checklist.html#1. Britain and Liber[11] propose two alternative models, the "conversational model" and the "organisational model", together with a set of evaluation criteria for each to help evaluate a VLE. Managed learning environments (MLEs) link a VLE to student record systems and can provide a method for quality control within an integrated student learning management system.

11 Britain, Sandy and Liber, Oleg, "A Framework for Pedagogical Evaluation of Virtual Learning Environments", http://www.jtap.ac.uk/reports/htm/jtap-041.html

The ICT Environment

Teachers also have to consider not only how they use the Internet, but also the infrastructure that will support learning. Will it be in a wireless environment in which students bring laptops to the lesson, or will they make use of whole class activity using an interactive whiteboard or one PC with a data projector? Perhaps they may choose to take students into the computer room. Choices are not always possible but when they are teachers are the ones who have to make the decisions to ensure that they provide the best learning environment for the task in hand.

Development of new learning models

To develop a robust and sound learning environment there must be a strong rationale and understanding of the power of ICT for the institution, together with a robust infrastructure that can expand and develop as the use of technology becomes the norm for learning in all sectors of education. E-learning is the term that is now used to define the Internet and multimedia that enable the learning process. Both senior managers in education and teachers need to be clear of their vision and where they see e-learning fitting into school development plans and to the culture and ethos of the institution. In order to do so they need to understand precisely what e-learning is and be convinced of its value in realising their vision.

Many people in industry believe that e-learning is a revolutionary way to empower a workforce with the skills and knowledge it needs to turn change to an advantage. However a real understanding of e-learning and its potential can be realised only if educators use it themselves. Positioning themselves as learners again is a valuable experience in itself, and it can also provide first-hand experience with which to review and evaluate the potential various e-learning tools that have emerged on the market.

Evolution of E-Learning

Early examples of e-learning in education were the traditional computer aided leaning (CAL) and computer based teaching (CBT) applications in which there was very little learner interaction with peers or tutors and the model was often based on a behaviourist view of learning. E-learning can support and enhance, and even extend learners' potential. The most important elements that make e-learning more than e-reading or e-training are communication and collaboration, and finally, it becomes e-learning when learners use it to learn in a new way. Today's e-learning tools recognise the potential of learners

working collaboratively and the need for teachers to ensure that their students develop well-rounded skills that will secure them excellent job prospects and develop good citizenship skills.

E-learning allows the learners more choice about how, when and where to learn and can be adapted to learning preferences and personal situations more readily that traditional learning offerings alone. Additionally learners can learn at their own pace and revisit resources as often as they wish or need to, in order to be sure they have developed the necessary understanding.

There is no doubt from much of the research evidence that individualised learning can improve the learning experience and learners' success. E-learning has also made such solutions affordable. Each knowledge domain and each skill taught through e-learning requires a set of tools that support the nature of the subject being studied. There is no one solution set that will suit all areas of learning. Where to offer e-learning as a discrete offering or blended with traditional teacher-led or distance learning materials needs further research, as does the extent to which learners also need to be educated in these new tools for learning. Action research in institutions will determine the path for e-learning, and it is those educators who understand the technological skills that students bring, and how they can be harnessed who will succeed in realising a vision of the education institution in the Knowledge Society.

The European Commission in their E-learning Action Plan published in March 2001 gave the following broad definition of e-learning:

> The use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration.

Any broad definition of e-learning , however, should reflect the fact that it covers a multitude of scenarios, and that e-learning can bring the learner closer to experts in their field through Internet-based solutions that negate the distance of time and space. It should demonstrate that the very best teachers could help learners through interactive sessions or through a video or a multimedia presentation, where learners can interact with them directly or indirectly through a range of asynchronous and synchronous communication tools described earlier.

E-learning can enhance and support what teachers already do well in face-to-face, real time settings by providing access to Web-based simulations, video, models, demonstrations, and animations moving learners from passive recipients of information to active participants in knowledge acquisition. Additionally e-learning offers flexibility in course delivery because resources can be updated, added to and improved far more quickly than text based materials ensuring that currency and relevance are maintained.

E-learning can provide learners with authentic data and authentic situations within which to study. Not simply a new word for e-reading, e-learning encompasses a host of tools and applications available across the Internet to bring creative ways of improving the learning experience. For example teachers can learn from the experience of other, more experienced teachers through digitised video case studies, text-based discussions and cases and the opportunity to communicate through voice, text or video conferencing with the authors in a way that can only enhance and bring to life the

processes of developing a strong and effective leadership or teaching style.

E-learning can offer learners flexibility in choice and personalised experience based on their learning style and personal situation. The ever increasing range of e-learning tools provides greater choice of when, where, how to learn and with whom to learn, and means that teachers themselves can experience e-learning first hand. Courses can be offered in various ways, through virtual teachers, Web-based courses, distance learning or classroom based courses. They can be assembled and delivered in the most appropriate way or in several ways giving the learner the freedom to choose the route that is most appropriate for their learning style or lifestyle.

Some e-learning tools

Schools, colleges and universities need high quality, reliable and easy to use technologies that suit their myriad of needs. Some of the most exciting developments are coming in the form of telephony in the guise of voice over IP (VoIP) and IP telephony. Voice over a data network, VoIP, has allowed institutions to place phones in every classroom with no additional wiring, because the phones can share an existing data port with a PC. IP telephony goes well beyond the traditional use of telephones. It can act as a terminal for class registration, provide a fast method for locating staff and students through an online timetable, and give access to e-mail. Coursework help can be introduced by using intelligent call handling software so that on-duty teachers could be contacted no matter where they are, and data on student attendance can be collated and sent to the management information system with minimum effort and error. Visitors can be invited remotely into the classroom or lecture theatre; for example, grandparents can talk to primary school children about their early lives through the speaker phone capability built into the phone, and conference calls can be set up between classrooms so one external speaker can communicate with several classes at the same time.

