THE FUTURE OF LEARNING

Tony Bates
University of British Columbia
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Abstract

It is argued that the rapidly changing context of adult learning requires equally rapid and radical changes in teaching methods and methods of delivery, with profound implications for the organization of post-secondary institutions.

The multimedia presentation on which this paper is based gives examples of some of the new teaching strategies that are being developed which are moving in the directions needed. As the technologies converge, and as access to computers and high-speed networks increase, it will become increasingly possible to provide learners with any course, any time and anywhere they need it.

It is critical for government, employers and educational institutions to work towards this goal, because in an age where knowledge and information is the basis of economic growth, those societies that successfully harness information technologies to the learning process will become the economic leaders of the 21st century.

This paper is derived from a multimedia presentation that gives illustrative examples of the various teaching approaches described.

Alternative futures

In a speech to a Labour Party conference in London on October 17th, 1994, David Puttnam, the producer of 'Chariots of Fire' and previously head of one of Hollywood's largest film companies, is reported as saying (McLeod, 1994):

'Multinational media companies are creating education programmes which leapfrog over schools and appeal directly to children and their parents...one senior executive has predicted that educators would be paid more than film stars by the end of the century...but this international 'edutainment' material would be driven by baby commercial values...we risk losing out to a tidal wave of relatively low quality and certainly low cost material with just enough educational content to make it attractive to parents.'

There market analysts have targeted adult education and training as an even more lucrative market. Is there an alternative to Japanese and American-originated 'low quality edutainment'? Is this the educational equivalent of cheap textiles and cars? Does it matter if multinational media organizations turn education into a business,

and people buy their products?

While there are important roles to be played by private sector organizations in the education and training of adults, there are many reasons why a strong public sector presence is needed in adult education. However, in order to win and maintain public sector support, the public sector will need radical changes in its approach to teaching and learning. This will require a clear and shared vision of the future that we want, a determined and co-ordinated policy approach, and partnership between government, employers and labour, and the public sector institutions. This paper concentrates on a vision for learning in the future, and attempts to suggest some of the issues that need to be resolved in order to achieve such a vision.

Technology change

Within the next 10 years, we will see the following important technological developments so commonplace that they will be found in the majority of homes and businesses in Alberta:

- integration of computers, television, and telecommunications, through digitization/compression techniques
- reduced costs and more flexible uses/applications of telecommunications, through developments such as ISDN/fibre optics/cellular radio
- increased processing power, through new micro-chip development and advanced software techniques.

These developments, all available or currently under development, will result in a single, integrated entertainment/communications/learning 'box' in each home and business. This will provide a much wider range of applications than now available, such as television programmes and music, home shopping and banking, and education and training, all available on demand.

Multi-media, through the integration of high quality graphics, audio, video and text, and more powerful editing and authoring software, provides a major enhancement of computer-based learning. The costs of hardware and the cost of producing multi-media materials are also dropping rapidly. 'Stand-alone' computer-based learning will become even more powerful as artificial intelligence and virtual reality develop.

However, while 'stand-alone' applications of multi-media will continue to be important in education, a much more significant development is the application of high-speed multi-media networks for educational purposes. As well as the convergence of different media within a common computer platform, we are also seeing the convergence of the previously separate technologies and industries of computing, telecommunications and television. For instance, in April 1994, Stentor, an alliance of Canadian telephone companies, announced an $8 billion, 10 year initiative, called BEACON, that will bring broadband, multi-media services to 80%-90% of all homes and businesses in Canada by the year 2004.

The implications for education and training are immense. Learning can be independent of time and place, and available at all stages of a person's life. The learning context will be technologically rich. Learners will have access not only to a wide range of media, but also to a wide range of sources of education. However the speed and extent to which these new technologies are being developed and applied is both revolutionary and deeply

challenging to established educational institutions.

The need for vision

'If you don't know where you're going, any road will do'

The White Rabbit, in 'Alice in Wonderland' (Lewis Carrol)

The way educational technology is developing somewhat resembles the frenetic activities of the White Rabbit in 'Alice in Wonderland'; because it does not seem to know where it is going, any road will do. Educational technology applications though should be driven by our vision of education and training in the 21st century. It is necessary to develop a shared vision of what we want the education and training system to achieve. That vision should take into account the potential of technology, but not be driven solely by what is possible technologically; what it *can* do may not be what we *want* it to do.

The need for change

Those from the business sector are well aware of the global economic changes that are affecting our societies. One of these changes is the need for a much more highly skilled workforce to remain economically competitive and to sustain a prosperous society based on high wages (Porter, 1991). This is making the training of the existing work-force a high priority, and this training must be continued throughout a person's lifetime. Investment in training is or will become as essential for company survival as capital or plant investment (Reich, 1991).

It is hard to quantify the need for 'work-force' training, but assuming that a person will need to re-train at least five times in a working life-time, and that such re-training requires the equivalent of three months full-time learning (probably a gross underestimate), then the capacity of the current education and training market, public and private, needs to be doubled (Open Learning Agency, 1992).

This is because of increased demand from two sources. The first is from young people continuing into post-secondary education. This demand will continue to increase slightly in most developed countries (between 2% to 5% per annum for another 10 years at least) as more and more young people realise the importance of further education for their future prosperity. However, the major increase in demand will be from all of us in the work-force who need to continue learning if we are to stay employed, and if our employers are to remain economically competitive.

The requirements of this new market for learning are very different from those of the youngsters the system

has traditionally served. Much of the learning in the work-force market will be initiated by individuals as part and parcel of their working and leisure lives. It will be informal (i.e. not leading to any formal qualification), self-directed, and piece-meal (broken into small chunks of learning, some as small as a few minutes a day, to some several hours in length). It will be driven as much by short-term needs as by any conscious plan of study. Thus it will not be determined by some master instructor, but by the task at hand (Weimer, 1992).

To see just how prevalent this kind of learning is already, just ask yourself how you have learned to use a computer. How much of this was due to formal training, with an instructor, and how much was picked up piece-meal by trial and error, with a bad manual, and help from colleagues? This is not to say that the learning would not have been much more effective if it had been structured and directed all through by a skilled tutor, but what drives such learning is not the control of an instructor but the needs and the motivation of the learner.

Employers however cannot rely entirely on the self-motivation of their employees. This kind of learning, although widespread and surprisingly effective, is not efficient. Management consultants have identified that most companies use less than 10% of the capacity or capabilities of the computer technology in which they have invested. In blunt terms, most employees do not know how to use their machines properly. As companies increasingly look to higher skill levels from their employees, not just in computer skills, but in the broader skills of verbal and written communication, problem-solving and management, the employers themselves will need to take greater responsibility for making this kind of learning more effective, both to keep valued staff, and to increase productivity.

Traditionally, large companies have done this by establishing their own training centres and programmes; small and medium sized companies have relied more on 'out-sourcing' the training, to private training companies or to the public sector institutions. All of these methods however are labour-intensive, and any increase in such activities will lead to proportional increases in cost, at a time when companies need to be more cost competitive.

While employers will be faced with the need to keep their current work-force highly skilled and up-to-date in the field in which they are working, they will not be able to rely on the public sector to provide, free of charge, the training services they require, for several reasons. In many countries, the public sector institutions still concentrate mainly on pre-service education and training. Furthermore, governments in many developed countries are in serious financial difficulties; they have borrowed too much. Merely servicing the debt is taking away funds that otherwise could be used for public services such as education and training. At the same time, these governments have reached the limit of tax elasticity; the public is unwilling to increase the amount they pay in taxes. In other words, governments are expected to do more with less. Consequently, many public sector institutions are looking on private sector training as a cow to milk, rather than to feed.

Lastly, many employers and members of the public are growing increasingly critical about the quality of education being provided through the public sector. There seems to be a mis-match between the skills taught and the requirements of the labour market (British Columbia Labour Force Development Board, 1995).

In some ways, this is an unfair criticism, since educational attainment of students in public schools has increased over the last 20 years; the problem is that the demands on the work-force have increased at an even faster rate (Drouin, 1990). For instance, production line workers need greater literacy skills today to deal with

written instructions, manuals, etc.; they now need more than just an arm and a leg to operate the production machinery; they need intellectual skills as well. Similarly with greater emphasis on teamwork and worker involvement and motivation, the level of communication and social skills required from managers and supervisors has increased. While a great deal of attention is being paid to the gap between the skills of those entering the workplace and the needs of employers, less attention is being paid to the much wider gap between the skills of those already in the workforce and the demands of the work-place. For instance, the older the worker, the lower the functional literacy level in most developed countries.

Another area which needs more attention is the gap between the way educational services are provided, and the needs of employers and working people. Working people are unable or cannot afford to give up jobs or move house to become full-time or even part-time campus-based students again.

Jobs are changing

While Alberta, like BC, will remain dependent on its primary resource industries for its economic well-being, the sources of employment in the province are rapidly changing, due to increased mechanization, the need to diversify to 'value-added' secondary industry (e.g. furniture, paper), and the growth of new industries and services not directly dependent on the primary resource industries, such as communications, information technology, financial services and international trading.

Most of the new jobs are either in service industries, in companies employing less than 20 people, or require highly skilled specialists in the larger, resource-based industries, each 'new' employee often replacing many existing staff. Many of the new jobs are on a part-time or contract basis, with at least two-thirds of the new jobs going to women, and a majority of new jobs are relatively low-paid (Kunin, 1988). Nevertheless, nearly half the new jobs created require graduates or people with the equivalent of 17 years full-time education (CLMPC, 1989).

The traditional picture of work as a lifetime commitment to a particular trade or institution, with a secure pension at the end, applies to an increasingly smaller proportion of the population. In particular, secure middle management jobs of a general kind, requiring little or no professional or technical expertise, are disappearing rapidly. A very small proportion of the youngsters leaving school will find employment in the traditional resource-based industries as unskilled or semi-skilled workers; the majority of those already unemployed, and a good proportion of those already working in large companies or in primary-resource industries, need to be re-trained in the next few years.

The most significant development is that many of the new jobs will require a much higher level of skill than the jobs they are replacing, especially in management and resource based industries; people will retain existing jobs only if they are retrained to higher standards; even for the majority of new jobs that will be low-paid and require generally low skill levels, training or re-training will be necessary, especially in basic skills, just in order to keep the job.

With respect to the skills needed in the work-force, these have been well defined by the Conference Board of Canada (1991):

- good communication skills (reading/writing/speaking/listening)
- ability to learn independently
- social skills: ethics; positive attitudes; responsibility
- teamwork
- ability to adapt to changing circumstances
- thinking skills: problem-solving; critical/logical/numerical
- knowledge navigation: where to get/how to process information.

Learning in the 21st century

Modern learning theory sees learning as an individual quest for meaning and relevance. Once learning moves beyond the recall of facts, principles or correct procedures, and into the area of creativity, problem-solving, analysis, or evaluation (the very skills needed in the work-place in a knowledge-based economy), learners need inter-personal communication, the opportunity to question, challenge and discuss. Learning is as much a social as an individual activity. However, for someone working in a small company, the nearest person with similar interests and expertise may be somewhere on the other side of the country, particularly in leading-edge technologies.

Learners will interact with their desk-top or portable workstations in a variety of ways, determined by the nature of the learning task, and their preferred style of learning in the work situation. These preferred styles will vary considerably, both within a single person, depending on the task, and, for the same task, between different individuals.

The learning context will need to encompass the following:

- working alone, interacting with learning material (which may be available locally or remotely)
- working collaboratively (and in an equal relationship) with fellow workers at different remote sites, either synchronously or asynchronously: both these modes are likely to be multi-media
- as an 'apprentice' or 'student', working with a more experienced worker, supervisor, or instructor
- as an instructor, supervisor or more experienced colleague for other less experienced colleagues.