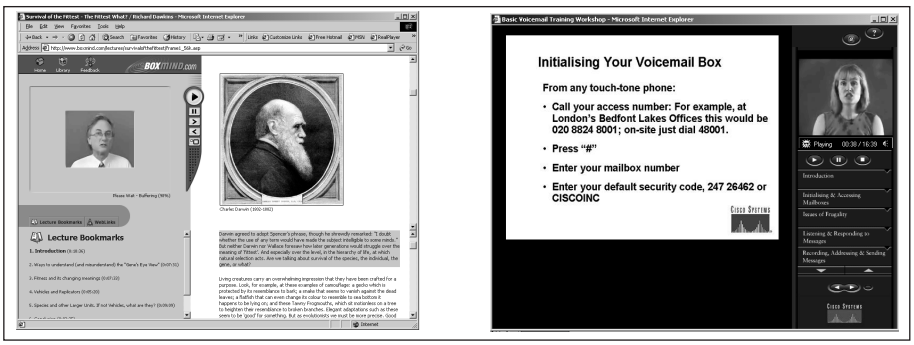
The UK government's latest initiative, Curriculum Online, mentioned previously, and similar initiatives in other countries will rely on schools having a robust and fast connection to the Internet. It will give teachers the opportunity to access teaching resources from leading publishers and to share teaching ideas and lesson plans with colleagues from all over the country. Students too will have access to the resources, and schools are beginning to consider how to facilitate this as effectively and efficiently as possible. One solution is wireless LANs (WLANs). The WLAN network has allowed the institution to bring the computer lab to the classroom in the form of mobile computer trolleys, typically equipped with 15 to 20 laptops with a projector for display purposes. A printer can also be attached to this network and accessed by all the PCs. The equipped trolley is then simply wheeled to the room in which the class is to be held in and all the laptops automatically connect to the network via the nearest base station. This has minimised the amount of disruption for PC-based lessons and allowed integration of ICT into subject teaching to be achieved and the whole institution is networked at a very low cabling cost. In addition, as the demand for PC access increases departments can arbitrate demand between the staff and additional PCs and entire mobile PC labs can be added when required with no change to the network infrastructure in the school and with minimal disruption.

Other technologies have also been developed to allow the network to operate in such a way that teachers and students can gain access to high quality multimedia when they need it by using a content distribution network (CDN) that allows, for example, broadcast quality video to be transmitted without loss of quality. Video conferencing can also be enabled across the network alleviating the need for an ISDN line or the need for the other party to have a compatible system. It also mans that video conferencing can take place from a classroom rather than from a specially designated room.

Video on Demand

Visiting speakers can record their presentations, as well as lecturers recording seminars for reviewing by students who would like to review the lecture or by students who may have missed it. Their talking head is synchronised with their slides, the text of their talk, an animation, a simulation or with video footage, and the resulting product, known as video on demand (VOD), can be accessed at any time by students (see Figure 10). The talking head gives some personalisation to the presentation and learners can download the audio and presentation whenever they need to review material previously taught.

Figure 10 Video on demand examples



Cisco IP/TV Solution

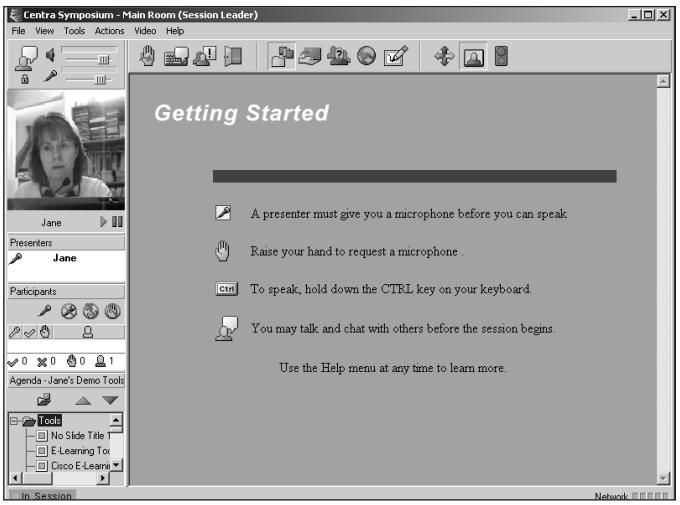
Broadcast quality real time video can be sent to all desktops within a network. The vice chancellor of the university could broadcast a welcome message to all the students each term, for example. This broadcast can be recorded and replayed at scheduled times. Later it can be saved as a VOD and accessed by those who missed it, or as required. The Cisco IP/TV® solution has an additional advantage over traditional television transmission; it supports interactivity. Viewers can type in questions and the speaker can relay answers.

Virtual Classroom

Virtual classroom software enables traditional teaching to take place over the Web with learners or tutors dispersed (see Figure 11). Tutors and learners log in to the same Web site, and they can listen through either their PC or a separate telephone connection. This solution can be used in a variety of situations, for example, where:

- All learners are based in different locations,.
- The teacher is in a different location from their class
- A guest tutor or expert is invited to speak to the group but ins unable to travel to the institution
- A group of learners are located at home or on another campus and are unable to be present

Figure 11: Virtual classroom



In the large space in Figure 11, the tutor can place a presentation, or a Web page and surveys are also possible, so tutors can check for understanding or gain immediate feedback on their lecture or seminar. The range of tools available with this software emulates the traditional teaching environment.