The same person may find themselves in each of these roles within a single working day. Learners will also need to be able to work from home, or from a work-site, or while in transit. They will need the following:

- access to information (searching, downloading) from multiple sources in multiple formats;
- selection, storage and re-ordering/re-creation of information;
- direct communication with instructors, colleagues, and other learners;
- incorporation of accessed/re-worked material into work documents;
- sharing and manipulation of information/documents/projects with others.

Learners will need to access, combine, create and transmit audio, video, text, and data as necessary. If we take this as the design requirement, there is then a need to build *systems* that support this form of learning, both for

formal and informal learning.

New models of teaching

A number of factors are leading many Canadian post-seconday institutions to experiment with new information technologies for teaching. There is pressure from governments for greater efficiency, requiring institutions to take more students, while at the same time reducing funding. Another influence is the use by governments of earmarked funds for innovation (funds often established by holding back a proportion of 'regular' funding).

Another factor is the increase in student fees, leading to more and more students becoming part-time, in order to work their way through university. For instance, almost half the students in the universities, and two-thirds of the college students, in British Columbia now are part-time. Also, the trend towards lifelong learning and the need for re-education and training for people already in the workforce is leading to a changing student population, with many more older students, working and with families, returning to post-secondary education (or in some cases never leaving it). These students need greater flexibility in the provision of learning, to fit it around their already busy and demanding lives.

It is not surprising then that many institutions are now turning almost in desperation to multimedia technologies as one possible solution to their increasingly pressing problems. It is from these often prototype developments that we will see some of the newer models of teaching and learning developing that will meet the needs of the changing adult learning market.

For instance, at the University of British Columbia, almost $4 million of its operating grant has been held back over the last two years by the government for an innovation fund for the university. The university has used approximately 50% of this for investment in technology infrastructure, such as fibre optic cabling across the campus, computer networks in buildings, computer labs, networked servers, and video-conferencing facilities, and the remaining 50% for technology applications. Almost all the application money has been used for projects (in each of the 12 faculties) using either World Wide Web or CD-ROM technologies.

This has lead to a great deal of innovation across the 50 or so projects that have been funded in this way, and some important lessons have also been learned. Also, some lessons learned in other contexts, such as the use of technology for distance education, have also proved just as relevant for on-campus use of technology. I will describe briefly some of the lessons learned and some principles to apply when creating multimedia courses and products.

Two-way video-conferencing, using either compressed or full motion television, has been the major new technology used for delivery in many universities and colleges across North America. One of the most technologically advanced systems of video-conferencing operates between the University of Calgary and the University of Alberta. Video-conferencing has been slow to take off at UBC, but this year one fourth year undergraduate plant sciences course has been delivered in this mode, interestingly with the teaching originating from a community college, the University College of the Fraser Valley, because there were insufficient students at UBC in this specialist area (temperate fruit management) to justify a local teacher. Because of the excellent teaching technique and careful advance preparation of the instructor (Tom Baumann),

this has been a very successful course. Video-conferencing has the advantage, from an instructor perspective, of not requiring a radically different approach from regular classroom instruction, and appears quick and easy to mount. However, unit costs are higher than regular classroom teaching, it does need considerably more preparation time, and students still need to be at a fixed place at a fixed time.

The biggest explosion in teaching technology in the last couple of years at UBC has been the World Wide Web (the Web), due to the development of relatively user-friendly hypercard technology such as Mosaic and Netscape. This enables "creators" of materials to store primarily text and graphics on "screens" that provide links to any other "screens" located anywhere on the Web. Thus by merely clicking on a highlighted or coloured section of text, a link can be made to another screen on another computer anywhere in the world.

The main use of the Web to date has been for accessing (and downloading) information. However, a number of institutions have started designing courses using Web technology. For instance, at UBC several courses were designed in 1995 using Web software and local servers for on-campus students. The first of UBC's distance education courses using Web software is in Continuing Studies, which began offering a course "Mastering Cyberspace", primarily aimed at people who want to use the Web for business purposes. In January 1996 UBC will deliver two Web-based credit courses to students off-campus.

Netscape software lends itself particulalrly to subject areas where there is a need for extensive colour illustration in still graphic form. Thus one of the most successful applications at UBC has been in Geology 202, where the combination of a structured approach to teaching with students able to access UBC-generated data-bases of graphics such as rock slides and rock formations, together with on-line access to other geology Web sites across the world, has considerably enhanced the flexibility of access for students.

At this stage there has been little evaluation of the use of the Web for the direct delivery of distance education courses. The UBC use is primarily that of information transmission, with some self-testing through multiple choice questions and in one case simulations. However, at the time of writing (November, 1995) Web software lacks the interactive flexibility of dedicated computer conferencing technology such as CoSy or First Class, although this will be available soon. Protocols also have to be established to ensure that only those who have paid their fees can access either the content or the interactive part of the course.

The main constraint of using the Web for direct teaching, once one goes off-campus, is the speed (or rather the slowness) at which pages can be accessed or downloaded. It is one thing to make material available on campus over high-speed networks and high-end modems; it is another to deliver a substantial amount of course materials over public telephone networks, through low-speed modems to the kind of computers that students are likely to have at home. We will be monitoring this aspect quite carefully. It may in many cases be better to provide the materials on a CD-ROM, with only up-dates being made available via the Web.

Computer-based multimedia

There has been a rapid development in recent years of computer-based learning, due to technological developments both in the computers themselves, through faster processing, greater storage capacity and 'embedded' software that enables the integration of graphics, sound and moving visuals from external sources, and in the development of 'peripheral' equipment, such as CD-ROM and video-discs. This has lead to the

development of computer-based multimedia materials (defined as textual data, sound, graphics and moving visuals integrated into a single computer platform).

Computers have for a long time been used for drill and practice. However, the combination of sound output, in the form of a digitized human voice and musical tones, recognition and analysis of human voice input, and feedback of results, has enabled the UBC Music department to apply off-the-shelf commercial software for the teaching of music. Students are asked to recognize either sheet music or tones generated by the computer and match that with their own singing input.

Off-the-shelf software, such as Supercard, can also be used for constructing teaching materials, making it much easier for instructors to develop materials for a particular context. There have been a wide number of projects at UBC in this area. Mark Broudo and colleagues in the Faculty of Medicine have developed teaching materials from scratch to assist students develop skills in the area of cardiovascular measurement, using animation, integrated full video and sound, and text, with multiple choice-type questions providing feedback. The material is structured in modules, with students able to access the material when they need it.

Brian Holl, a specialist in turf grass management at UBC, has developed a "virtual" office and laboratory to allow students to diagnose and treat turf disease. Students can click on a number of "tools" in the office and laboratory to access information. In addition, there is a virtual workbook that allows students to enter their own diagnoses and treatments, which is automatically transmitted to the instructor for checking. The interface also includes links to the WorldWideWeb, and e-mail and messaging capabilities.

One of the more exciting uses of multimedia is the development of expert systems that allow the user to test hypotheses and simulate different conditions and see the outcome. One such module developed by Dr. Hamish Kimmins at UBC allows users to test different approaches to forestry management. The module shows the relationship between different forestry practices in terms of revenue yield, sustainability, bio-diversity and the aesthetic features of the landscape, and shows the impact of a particular decision over the various time periods of five, ten and forty years.

The increased user-friendliness of multimedia development tools enables even the learners themselves to create their own instructional materials. Liz Hammond-Karreemaa, a college instructor at Malaspina College on Vancouver Island, has developed a multimedia package on killer whales, based on local wildlife resources, in such a way that learners can create their own reports from the materials she has assembled.

There are several lessons to be learned from these experiences. With the exception of the video-conferencing example, the construction of learning materials frees the instructor from the need for direct 'real-time' delivery of the teaching material. Once created it can be used any time, anywhere by the learners. The examples also progressively move away from using the technology just for information transmission. There is some simple feedback and testing of students, and some provide skills development, but some of the examples, particularly the turf grass and forestry management examples, go further and develop problem-solving techniques which students can practice. Brian Holl's and Liz Hammond-Kaarreemaa's approaches require students to develop research skills. Some of the examples also enable students to provide open-ended responses using natural language, and all provide learners with much greater control over their learning, but within a clearly defined and structured learning environment. Such approaches are particularly valuable for adult learners in the new

learning context.

New models

However, these examples by no means exhaust the range of new teaching models needed. These examples still reflect the early stages of a new paradigm for learning, rather like Max Sennett's Keystone Cops were merely a necessary step towards Jurassic Park.

UBC has not for instance moved yet into the area of on-line collaborative learning, using computer mediated communications such as listserves, computer conferencing systems such as FirstClass (used extensively at the Open Learning Agency in BC), or the Virtual University model, based on integrating new tools with Web software, being developed at Simon Fraser University. These models encourage learners to work together from different sites and asynchronously on common projects, to construct new knowledge.

One interesting use of the Web is the design of courses around material publicly available on the Web, where students are guided or encouraged to seek information through the Web, and incorporate it into assignments. Some courses at the Open Learning Agency in British Columbia are planning to use this strategy.

These technologies now enable us to consider new approaches to teaching and learning that meet the needs already defined. For instance, it is now possible to offer students truly international courses, with faculty and other students drawn from across the world. Millions of dollars are spent by many countries in sending students to Canadian universities and colleges for extensive periods. The technology now allows students to come for shorter periods and study the rest of the program at home. This will allow many more students to benefit from such international programs. The benefits to Canadians of being able to make contacts with and understand the business practices and culture of different countries, and the different perspectives brought to common problems, are obvious.

Thus one interesting use of the Web has been for networking post-graduate students in different specialist areas. For instance, the School of Architecture at UBC, together with Schools of Architecture at the University of Sydney in Australia, the University of Hong Kong, MIT, and several other universities around the world, have been using the Web to allow graduate students to present and critique each others' design projects.

Resource-based tutoring

Another model is aimed at students seeking accreditation within a particular subject area who already have a good foundation, but who are working towards a more advanced level of study and a personally relevant area of expertise. In this model, the learner is put in touch with a tutor with specialist expertise who can guide the learner to sources of information and pre-prepared multimedia learning materials relevant to their interests. In this model, the tutor helps the learner navigate remote databases, or institutional libraries, which contain the multimedia instructional materials needed by the learner, sets and evaluates relevant learning tasks such as project work, and puts the learner in contact with other learners and experts with similar interests. This model is not very different from learner-centred teaching practised in British primary schools, except that it operates at a distance via telecommunications.

Just-in-time training in the workplace

It is not difficult to build a convincing portrait of learning at the work-place. We can envisage a computer software designer or television animation artist, called Wayne, probably working from home, needing information on a certain technique or approach, or advice on how best to create a certain effect. From previous experience and contacts, or on the advice of a colleague, he has the name of someone half-way across the country (Sue). From his work-station, Wayne calls Sue, talks about the problem, and Sue loads up some software which she 'shares' with Wayne via the network. Wayne asks a few questions, tries a couple of things on-line while Sue watches and comments, then downloads the software. Sue and Wayne are both registered with an educational institution that has been set up to enable the exchange of commercially sensitive material for learning purposes. Wayne's work-station has automatically displayed the cost per minute of consulting Sue, and the cost of rights for downloading the software. However, Wayne was also able to give Sue some information, and this is charged back to Sue's account. Wayne now not only has the software he needs, but also can contact Sue (on a chargeable basis) any time he has a problem with the software. The learning context has been established. Note it is fragmented, on demand, and charged at cost.