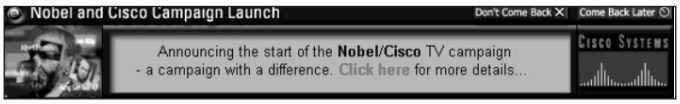
Collaboration and communication

As discussed earlier, a range of solutions are available that support and promote collaboration and improve communication between learners and between learners and tutors. Synchronous tools such as video conferencing and real time discussion have enabled learners to engage as if they were in the same room as their learners or tutors. However, synchronous communication may not suit all learners. Those who like to take time to consider the debate and different ways of responding prefer asynchronous communication. They are likely to be reticent and need more time for reflection before posting a response. Many of these people value asynchronous communication more highly than synchronous, because for the fist time they can participate equally in a debate. In face-to-face or synchronous discussions such people have less opportunity to participate in a discussion because articulation of their thoughts may be too slow to allow them to join in the discussion.

Administrative communication tools

BackWeb is an example of a communication tool often used in companies to bring high level, carefully targeted information to the work force (see Figure 12). People are assigned to groups according to a range of criteria so that high level information and messages can be sent to them via a message that arrives at the bottom of their computer screen. This could be an invaluable tool in education for ensuring that teachers are informed about registration procedures, health and safety issues, timetabling changes and other administrative issues. Each message gives a small amount of information. Learners or staff scan and then choose to read more now or revisit it later. If they choose to follow up the information immediately they are directed to some further information from which they can ascertain whether they need to find out more and visit the targeted Web site.

Figure 12: BackWeb message



Portals

E-learning offerings need to be easy to access and navigate. Effective access to e- learning and communications is usually gained through a main portal. From there individuals can access the relevant portal where details of all courses they can take are listed and a roadmap signals the route they need to take in their education. This portal becomes a student's own personal education page on which is listed all the learning the student has undertaken and is currently engaged in.

Personalisation through e-learning

The political climate in many countries is encouraging a culture of lifelong learning. This stems from a recognition that many of the population will have, or currently have, redundant skills sets, and that there is a rapid shift from the skills needed in an industrial age to the new skills needed for the information age. E-learning can facilitate re-skilling of the workforce. Part-time, just-enough, just-in-time and just-for-you learning have all been receiving a lot of attention, recognising that long courses are not always required, instead, small chunks of knowledge aimed at particular job functions can be given to update an employee on new products or new techniques. Education needs to prepare the future workforce for participation in lifelong learning, particularly in the digital literacy skills needed to take part in e-learning. Learners need to know when, where and how to access learning, and how to make choices about the nature of the learning that suits them best.

The development of e-learning tools that make use of reusable learning objects enables courses to be tailored to students' individual needs. Development work is currently being undertaken on tailoring courses according to an individual's learning preferences and delivering them a program in the most appropriate format. Currently courses such as the Cisco Networking Academy Program offer students the opportunity to take a pre-assessment prior to starting a course. Then the program offers the students only those elements of the course that they need to study or to revisit. With reusable learning objects students can be offered a different set of teaching materials from those that they were used in their first run through the teaching package on items they failed to grasp.

Development of new learning models- e-learning as the new distance learning?

The notion that education has to take place within the walls of an institution, such as a school or university building, has been redundant for some time. "Education" is a broad concept, and providers of education are similarly diverse - many sources of education are entirely beyond the public sector and are made up of highly specialised and specific courses aimed at imbuing certain skills. The rise of the corporate university with the likes of McDonalds and Disney providing campus-style learning environments for their employees is a frequently referenced manifestation of this diversity. Many employers spend a considerable amount of money and time on training, and some have even created institutions that are dedicated solely to the training of their employees – the corporate university. Governments too have expanded the scope of who and how citizens may be educated. "Life-long learning" is a concept that both public and private sector organisations have pledged themselves to support. The corporate university is discussed in more detail later.

The creation of greater access to education through distance learning has been one of the most common methods used by government, enterprise and other less formal programmes over the course of many years, and some of these initiatives have achieved significant success.

Bodies such as the UK Open University, which in its 30-year history has provided degree courses to more than 2 million people in the United Kingdom, amply demonstrate the potential that such institutions offer. Most of the students enrolled at the Open University follow their degree courses through distance learning. Though they may occasionally meet with their tutors and fellow students in person, it is more likely that they will spend the majority of their degree course learning through some form of distance learning through a whole range of media, that can include correspondence, television, audio or video cassettes or a combination of these media and methods. In more recent years the Open University has looked to the Internet and Web-based solutions for the delivery of much of its content and teaching. About 160,000 Open University students are online, using the university's e-mail and conferencing system to exchange messages and hold online discussions via their PCs.

The use of ICT by institutions such as the Open University can be seen as traditional distance learning achieved by other means. A student submitting an essay for assessment by a tutor using email rather than the postal system is hardly a cutting-edge vision of e-learning. But to see e-learning as simply the replacement of one method of communication – one means of bridging the distance in distance learning - is perhaps missing the point. The real challenge and excitement generated by the use of new and emerging information and communications technology is the ability that it delivers to change not simply the tools for education but the entire educational experience for a far broader group of people than ever before.

The potential ability of ICT to achieve a substantial improvement not only in how material is delivered, but in the very material itself, is also made clear from numerous examples. For example, the ability of medical students to experience live surgery is limited by a number of obvious physical factors and constraints. But by using high quality video links delivered over broadband Internet, student surgeons gain first-hand experience that is closer than "being there" than anything other than physical presence could deliver (and may even provide a superior experience because of the multimedia possibilities of the Internet such as automatically annotated demonstrations of surgical techniques). The clear advantage for educators of such techniques is that the number of students who can enjoy a direct and close relationship to the content is unlimited by physical space, geography, time or the scarce availability of surgeons to provide a practical demonstration. In addition, by being able to capture vision and sound in digital formats that can be made available online, the excellence of one surgeon can be made available to many when they need it, as opposed to being restricted to a small group of students able to be present at a live demonstration.