Lastly, the whole question of delivery of learning has been implicit in the discussion of new models of teaching. Adults need flexibility. They have families, and work commitments around which they have to fit their learning. This means that learning should as far as possible be accessible at any time and at any place. This means making use of delivery to the home, to local learning centres, such as the Community Skills Centres being established in small towns in BC, in the workplace, and into other institutions.

One project with an innovative method of delivery in British Columbia is SkillPlan. This project was developed as a result of a partnership with construction industry unions. The unions found that their members, many of whom were doing contract work at different sites, and often had some spare time between jobs, were needing to up-grade their basic literacy, numeracy and communication skills. The Open Learning Agency identified a computer managed learning system developed by the Jostens Corporation in the USA that provided adult basic education courses aimed at adults who have not completed high school graduation. Workers who need to improve their reading and writing skills can 'drop in' at the Agency's local centres, and use the system when it suits them. The system keeps track of each individual's progress, and enables learners to carry on where they left off the last time they were able to drop in.

Many other new curriculum models can be suggested (see Bates, 1993, for instance). The challenge for educators and trainers in a world where information is multiplying so fast that even specialists in a particular field cannot keep pace is to ensure that learners have the learning skills and the preparation to go beyond accessing and navigating information to making sense of that information, and applying it in ways that are relevant to their lives and their work; in other words to move beyond information to knowledge. This means being able to construct new knowledge, by finding new ways to do things, based on knowledge already acquired, and to communicate that to others.

Many would argue that this is exactly what a traditional liberal arts education develops in learners. Employers on the other hand argue that workers are not coming to them with the necessary skills, and students should be trained to be more job specific (BC Labour Development Board, 1995). There is not necessarily a contradiction here. It can be seen from the examples given that good teaching approaches can develop both good generic skills and be applied at the same time.

However, it is important to note that problem-solving and decision-making approaches such as those found in the turf and forestry management examples depend on expert systems, in other words knowledge bases developed from research, which are then applied to a particular problem. Secondly, in a world where jobs change for most people every five years, it is extremely dangerous to train for just the skills large companies say are needed here and now. The new jobs are less and less with large industrial or resource-based companies, and much more with the small entrepreneur. These need skills that allow for adaptation to changing conditions, not narrowly focused skills that may become redundant in a few years.

What is required then is a teaching and learning environment that more closely integrates basic research, navigation and understanding of information, application of knowledge, and skills development.

The challenge for public institutions

Daryl Le Grew, the Vice-President (Academic) at Deakin University, Australia, has pointed out that many post-secondary institutions `are moving to recontruct their infrastructure, redesign policy and realign external relationships to gain comparative advantage in the Information Superhighway environment'. He argues (Le Grew, 1995) that there is a transformation taking place (a 'paradigm shift') in post-secondary education, characterized by the table:

Industrial society	to	**Information society**
technology peripheral	to	multimedia central
once-only education	to	lifelong learning
fixed curriculum	to	flexible/open curriculum
institutional focus	to	learner focus
self-contained	to	partnerships
local focus	to	global networking

In particular, he argues that the new technological environment 'opens access to study across sectoral, disciplinary and cultural boundaries', which 'will quickly erode traditional ideas of the *course* of study': selective access, sequenced and carefully integrated content, and level-based progress rules that are pre-determined by the institution. On the contrary, he argues, 'curricula will be increasingly dissassembled, modularized and customized to suit a wide range of clients requiring flexible delivery.....What constitutes a course will be increasingly negotiated between provider institutions, students and client groups.'

If he is correct, this will require some major changes in the organization of post-secondary institutions.

Who's in Charge? Managing Multimedia Projects

The most common procedure adopted by faculty when embarking on multimedia projects is to develop a proposal, usually around a particular technology or software (e.g. video-conferencing or Netscape). Once funding is received, faculty order equipment and software, and find some willing, interested and computer-skilled post-graduate student to help with the development of the computer-based material. This I call the Lone Ranger approach, with the post-grad as Tonto.

There have been several advantages in this approach. First, it has brought a lot of faculty into exploring the use of new technology who would not otherwise have done so. Secondly, by choosing a cheap and (apparently) easy approach, faculty are able to make the most of materials already prepared, such as lecture notes and student handouts, which are then converted into multimedia materials. Most important of all, faculty themselves retain control of the project, and learn, usually the hard way, that there is more to multimedia design than they had anticipated. In fact, the experience in general is that faculty become excited by the potential, underestimate the work and problems they eventually have to face, and finally recognize the need for more help.

Another approach, and one used extensively in the private sector, is to develop project teams to create multimedia materials. Thus, as well as faculty, there would be an instructional designer, who will help with choosing the most appropriate technologies, with structuring the material and defining the teaching strategies and learning activities to be deployed in the multimedia materials, recommend student assessment strategies, and design the piloting and evaluation of the product.

Secondly, it is important to construct a "screen" environment that allows the designers to maximize the learning features of high quality multimedia materials. This means designing an interface so that learners can interact in a variety of ways with the learning materials. This requires an interface designer to work with the subject expert and instructional designer. There is also need for someone with specialized multimedia graphics design skills to make screens look professional.

Someone is also needed who has the skills to obtain video and audio recordings, and the ability to edit and convert these recordings into digital format, for incorporation in the learning materials. And someone is needed who can develop a working script, integrate all these different elements into a well-edited and well-constructed final format, and who can choose appropriate software to facilitate the various production processes.

Lastly, each project will need a manager. The project manager sets up meetings, breaks up the design and development process into discrete stages with estimated amount of work and set deadlines for each piece of work, monitors work flow and deadlines, manages the budget, and works on delivery and student support. The project manager may also handle liaison with external contractors and publishers, and marketing activities.

The importance of teamwork

Some people will be able to combine more than one role. However, each role needs a high level of expertise. Teamwork, and a recognition by each member of the team of their own limitations, and the contribution that other members of the team can make, are critical to success.

Project management and a team of experienced specialists will initially seem like an expensive way to produce material, but in the end, it is almost always more cost-effective than just ploughing on with a multimedia project, and learning as one goes. In particular, it can reduce the time spent by faculty in mastering skills that they do not necessarily need, thus freeing them up for other activities. A good project team will also substantially reduce the time needed to complete the project, compared with a faculty member and a research student soldiering on alone. Lastly, if a higher quality product is produced, there are more possibilities of cost recovery from other applications than the original 'targeted' use.

Faculty often criticise multimedia development as too expensive or too demanding of faculty time. It is also very challenging, requiring faculty to try methods and technologies with which they are not familiar or comfortable. These are all valid concerns. Multimedia teaching will be more expensive, time-consuming and threatening if it is merely added on to all the other duties of faculty, within an organizational environment that has not been modified to support such activities. Just as automation required major changes in industrial manufacturing methods, so too is there a need to re-structure universities and colleges to enable the benefits of the new technologies to be realised.

Institutional change

Consequently, a number of issues need to be addressed. Most universities and colleges are aware of the need to put in a comprehensive technology infrastructure on campus. However, probably the most important step to be taken is to provide support to the people who will be most affected by technological innovation: faculty and students.

Human resource development

Bluntly, faculty need training, not just in how to use the technology, but more importantly, in understanding how learning takes place, and how to design teaching approaches based on that knowledge. Without this fundamental understanding of the teaching and learning process, it is almost impossible to design high quality multimedia learning experiences.

There are at least three practical steps management can take in this regard. The first is to organize regular workshops on teaching practice and the use of technology (which in some institutions will mean creating or strengthening faculty development departments). The second is to provide rewards, in terms of tenure and promotion criteria, for successful, innovative teaching. Thirdly, while workshops are important, there is a need for more comprehensive and systematic courses or programs aimed at teachers of higher education. These are minimum requirements. An even more radical step would be to require successful completion of a higher education teaching qualification for tenure appointments; unfortunately such courses, if they exist at all, are not available in a manner that makes it practical for most faculty, i.e. part-time and at a distance, even if faculty associations could be persuaded into accepting such a policy.

The convergence of on-campus and distance teaching

However, while such strategies are important, they do not necessarily provide any solution to faculty overload. This has to come from re-organizing the way that teaching is provided. One of the impacts of technological innovation on campuses is the convergence of on-campus and off-campus or distance teaching. Once materials are developed for on-campus students, they can, if designed with this in mind, be just as easily available to off-campus learners. Also, many more learners can access the same material, once it is created. Thus the use of technology can allow for more students to be accommodated for the same number of faculty, with scope for re-allocation of resources to free up faculty for the development of teaching materials.

Furthermore, is a student registered as full-time who opts to take most of the course from home a distance student or an on-campus student? Does it matter? The introduction of multimedia courses opens up questions about the relevance of residential and prior qualifications for entrance; if space is not a limitation, why restrict students who want access? What becomes clear is that once courses are created in ways that allow for open and flexible learning, accessible anywhere and at any time, careful consideration needs to be given as to who needs access to a campus, and for what reasons.

Student access to technology

There are though two large assumptions being made about the use of multimedia. The first is that students will have access to computers, Internet, CD-ROM players, etc.. Student access to computers is increasing, but there is also a need for a clear policy to help students access the necessary technology being used for teaching and learning. While many students now arriving in universities already have their own computers (about 40%), many do not. In any case, there is a need for common standards; multimedia materials require medium- or high-range personal computers and fast networks. These are often not available off-campus or in student's homes.

Again, there are several strategies that can be adopted. Institutions can negotiate leasing arrangements with suppliers, so students can pay a modest rental fee with the option for low-cost purchase at the end of the leasing period. A college can ensure there are ports on campus to allow students to plug in their own computers (much cheaper than providing computer labs). Capital funds for buildings (and car parks) can be re-allocated to support student's off-campus access to courses, thereby reducing the demand for campus facilities. Institutions can form consortia to block-buy long-distance Internet access throughout a province or state for students (the Open Learning Agency in British Columbia has recently negotiated such a deal, allowing students local call access to the Internet and OLA's services from most parts of the province). Governments may even install or buy leased network facilities for educational use, as in New Brunswick, Canada.