Extending the learning experience over space and time

The Open University in the United Kingdom opened the way for many adult learners to extend and continue the experience of education that had for one reason or another been truncated earlier in their lives. The idea of taking the educational institution to the learner was not of course, in itself, a radical departure, but the creation of distance learning in a mass form was a significant step towards creating genuine open access to higher education. Developments in ICT mean that e-learning is also likely to bring about a profound change in the way that education is created and to whom it is delivered.

The sociologist Alvin Toffler has argued that the present prevalent systems of education, though well suited to the industrial age, are too narrowly conceived and too rigidly enforced, for the more fluid demands of the information age. In a March 2001 interview with the Wall Street Journal, Toffler commented: "Now that we're moving from factory work to any time, any place work, we need an any time, any place education parallel." Of course, the use of ICT alone does not address the requirements of a more flexible and open-ended education system as Toffler thinks the information age seems to require, but there is little doubt that it is ICT which makes such an imaginatively conceived of system a practical possibility.

E-learning is in many ways the "new" distance learning. However, certain aspects of e-learning that give it the potential to be more than this in both the style and nature of its content, and the ability to reach wider and more diverse populations than ever before. The phrase "lifelong learning", is popular with educationalists and human resources directors alike, and has come more and more to stand for the new models of learning that ICT is making possible, and the access to knowledge that the Internet with its ability to create direct connections between unlimited numbers of producers and consumers is able to deliver.

In his paper "Four fictional views of the future of learning." Alfred Bork, Professor of Information and Computer Science at the University of California, says " The computer makes large-scale distance learning possible. Interactive learning can now be made available in homes, libraries, shopping centres, children's buildings and other informal environments, for all ages everywhere. Further, with distance learning we can do a better job of matching students who can learn from their peers…Physical proximity is not what is needed, but rather students involved in peer learning must be in the same situation."

Bork is critical of much present e-learning, arguing that " the origin of most problems is that almost all e-learning today is based on imitating what happens in the classroom, trying to recreate this environment in distance education. Yet there are strong signs that the classroom, and the educational philosophy supporting it, is insufficient for twenty-first century students." Bork identifies the tutorial system - the intimate gathering of a tutor and one or two students to ask questions and review work favoured by the elite universities in both the United States and Europe - a system that he believes delivers the optimal in learning environments:

> A skilled tutor works with one, two or three students, in a highly interactive fashion, often asking questions or discussing students' assignments. Learning with this approach has been spectacularly successful. This has usually been the learning paradigm for the children of the wealthy, who recognize its superiority. Even rich dullards get college degrees this way. But it has been too expensive for most learning.

Though the tutorial system may be too expensive when conducted by costly human beings to be of any practical use to any more than a restricted number of the most privileged members of a society, Bork argues that a computer is capable of acting the role of the skilled tutor, at a significantly lower cost and with a substantially higher number of students. Bork is not here predicting the use of artificial intelligence to replace the human dimension of the education system, but is arguing for the use of existing computer resources, applied in a more intelligent way, to create and foster new models of learning.

The development of the virtual university

The first Virtual University www.vu.org, was founded when the World Wide Web consisted of just 500 sites, and the use of the Internet was considered a fringe activity. The site is still an active wholly Web-based learning resource for subjects as diverse as basic HTML to the teaching of memoir writing.

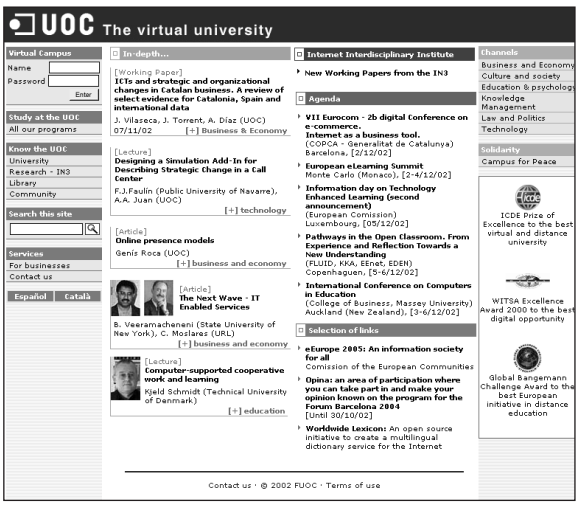
Since its origins among IT academics in the 1970s the Internet has propelled itself to the centre of many if not all areas of human activity. Many universities use some element of e-learning as part of their core syllabus, with material available to students online, the ability to search electronic libraries and online communication between teachers and students a common phenomenon. However, all of these could be characterised as an extension of existing physical institutions. The potential for e-learning is to obviate the necessity for physical institutions and to create virtual education "centres" that, in fact, have no physical centre at all, and can be accessed from anywhere in the world. If this vision sounds somewhat utopian, there is a good reason for it: it is. Some of the more spectacular early attempts at creating "virtual universities" were launched on the surge of misplaced enthusiasm in the late 1980s and early 1990s that saw the attempt to turn virtually every human want and need into an online, virtual experience. The California Virtual University (CVU), created in 1997 by some of the largest and most prestigious colleges in the state, was heralded at the time as a major breakthrough in the development of online education. The consortium behind the plans had placed few limits on their ambition: "We're aiming to be the Amazon.com of technology-mediated education in California" said Rich Halberg, CVU's spokesman at the time, to the Los Angeles Times. Yet, by 1999 many of its sponsors had abandoned the project and it collapsed soon after. Such high profile failures, however, should be seen in the context of over-exuberant times. Many similar projects are in development now around the world, and most of these have significantly more modest aspirations. Though the CVU failed to live up to its promise - defeated by political and commercial wrangling rather than the failure of the concept itself - many other more modest initiatives around the world have flourished providing ample demonstration of the potential that resides in the combination of distance-learning models and the use of ICT.

One of the first governments to push for the creation of a virtual educational institute was in the semi-autonomous region of Spain, Catalonia. Universitat Oberta de Catalunya (the Open University of Catalonia - UOC) opened its virtual doors in 1997, and has become one of the most successful institutions of its kind anywhere in the world (see Figure 13). The Catalan project was the fist to be built entirely around the use of communications technology. Students use e-mail to correspond with tutors, and are able to "meet" and discuss their courses with one another online in the university's virtual campus, which the university on its Web site itself describes as:

The Virtual Campus may be defined as the set of functions that make interaction possible between all the collectives that make up the university (students, teaching staff, and management staff), without any need for them to coincide either in time or space.

> The fact of studying from home does not mean that UOC students are not connected with what goes on in their university. At the UOC, students chat with one another just as students from any other university do in the corridors, they may check available books at the UOC library or at the rest of the University libraries of Catalonia, they can walk into the Kiosk and check the day's press, or ask their lecturers to sort out any doubts they may have on a particular issue. This close and permanent contact between teaching staff and students guarantees the constant attention and stimulus required in distance learning.
>
> By means of e-mail facilities, students can get into touch with counsellors and tutors, take part in colloquia with their colleagues, or carry out any relevant academic transactions.

Figure 13: Homepage of the University of Catalonia



The UOC describes itself as: "an educational model based on the Internet…students obtain from any location easy access to a useful and dynamic learning experience and become the centre of an absolutely personal educational process."

Such personalisation of the learning experience is one of the key benefits that the use of the Internet and computer technology offers both students and institutions. Because students can (given the availability of appropriate technology) choose how, when and where their learning takes place, they are freed from the constraints of time and space in adhering to rigid curricula and schedules. Learning can be adapted to fit with other life priorities, so rather than having to make a decision between, say, work and university ("either or"), individuals are faced with a more balanced set of "how and when" decisions. Because the Internet can put individuals in direct contact with institutions and organisations, students may approach their learning over extended periods of time, and regardless of location. Eventually, students may be able to take a portfolio approach to education, picking elements of a degree or other form of course from elements made available from globally dispersed providers. In many ways, the e-university of the future will act as a co-ordinator, putting students in touch with the best providers of the material and courses that they wish to follow. In a report for the e-University project in the United Kingdom, consultants PricewaterhouseCoopers outlined a similarly diffuse role for the proposed eUniversity(e-U) in the United Kingdom:

> We suggest that the e-U should be viewed more as a facilitator than as a "university" in any traditional sense. It should enable learners to learn, providers to provide and awarding bodies to award, in ways, which meet their (joint) requirements. But it should couple the provision of facilities to enable this to happen with the drive and energy to make sure that it does…
>
> We can identify four main modes of operation for the e-U. First, and most conventional, would be for UK universities to convert some of their award bearing courses into e-learning ones, but maintaining the same course structure, and then to make them available through the e-U to potential learners, perhaps supplemented with their own e-based tutorial support. To receive their awards, some universities might make it a requirement that learners made use of their tutorial support as a supplement to their learning material.
>
> A second mode for the e-U's operation would be that some UK universities might agree that certain aggregations of modules, some of which would be their own, some those of others, would be eligible for their awards. These aggregations might be pre-specified or could be negotiated with potential learners. Over time, this might lead to the development of a system of credits. In either of these two modes, the university making the award would be responsible for ensuring the coherence of the learning programme leading to the award.
>
> A third mode would be that other bodies (such as overseas universities, governments or companies) might use one or more modules from the e-U, perhaps adding their own provision and providing their own awards or certificates. We think that this prospect of combining e-U with local provision may offer a particularly attractive market opportunity.
>
> A fourth mode would simply be that individual learners might study an e-U module or course with no intention of seeking a qualification.*

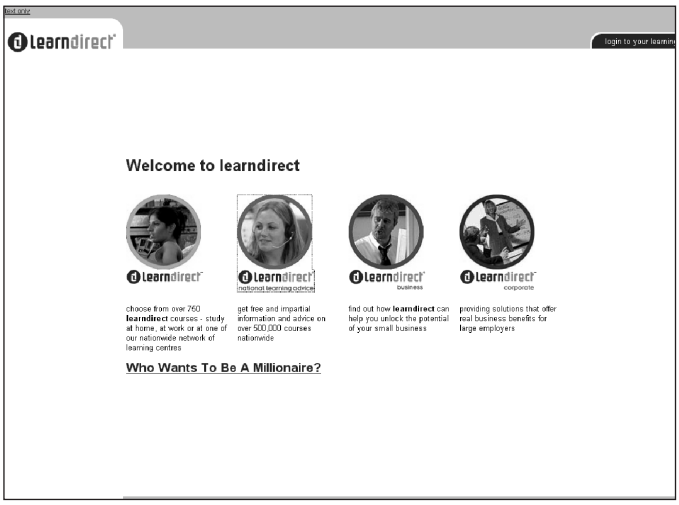
*Taken from a report by PricewaterhouseCoopers for the Higher Education Funding Council for England: Business model for the e-University, published 2000.

Embracing New Learning Styles

Lifelong learning

"Lifelong learning" has acquired almost mantra-like status among government, training and employment professionals. The launch of high profile initiatives such as Learn Direct in the United Kingdom or similar projects elsewhere in Europe, and the backing from the EU for major initiatives to promote lifelong learning, provide ample evidence for the seriousness that administrators and employers attach to efforts designed to ensure that education and training extends well beyond the boundaries of formal, statutory schooling (see Figure 14). However, according to figures compiled by the EU, less than 10 percent of the adult population of Europe received any training at all in 2001. Recalling that the European Council of Ministers pledged at its summit meeting in Lisbon 2000 to make Europe: "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth, with more and better jobs and greater social cohesion", such statistics for training can hardly inspire boundless optimism in the hearts of those set on such an achievement.