Comparative costs of multimedia and conventional education

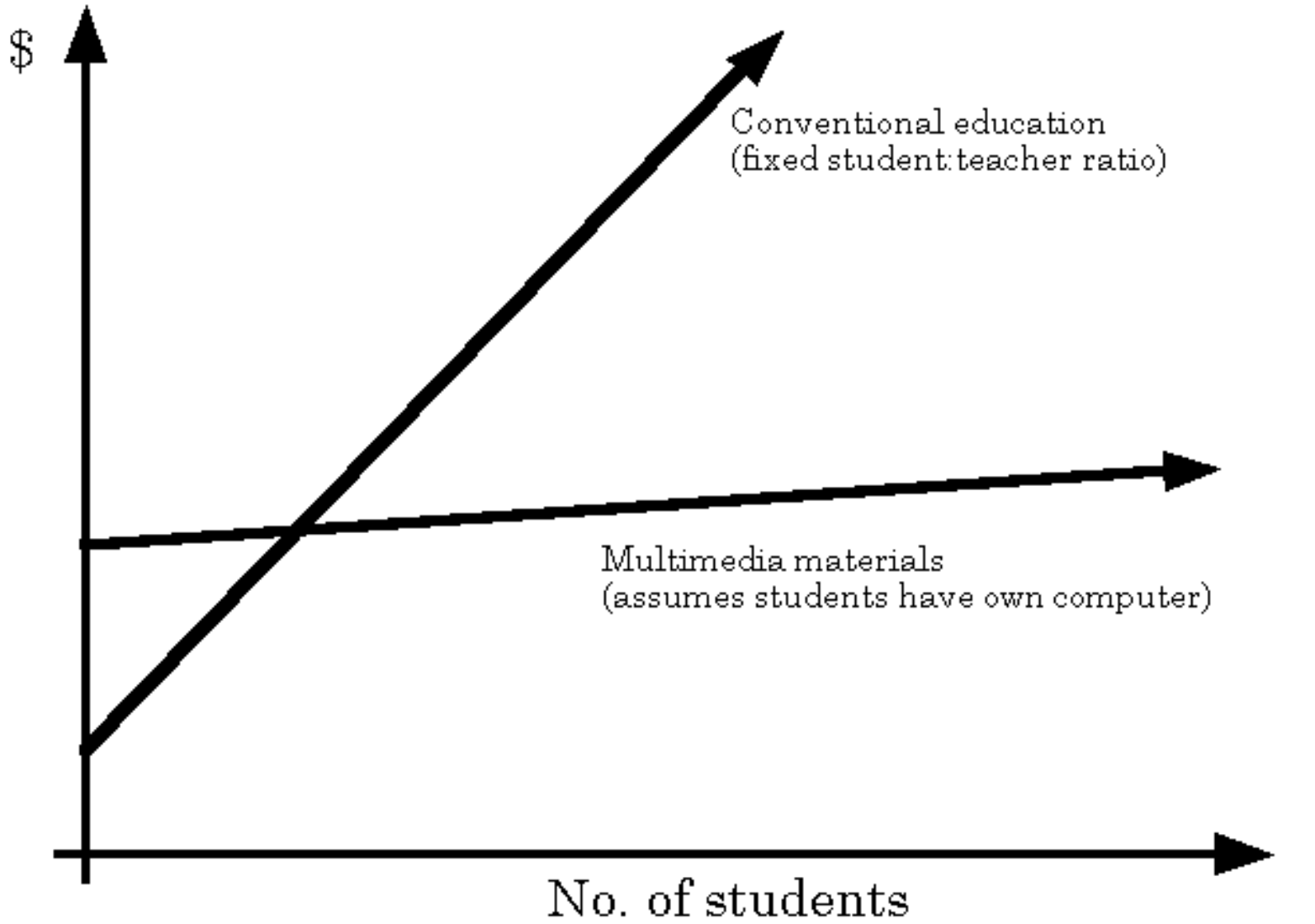
A more fundamental issue is the change in cost structures resulting from the development of multimedia courses. In the conventional higher education model, costs have tended to increase with student numbers, or quality drops. In other words, if the student/teacher ratio is kept constant, more teachers are needed. If more teachers are not recruited, class sizes increase, interaction with the teacher drops, and hence quality declines. We have seen over the past 10 years in many countries access to higher education being increased by

increasing the student/teacher ratio, or by the hiring of young Teaching Assistants scarcely more than a couple of years ahead of the students they are teaching.

However, the cost structures for pre-prepared multimedia materials are quite different. They cost a good deal of money up-front to create, but once created, they can be used by as many students as necessary with minimal increases in costs. This becomes even more pronounced when the life of the course materials are taken into account.

Original multimedia materials created from scratch have a higher 'starting' or fixed cost than classroom teaching, but after production, the only additional costs are the cost of making and distributing compact discs (assuming that students have their own computer and CD-ROM player). Classroom or lecture hall teaching however increases roughly in proportion to the number of students. In fact, costs increase in steps, depending on the assumption about maximum class or group size before the level of teacher/student interaction, and hence the quality of the teaching, is considered to drop. Thus as student numbers increase, extra sessions or classes have to be opened, and additional teachers or instructors found. Figure 1 shows the relationship between the costs of classroom teaching and the costs of pre-prepared multimedia.

Figure 1: Conventional classroom teaching vs. multimedia materials



No. of students

Most universities and colleges have absorbed extra numbers of students in recent years by either increasing class size, or by using more and more low-paid and inexperienced teaching assistants (or both); in other words, the quality of teaching has been reduced.