Figure 14: Learn direct: the UK government portal for lifelong learning – though relatively few in Europe are taking advantage of learning opportunities



In response to the relatively low level of training among the working population of Europe, and mindful of its stated goal to become the leading knowledge economy, the EU has set up a number of initiatives to increase the availability and general awareness of opportunities for training and education.

The National Adult Learning survey 2001 carried out in the United Kingdom found that the reasons given by respondents for why they had not done any training included the following:

- Lack of time
- Cost
- Inadequate information and guidance
- Inconvenient provision

Each of these barriers to training can be overcome by the use of ICT and, in particular, Web- and network-based solutions. Web-based e-learning allows learners to learn at a time and place that is convenient for them. The costs of training are also likely to be considerably lower in may cases because the volume of training that can be achieved online is clearly of a far greater magnitude than that which can be provided from a physical classroom setting , or where personal interaction is required.

Home-School Links to Learning

The opportunities for learners to be educated anywhere, any time and by anyone constantly increases. Innovative schools are beginning to take advantage of the Internet and giving students access to schools resources from home through the school's intranet, so homework and lesson notes can be collected remotely and parents can be more involved in their children's education through access to their child's web portfolio, lesson resources, the school's intranet and extranet, and e-mail dialogue with teachers. Where this becomes policy, schools have to ensure that the digital divide does not widen and that students who have no personal access from home are not disadvantaged. Some schools offer loan or lease schemes for computers according to parental income but the costs of Internet access are rarely provided. There are also a number of initiatives aimed at students who for some reason or another do not attend school, an example of this being the Not School project operated by Ultralab in the United Kingdom.

In universities there is a growing demand from off-campus students to access lectures, notes and other resources online, and for opportunities to communicate and collaborate with students and teachers remotely. This demand is growing because of the increasing number of non-traditional students who are being encouraged to return to study in order to improve skill or re-skill in response to the demands of the Information Age and government agendas for a well-educated, flexible workforce. At the University of Twente for example, many students live and work locally, and the university is investing in a wireless network that will give both on- and off-campus students equal access to the university resources and infrastructure.

Borderless Education

The term "borderless education" is used to indicate developments that cross (or have the potential to cross) the traditional borders of post-secondary education, whether geographical or conceptual. The issues for schools are less marked to date, but that may change in the future. One of the major issues surrounding the internationalisation of education through e-learning and ICT are concerns about increased competition from private, corporate, overseas and virtual universities. The CVCP and the Higher Education Funding Council report, *The Business of Borderless Education: UK perspectives*, discusses teaching and learning in the borderless context as a hybrid of existing modes.

> In distance learning currently paper-based delivery is still more common than virtual approaches. The scene is one of increasing complexity with a convergence of face-to-face and distance learning approaches. A shift towards treating students as "customers" or "clients" is also becoming more pronounced, particularly in relation to the working adult market.
>
> In most examples of borderless higher education, curriculum development generally reflects the needs of employment and "earner-learners". New providers are positioning their wares as "just-in-time" learning that can be immediately applied in the workplace as opposed to the "just-in-case" acquisition of knowledge traditionally supplied by universities. The craft tradition that saw individual academics responsible for the development and delivery of a course is under pressure from a more industrial model where discrete elements (such as subject knowledge, pedagogical expertise, multimedia skills, assessment techniques) are drawn together within course teams of individuals with specific roles. For advocates of the new forms of provision the decline of the cottage industry approach adopted by universities to teaching and learning may be a matter for celebration, however, for many academic staff fundamental questions emerge about key educational processes and values. (p15)

The expansion of corporate education falls into this category for two main reasons: first many of its imperatives rest on the lifelong learning needs of staff in multi-national organisations, and second, in some (but not all) cases corporate universities may act as a special kind of private for-profit provider. Before corporate universities are discussed in more detail, other issues of borderless education need to be revisited. These are the questions discussed earlier in relation to content and relates to how e-learning programs can be rolled out internationally, regardless of the prevailing culture and pedagogy of the host country compared to that of the recipient country, and the relative costs and speed of Internet access.

The Place of Corporate Universities and Vendor Training Programmes

Corporate universities have evolved rapidly in the United States and are emerging gradually in Western Europe and Asia. Not only have the number of such organisations increased considerably, but they have also developed qualitatively. At the Global Corporate University Week 2000 conference in Cannes, France a survey was conducted which yielded useful insights particularly with respect to the importance of corporate universities as vehicles for strategically relevant research. Highlights of the survey results are presented and discussed in an article in the *New Corporate University Review* published in December 2000 (volume 8(6)), and three major stages of corporate university development are defined: operational, tactical and strategic.

What makes corporate universities "corporate" is their strong link with corporate strategy, although involvement of senior management in the training programmes was questionable. Most corporate university programs are aimed primarily at disseminating knowledge and information, not creating new knowledge. Companies need a continuous supply of new and company-specific knowledge to keep pace with the rapid developments in their environment. Given this demand, business research conducted by corporate universities can be an important source of new knowledge. And if research is considered as one of the core activities of conventional universities, one may ask: How "university-like" are corporate universities? About half the respondents said that their corporate university staff was largely, if not entirely, focused on education and not involved in research. Others said that some staff carry out research, but it is not considered a key activity. The survey results also showed that corporate universities, in general, are not very strongly involved in research on strategic issues. Traditionally companies have undertaken research with conventional universities, and it may be that the trend towards corporate universities engaging in more research could have a detrimental affect on conventional universities funding and research output unless synergies between the two sectors are developed. However in the undergraduate area, at least, it seems that the importance of these interactions has been recognised, because there is very little evidence that corporate universities have any intention of operating independently in a major way. Most corporate universities have chosen or wish to collaborate with existing universities and colleges, although they are highly selective in their choice of partners (see the report *The Business of Borderless Education:* UK perspectives published by CVCP and HEFCE).