Quality comparisons between conventional and multimedia teaching

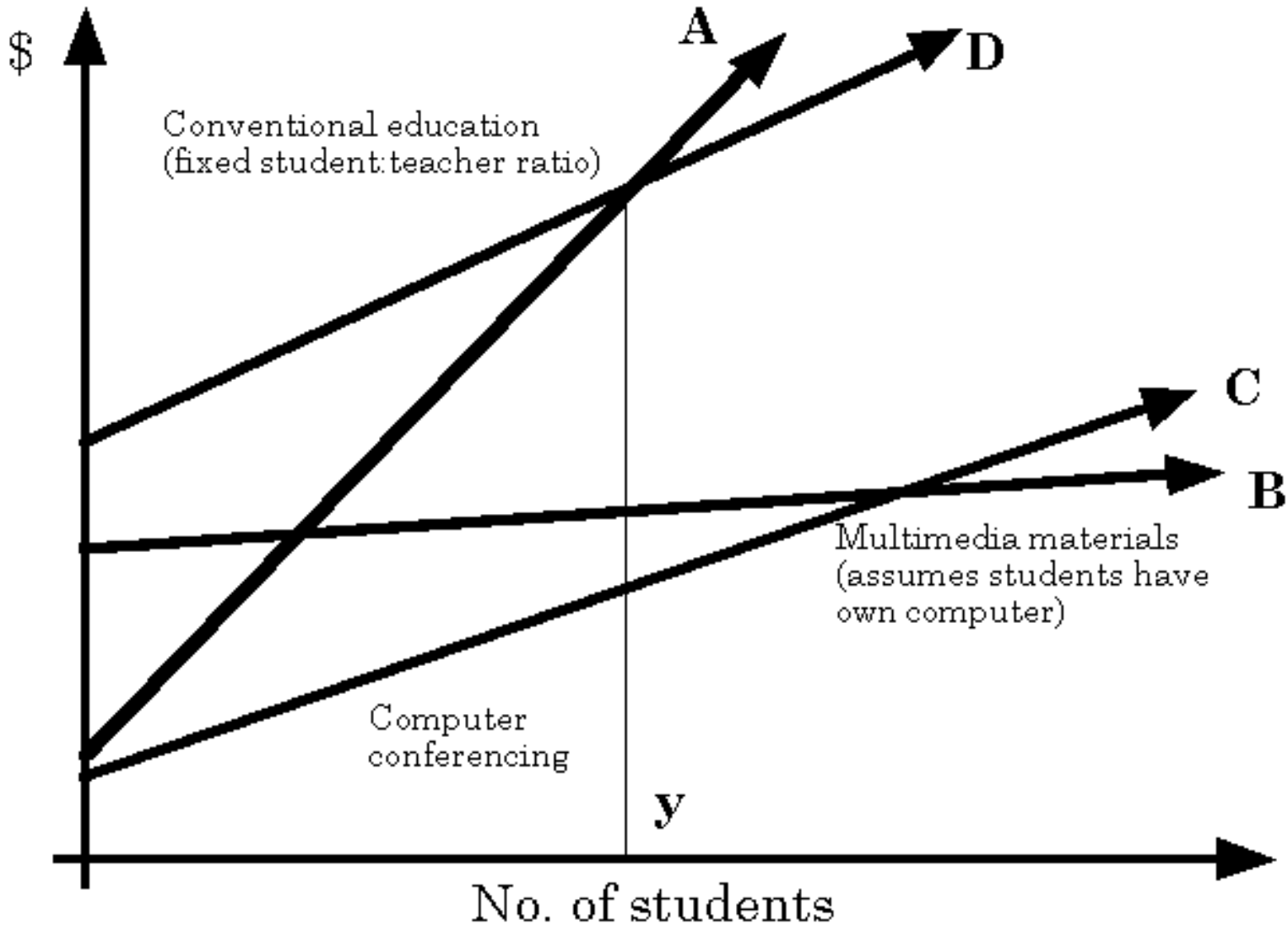
The second assumption is that the quality of interaction with pre-prepared multimedia materials is the same as between individual students and a teacher. This in fact is not the case. Well-designed multimedia materials can both present information and provide a large amount of the interaction and feedback previously provided by teachers. This frees up the time for the teacher then to concentrate just on those areas where person-to-person interaction is critical. However, computers are not smart enough to anticipate all the questions, misunderstandings, and more importantly, original and creative outputs that students can generate. Thus there is still the need for some form of provision, not only for student/teacher interaction, but even more importantly for interaction amongst students. This can be provided either in the traditional face-to-face small group seminars, or 'on-linei' and at a distance by using e-mail or computer,

Basically, with multimedia, the teaching falls into two parts: presentation and interrogation of information, some feedback, and some skills development through the use of interactive, pre-prepared multimedia materials; and counselling, student guidance, knowledge building, argument and creative thinking, hypothesis development and testing, inter-personal skills development, and group work through either on-line or face-to-face group contacts. The aim is to use the most valuable and costly resource - that of the teacher - more efficiently, by allowing teachers to concentrate their time with students on what they can do best, namely encouraging and responding to the great variety of contributions that students make to the learning process.

Comparing cost and quality

Figure 2 not only indicates the cost of providing on-line student/teacher and student/student interaction (via computer conferencing - arrow C), but the cumulative cost of multimedia materials plus computer conferencing (arrow D - see Bates, 1995, for a methodology for costing educational technologies).

Figure 2: Conventional classroom teaching vs. multimedia materials combined with computer conferencing



It can be seen in this model that for smaller numbers of students, conventional classroom teaching is likely to be less costly than multimedia and computer conferencing combined. However, as numbers increase the new media become increasingly more cost-effective.

The need for cost-benefit analysis

It must be stressed that this is a hypothetical model. There is a great lack of hard data on the actual costs, not only of the new media, but even of conventional teaching in post-secondary education. Thus we do not know (a) if the model will hold in real-life (b) even if it does, where the critical point 'y' is, i.e. the number of students where the new media become more cost-effective. What is needed is at least some cost-benefit analyses of the actual applications of these new technologies in post-secondary education. There is no guarantee that these new technologies will be more cost-effective. Nevertheless, it can be seen that, in theory at any rate, the new multimedia technologies offer the hope of maintaining or increasing the quality of teaching as student numbers increase, at relatively less cost than conventional classroom methods.

Conclusions

It is more than unfortunate that at a time when there is a need for major changes in the structure and operation of the post-secondary education system, governments across Canada are threatening reductions in resources. This is unfortunate for two reasons. Now is not the time to reduce activity in adult education. There is a major new market, those in the workforce, and students coming from high schools need new approaches too. Nor is there any clear evidence that the application of new technologies and methods of teaching will save money; indeed they are likely to cost more, and there is certainly a substantial cost of change. The second reason is that the threat of cuts is likely to lead to defensiveness and a retreat to 'the good old days'.

At the same time, many of the new activities in adult learning do not need to be directly funded by the state. People who are working and in good jobs, and employers who want to keep ahead of the competition, get direct benefits from re-education and re-training. We are likely to see then increasing entrepreneurship from the public sector, and increasing competition with the private training sector. Indeed, competition generally is likely to increase, as the provincial and national borders of education are powerless to stop educational offerings through electronic networks. For instance, there are four out-of-province MBAs available at a distance in BC already. The main threat though to the public sector institutions will come not from out-of-province universities and colleges, but the large multinational media organizations, who see adult learning as a major new business for them.

Lastly, it is easy to get hung up on the technology, which is exciting, challenging and not without major risks and hazards. However, technology is not the issue. There is more than enough technology available already for us to teach in more or less any way we like. The issue is the changing needs of adult leaners, and the need to find new ways of teaching and learning that will prepare them for the uncertainties of the 21st century.

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