Corporate university goals

The respondents were asked to rank five potential goals, resulting in the following list:

- Enable employees to fulfil individual learning needs
- Realise a match between corporate goals and individual learning preferences
- Realise higher returns
- Attract, motivate and retain employees
- Enhance employees' employability

Enabling employees to fulfil their individual training needs is considered to be the most important goal for corporate universities. Also, matching corporate goals and individual learning needs and realising higher returns were found almost equally important. What was striking was that the respondents were indifferent about using corporate universities to attract, motivate and retain employees. Enhancing employees' employability was ranked lowest.

The survey led to a number of tentative insights into the current stage of development in corporate universities. The results indicated that three stages can be identified. Corporate universities in the first part of development operate largely as enhanced training departments that bundle corporate education activities.

Many organisations, though not the majority, are at this stage. In a more advanced stage, corporate universities align themselves with corporate strategy to form the "knowledge backbone" of their organisation and have a strong and durable link with corporate strategy. Given the strong awareness among corporate university managers about the relevance of this link with strategy, many organisations are working on advancing to this stage of development. Only a few corporate universities have entered the strategic stage in which the organisation not only disseminates and repackages knowledge, but also creates strategically relevant new knowledge through research. It is a widely accepted observation that the competitive advantage of firms in advanced economies is increasingly based on knowledge rather than on physical assets. Given the strategic role of knowledge, a higher priority for corporate university development can be expected. Some corporate universities will prepare themselves for a move from the "operational" to the "tactical" stage. Others will take the next evolutionary step to become the "knowledge factories" of their company.

Vendor programmes

One area in which the corporate and education sector can and do concur is in the increasing adoption of vendor training programmes, leading to a vendor accreditation recognised in industry. Microsoft, Oracle, Novell and Cisco all offer such programmes through a public partnership between schools, colleges, universities and other non-profit organisations. In some cases these vocational ICT courses receive accreditation into national assessment and curricular frameworks, and theyattract financial support from education authorities accordingly.

An Example: The Cisco Networking Academy Program

Formally launched in 1997, the Cisco Networking Academy Program is a comprehensive four semester, 280 hour course that teaches students and in-transition workers to design, build and maintain computer networks. The program is operated through, and in partnership with, technology learning centres such as schools, colleges, universities, and occupational training centres in 148 countries worldwide. The program is operated on a non-profit basis so all moneys are invested back into the program. The Cisco Networking Academy Program is an e-learning model that delivers Web-based educational content, on-line testing, student performance tracking, and instructor training and support as well as hands-on labs.

The program is designed to create a reciprocal relationship between Cisco and the educational establishment at which the academy is hosted. The establishment implements, administers and runs the courses. Cisco provides the curriculum, learning materials, and networking technology to create the academy's networking lab. In addition, Cisco works with the institution to train the tutors on the latest networking technology they will be involved in, and in best practice for delivering these courses. The developers have created effective lesson plans and tools to support Cisco Networking Academy instructors. Through a holistic approach to curriculum development, the program unites the core competencies of the world's leading networking company with educational experts, faculty and student interns globally who continually review and evaluate the curriculum and validate testing methodologies.

Recently Cisco has been working with a number of key companies including Sun Microsystems, Hewlett Packard and Panduit to further develop educational programs for institutions using the e-learning environment that drives the Cisco Networking Academy Program. These curricula offerings all attempt to reduce the ICT skills shortage and to introduce relevant new skills into the current educational curricular, making skills more aligned to the demands of the Information Age.

Chapter 3 Teacher Training for the Information Age

Teachers have many roles and, depending on views of teaching, this could mean meeting curriculum objectives, telling students what to do, showing them how to do it, directing learning, supporting learning needs or nurturing students' curiosity. But their essential roles are talking to students and being learning facilitators. Michael Young[12] described teachers as educational companions who helped shape students' lives and accompanied them part of the way. As companions, teachers help students understand how they learn best: they help students to shape and make decisions about appropriate learning pathways, and with ICT they can choose whether students should be experiencing real or virtual experiences in different situations. Teachers select appropriate software or tasks to support the learning process between student and machine, helping them to ask the sort of questions to take them forward to the next stage.

There is a growing tension between demands for radical change in educational priorities and processes and the expectations for teachers, especially in the use of ICT in the teaching and learning process. Whether these priorities are determined locally or nationally, the teaching profession is having difficulty adapting to these priorities at a pace that is fast enough to support the radical changes demanded. Teachers are increasingly on the front line in implementing policies designed to reap educational benefits from investments in ICT. Innovations in the effectiveness of teacher recruitment, training and professional development have become key issues and will remain so.

Niki Davis and Penni Tearle[13] noted, "Many countries around the world are taking action to ensure that their educational systems are updated to permit equality of access and to ensure that the key ICT skills are developed in schools and other educational institutions… It has become abundantly clear that the training of teachers in ICT skills and appropriate pedagogical approaches is essential. "Preparing teachers is perceived as the main critical success factor in deploying ICT in education".

Most countries have now made ICT a priority for initial teacher training. In some countries, such as the United Kingdom and Sweden, it is legislated through the national curriculum for initial teacher training (UK) and by law (Sweden), whereas in others it is advised As a result teachers are emerging from training confident users of ICT, albeit some feel frustrated by the lack of opportunity to use ICT during school placements. Sometimes government policy has forged ahead with developments without allowing schools and teacher training establishments to be fully prepared. However it could be said that waiting for the infrastructure to be in place might have delayed progress and the UK government, for example, now prides itself in being a world leader in the deployment of ICT into schools. Much of teacher training has tended to focus more on learning about ICT, and some argue that the time has come to place the emphasis in teacher education courses on learning with ICT[14]. This means that trainee teachers will come to their courses competent users of ICT but will have little idea how to organise their teaching with ICT.

12 Michael Young founded of the UK Open University

13 Quoted in Weets, G. (Ed.). (1997) European Commission V Framework Programme: Information Society programme for technologies and skill acquisition. Proposal for a research agenda. Draft for large scale consulting. European Commission DG XIII-C, Brussels. <http://www.ecotec.com/sharedtetriss/interact/bul_5th2.html>

14 Pearson, J (2002) ICT and Teacher Education in Australia, Technology, Pedagogy and Education 1(1)

Finland is another country in which policy documents have guided developments in the training of teachers to use ICT for teaching and learning, and leading to the use of ICT for a learning society. Finland is well known for its rapid emergence as a leading technological country and there is now a tendency towards using ICT "more as a mind tool, moving towards more collaboration, interactivity and active learning, towards more integration ICT in curricula and a better technical and pedagogical infrastructure", according to Hannele Niemi in a special issue of the journal *Technology, Pedagogy and Education*[15].

Some countries have enjpoyed corporate sponsorship of teacher training, whereas in others funding has come from the government or from fund such as the National Lottery in the United Kingdom. In South Africa, Vodacom Foundation is establishing e-learning resource centres throughout the country to bridge the existing digital divide, by donating more than 1.5 million rand to the project in which 40 "master facilitators" will train teachers in the use of information and communication. The e-learning centres are part of an international collaboration, known as the Digital Partnership, of which South Africa is the site of the first pilot programme. The partnership, involving private, public and non-profit-sectors across the globe, has been established to support the acquisition of computer literacy and the development of access for learning, enterprise and social development in developing countries. In this programme is an initiative that will see redundant PCs from first world countries around the world come into South Africa for refurbishment and installation in selected schools. As in other countries access to ICT and trained teachers can provide a means with which to improve education, build skills, and contribute to the development of communities. It is not seen as solution to poverty but as a way of empowering those on the wrong side of the digital divide.

A novel in-service training programme for teachers was tested in Norway. The programme uses a combination of input, practice, reflection on practice and new input using problem-based-learning. Teachers are introduced to a teaching method with ICT; they experience this method for themselves first and then use it later in the classroom and develop their own experience. In a follow-up workshop, teachers work together with colleagues and mentors to reflect on their learning experiences. The increased confidence in using ICT in teaching, was thought to be due to the way the in-service teacher training course was tailored to the participants' needs and therefore acted as a positive enabling factor. Certainly research in other areas of professional development for teachers has highlighted the importance of opportunities to put new ideas into practice and then to reflect collectively on those ideas as a way of ensuring sustainable teacher development. The Raising Achievement in Mathematics Project in the United Kingdom was on example of this and details can be found in the report *Better Mathematics* published in 1986 by the UK Department for Education. The evaluators in this Norwegian project concluded that in addition to support from colleagues and institution leaders, personal, reinforcing and enabling factors must be considered when planning ICT-based in-service teacher training, with special emphasis on ensuring that teachers have a sense of ownership.
(See http://www.nsd.uib.no/skoleveven/poster_n.htm for more details.)

15 Niemi, H (2002) Towards a learning society in Finland - ICT in Teacher Education, Technology, Pedagogy and Education 1(1)

A survey undertaken in 2000 by the European SchoolNet (www.eun.org) highlighted teacher training in the use of ICT for teaching and learning as a major issue in primary and secondary schools across Europe. The report indicated that in the UK, although about 90 percent of the teachers received ICT related training during the last 2 years, only 65 percent of the teachers felt confident using ICT in the classroom. In Denmark only about 20 percent of all teachers in primary and lower secondary education have signed up for a pedagogical ICT driver's license. In teacher training colleges approximately 50 percent take this course. In Finland between 1996 and 1999, about 10,000 teachers took a five week in-service training program related to information society issues. Until 2004 50 percent of the teaching staff on all levels is expected to acquire good ICT skills. In Sweden a law passed in 1996 requires all newly educated teachers to have basic ICT skills, including use in teaching.

Some countries provide special equipment for teachers. In Luxembourg teachers are given home access to the National Network for Education and Research. In Sweden those who complete the special ICT training program receive a multimedia PC for use at home, and in the United Kingdom teachers can buy discounted laptop computers. In Germany AOL announced an initiative for free home access for teachers and reduced access for students. But although effort is being put into teacher training, the actual use of ICT in daily teaching remains an issue for the future - the use of ICT in teaching is not yet ubiquitous. Even in a country such as Finland, which has a good technological infrastructure and successful pilot projects in 1998, only half the teachers surveyed reported to use ICT for preparation of their lessons, and only about 20 percent used ICT in their daily teaching.

Strategies for teacher training should now have two goals, the prevention of skills obsolescence and keeping new and existing teachers abreast of emerging developments. What appears to be lacking in teacher training courses is ensuring that teachers understand the policy frameworks that underlie the use of ICT for teaching and e-learning and understand the range of assessment tools that use ICT.

UNESCO has published a portal for access to information about ICT and teacher training at http://www.unescobkk.org/ips/ict/ict.htm; this site links to numerous papers and resources to support teacher training in the use of ICT

Teacher training for higher education has less legislation and the demand for academics to have ICT skills arises more from research requirements, whereas the demand for innovative teaching with ICT is fuelled by the need for universities to become more efficient, to distinguish themselves from the growing competition from other universities, and to offer alternative routes into education for non-traditional students, including students studying at a distance, online and part-time.

Summary

Coherent and comprehensive strategies by Governments across Europe, the Middle East and Africa have no doubt played a significant role in developing the use of ICT in education in an attempt to drive up standards through the funding and provision of new technologies. What is now needed is more radical thinking about how these technologies can be used innovatively, how teachers should be trained to rethink their role and how educational structures can be made more adaptable to welcome and embrace the changes that need to be made in order to take full advantage of the potential of global access to information, knowledge and experts.

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